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Editorial:
Special Issue – Journal of Electronic Systems and Programming

We are delighted to announce the publication of the first special issue that contains 10 selected papers from 4th International Conference on Technical Science.

One of the successful conferences in Libya is the International Conference on Technical Science. The conference aims primarily to establish the scientific research bases within academic institutions and research centers in Libya in particular and in neighboring countries in general, and to encourage researchers to present their scientific and research production.

Finally, we thank the conference preparatory committee for chosen JESP to publish the distinguished papers that presented on the conference.

Editorial Board

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CONFIRMATORY FACTOR ANALYSIS (CFA) APPROACH TO IDENTIFY CRITICAL SUCCESS FACTORS OF TECHNOLOGY TRANSFER MODEL FOR INFORMATION AND COMMUNICATION INDUSTRY

Confirmatory factor analysis (CFA) Approach to Identify Critical Success Factors of Technology Transfer model for Information and Communication Industry

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Abstract

This article propose a technology transfer(TT) model, that describes the TT process of importing the international advanced information and communication technology (ICT) by the Libyan ICT companies and their related SME's projects. The proposed model was based on a thorough literature review on a TT modelling studies and the variables, which extracted and modified from the past-investigated models are believed to influence the transfer process effectiveness. The classified factors and sub-factors are arranged in a conceptual ICT industry context. A questionnaire that conducted recently in the TT process in the Libyan ICT industry was utilized to verify the model.

Major statistical techniques are applied to analyze the collected data. These approaches included descriptive statistic and inferential statistics. The model factors and sub-factors are reformed by utilizing exploratory factor analysis (EFA). In addition, the significance of direct and indirect interrelationships between model factors was determined through confirmatory factor analysis (CFA).

Keywords: Modelling; International Technology Transfer (ITT); Information and Communication Technology companies (ICT)

1. Introduction

The technology transfer (TT) process from developed to developing countries has a paramount importance to growing countries for it being important a key factor to getting the advanced technologies that necessary for the economic development. Several researchers in different industrial areas have investigated International TT process. They were recognized that the ITT process is a multifaceted process and influenced by several factors. A surveyed literature on relevant ITT models reveals that none of these researches was consecrated to studying the TT process in the area of ICT-based SME's projects. In addition, these considered models had an unclear assertion to the interactions between TT process enablers and outcome factors in the ICT industry context.

This study suggests a model that describes the TT process of importing the foreign advanced technology by ICT companies and ICT-based SME's projects in Libya. The ICT industry in Libya is dependent on foreign technology transferred into the country by foreign ICT companies. In this study, the TT processes were defined as some form of ICT equipment, materials, or knowledge is transferred from a foreign party (organization) to another local party

(Libyan organization). The ITT developed model was specifically designed to be applied to the study of TT from developed countries to the Libyan ICT industry.

We believe in the importance and the uniqueness of the Libyan ICT industry TT processes and this ITT process has not been investigated before. The model, shown in Figure 1 was based on a methodical literature review on a TT processes. The variables, which extracted and modified from these past-investigated studies are classified as in a conceptual ICT industry context model. The model factors and sub-factors are regrouped by utilizing Exploratory Factor Analysis (EFA).To investigate and confirm the model's factor and sub-factors interrelationships, confirmatory factor analysis (CFA) were implemented. The developed TT model presented herein illustrates the influences of TT enablers on the outcome factor. These ITT process influential factors are identified as TT government support initiatives, transferor characteristics, transferee characteristics, TT environment, learning centres and their respective sub-factors (variables). The outcome (achievements) factors are identified and explained through their relevant sub-factors (variables).

2. Literature Review

A brief literature on relevant TT models is presented here to extract and classify the most influential TT factors.

Lin and Berg [1] primarily explore the major factors that affect the performance of an ITT process. This model categorizes three groups of identified factors: the nature of the technology, previous international experience, and cultural difference between the technology provider and receiver. Meanwhile Malik [2] in his study investigates the complex issues involved in the effective management of intra-firm TT within a multinational company (MNC)

environment. The two-stage model was developed by Wang et al [3] to describe the knowledge transfer process from MNCs to their subsidiaries. This study is concerned with the transfer of both management and technical knowledge. Steenhuis and Bruijn [4] model emphasizes that the two individual companies (transferor and transferee) need to be balanced with each other for an efficient transfer. Thai construction projects were the mean concern of Waroonkun and Stewart [5] model as it consists of four process enablers: government influence, transferee characteristics, transferor characteristics, and relationship building. It also involves one outcome factor TT value added. Mohamed et al. [6] categorized the influential factors into enabling and TT outcome factors. This model is especially significant for publicly funded petroleum infrastructure. Lastly Khabiri et al. [7] identifies the main influential elements in the TT process when an SME wants to acquire a foreign technology.

3. ICT International Technology Transfer Model

The model shown in figure 1 defines the significant factors that influence the effectiveness of the ITT process and results (achievements). These relevant factors are modified from the examined literature on TT phenomenon and technology adoption. The model presents the four identified factors and how they impact on the TT process factor, and the outcome factor. The model factors and sub-factors are listed in Table 1.

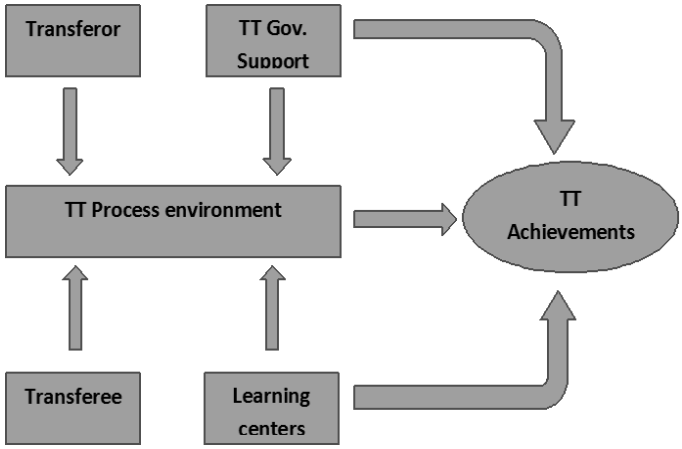

Figure 1: ICT International Technology Transfer Model

Government policy sub-factor was concerned with the degree to which the government's policies and enforcement practices encourage TT to occur. While the learning centres are obviously an important and influential factor in the TT to the developing countries; this factor related to host country-learning capability. The transferor's characteristic factor is concerned with the transferor's readiness and ability to provide the appropriate technology to the recipient, and transferor's previous experience level in ITT process. On the other hand, the transferee characteristics factor is a significant factor that affects ITT process, among the recipient characteristics that have been identified by literature to influence TT, are absorptive capacity, prior knowledge and experience, learning intent, and technological ability.

The TT process (TT environment) factor explores the effect of technology characteristics, transfer mode and the relationships between transferor and transferee. The management of TT program and the role of the agent middleman in the TT process are also investigated.

In this study, the performance of and interrelationship between, the above-mentioned TT factors contributes to the achievements to the host ICT sector. The model defines four main areas (sub-factors) where potential benefits may be derived from international TT initiatives: economic development, project (firm) performance, knowledge and technological capability improvement, and development and survive of ICT technology SME's. The model output factor (TT achievement) is explained through 4 sub-factors and these 4 sub-factors were detailed into several items as shown in Table 2.

Table-1: The model identified factors and sub- factors

Code	Factor	Sub Factor
A2.	TT government support initiatives	
A2.1		Government policy that governing the ICT industry.
A2.2		Availability of adequate infrastructure.
A2.3		Government Support.
4A2.		Parent companies encouragement to the skilled workers and entrepreneurs
A2.5		ICT Parent companies supporting to ICT SMEs.
B2	Learning centers and ICT entrepreneurs Learning Capability	
B2.1		The educational systems, training programs, and R&D centers.
B2.2		ICT entrepreneurial training and development.
B2.3		ICT Technology based incubator.
B2.4		Involvement of ICT industry in university programs.
C 2	Transferor’s characteristic	
C2.1		Transferor's willingness to implement TT initiatives and cooperate with local workers.

C2.2		Transferor's knowledge base and skills.
C2.3		Transferor's ability to transfer technology.
C2.4		Transferor's degree of previous international experience.
D2	Transferee's characteristic	
D2.1		Technology absorption capabilities of the recipient firms.
D2.2		The transferee's degree of experience in ITT process.
D2.3		The shortage of a skilled/expert workforce with the recipient company.
D2.4		The transferee's motivation to learn new technologies.
E2	TT process. (TT environment)	
E2.1		Complexity level of the technology to be transferred.
E2.2		The mode of technology transfer.
E2.3		The formally planned and well-managed TT agreements.
E2.4		The relationship between the transferor and transferee
E2.5		The cultural traits of the both parties.
E2.6		The entrepreneurial agent middleman.

Table-2: The model output factor (TT achievement) and its related sub-factors and items.

Code	Factor	Sub Factor
A4	**Economic development**	
A4.1		**Host country industrialization and economic development.**
A4.2		**Local ICT firm's competitiveness in national markets.**
A4.3		**The financial performance of local ICT firms.**
A4.4		**Utilization of Libyan natural and human**

		resources.
A4.5		**Diversification into new products or markets.**
B4	**Project (firm) performance**	
B4.1		**Libyan ICT industry overall long term performance.**
B4.2		**Efficiency, services cost and service quality of the host project.**
B4.3		**Quality standards in Libyan ICT firms.**
B4.4		**Mastering the new technology, by the Libyan ICT firms.**
B4.5		**Functional performance of the products, products cost and quality.**
C4	**knowledge and technological capability improvement**	
C4.1		**The ICT local firm's technological capabilities and skills base.**
C4.2		**The recipient's ability to operate, learn, acquire, absorb and apply new external technologies and knowledge**
C4.3		**Local workers' development.**
C4.4		**Libyan ICT sector working practices over the long term.**
D4	**development and survive of ICT technology SME's**	
D4.1		**Develop and surviving of ICT SMEs.**
D4.2		**Reducing cost of production, maintain consistency in quality, improve productivity for ICT SMEs.**
D4.3		**The ability to employ a significant amount of the labor.**
D4.4		**Mastering a new process techniques by ICT based SMEs, and improve its marketing and management procedures**
D4.5		**The emergence of ICT entrepreneurs and skilled workers in a small-scale enterprise.**
D4.6		**Increasing technological capabilities and capacities for ICT SMEs.**

4. Data analysis and results discussion

A. Data screening

The received questionnaires were checked against missing data, vital missing information that determines the inclusion or exclusion of certain questionnaires is the response towards the participation in TT process with international partners. In addition, responses are excluded based on the sampling criteria guidelines. Accordingly, among the 162 received answers, 11responses were excluded due to that do not adhere with mentioned specified sampling criteria.

B. Respondent Profile

Gathering the personal characteristics of the respondents was essential to develop a good understanding of their perspective on the TT process and their field of specialization. The evaluation of the position held by respondents was necessary to confirm the validity and reliability of responses. Determining the experience of process participants was decisive for ensuring the validity of results. The greater the experience of the respondent in the ICT industry means a greater understanding of process performance and influences. Respondents were requested to detail their qualifications in order to confirm they are qualified enough to develop an informed perspective on the ITT process. The aim was to develop a greater understanding of the respondent's exposure to ITT and their experience in the local ICT industry sector.

The respondent profile showed that; According to the position of the respondents the majority were engineers with a (41.1%); followed by the technician (17.9%); administrative officer (9.9%); academic staff (6.6%). The highest frequency of respondents had a bachelor degree (48.3%) while the Diploma holders come with (28.5%) and Master holders percentage (18.5%) followed by the doctorate (4%). statistics

shows that the respondents have various working experience ranging from less than 5 years to more than 20 years. The respondents with experience of 6 to 10 years got the highest frequency (39.1%).

C. Exploratory factor analysis EFA

The EFA analysis showed that all factors and sub-factors in the model satisfy the condition of univariate normality, as all the sub-factors has skewness and kurtosis fall within the recommended range to indicate normality, as a rule of thumb says that, a variable is reasonably close to normal if its skewness and kurtosis have values between -1.0 and +1.0. Furthermore, to ensure the adequacy of sample size, the associated KMO test was examined. Kaiser [8], recommended the value of KMO to be above 0.5 and Bartlett's Test of Sphericity to be significant (P-value <0.05), to make the statistical inference that there is factorability. The initial inspection of the single factor solution has resulted in poor total variance explained. Therefore, there was a need to improve the statistical figures. Such improvement is achieved through removing sub-factors with low loading. The inspection of factor loadings, suggested the removal of sub-factors, D2.3, E2.4 and E2.6 from Transferee's characteristic and TT environment factors respectively, as they were having the lowest factor loadings. With such removal, the assumption of EFA was revisited. Table-3 summarizes the results.

Table-3: Varimax rotated factor loading

Factor	Items	Loading
TT government support initiatives		
KMO= 0.767	A2.1	.628
P value (Sig. = 0.000)	A2.2	.695
Viaernce explained =55.279	A2.3	.689
Cornabach alpha = 0.794	A2.4	.848
Eigen value = 2.764	A2.5	.833
Learning centres		

KMO= .775 P value (Sig. = 0.000) Viaernce explained =71.655 Cornabach alpha = .862 Eigen value = 2.866	B2.1 B2.2 B2.3 B2.4	.874 .877 .897 .727
Transferor's characteristics KMO= .731 P value (Sig. = 0.000) Viaernce explained =51.950 Cornabach alpha = .691 Eigen value = 2.078	C2.1 C2.2 C2.3 C2.4	.700 .716 .721 .746
Transferee's characteristic KMO= .597 P value (Sig. = 0.000) Viaernce explained =56.711 Cornabach alpha = .611 Eigen value = 1.701	D2.1 D2.2 D2.4	.752 .669 .830
TT process. (TT environment) KMO= .737 P value (Sig. = 0.000) Viaernce explained =53.238 Cornabach alpha = .698 Eigen value = 2.130	E2.1 E2.2 E2.3 E2.5	.765 .796 .663 .686

For the endogenous factor TT achievements, all sub-factors from A4.1 until D4.6 showed adequate univariate normality. The univariate normality was judged based on the corresponding values of skewness and kurtosis. As shown in Table 4, the KMO test has the value of 0.935, which indicates that the sample size is adequate to perform EFA according to Hair et al. [9] On the other hand, the total variance explained was lower than the minimum acceptable per cent, this necessitates removing some sub-factors in order to improve the total variance explained. Several sub-factors with lowest factor loadings were detected and they were removed, such sub-factors are A4.2, A4.5, B4.2, C4.1, C4.2, C4.3, D4.2, and D4.5. This left the

achievement to present with 3 sub-factors, and 12 items only Table 5. The Rotated Component Matrix generate 3 component with 12 items with an appropriate total explained variance of 27.513, 19.640, and 16.501 percent respectively. Moreover, all the retained items have factor loadings that exceed the recommended value of 0.5, and they are ranging from 0.602 until 0.796. The reliability test shows that the factor has a reliability of 0.953.

Table-4: Varimax rotated factor loading for TT Achievements factor solution

Factor	Sub-Factors	Items	Loading
(TTA) TT Achievements KMO= 0.935 P value (Sig. = 0.000) Cornabach alpha = .953	(TTA1) Firm Performance and Technological Capability Viaernce explained =27.513 Eigen value = 10.640	B4.1 B4.3 B4.4 B4.5 C4.4 D4.1	.724 .785 .656 .749 .698 .694
	(TTA2) Development and Survive of ICT based SME's Viaernce explained =19.642 Eigen value = 1.077	D4.3 D4.4 D4.6	.796 .773 .669
	(TTA3) Economic Development Viaernce explained =16.501 Eigen value = 1.015	A4.1 A4.3 A4.4	.602 .723 .728

D. Confirmatory Factor analysis (CFA)

As reported by Schumaker and Lomax [10], CFA is used to determine the adequacy of the measurement model. Confirmatory Factor Analysis is to validate the relationship between observed and unobserved variables [11].

Figure 2 illustrates the pooled measurement model in AMOS Graphic. The output of CFA illustrates the factor loading for every item, every component, and the correlation between the constructs.

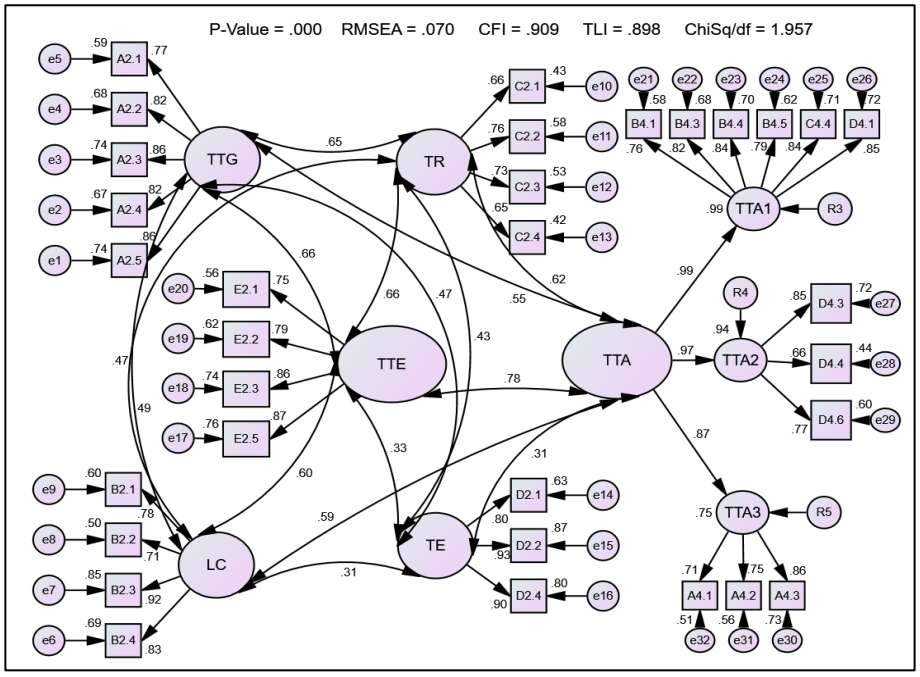

Figure 2: The Pooled CFA for measurement model of all latent constructs

The model consists of six main constructs (TTA second-order with three sub-constructs). There are five exogenous constructs contributes to TT achievements endogenous construct namely TT government support initiatives (TTG), Learning Centres and ICT entrepreneurs learning capability (LC), Transferor's characteristic (TR), Transferee's characteristic (TE), and TT environment (TTE) and three

sub-constructs measuring TTA Performance namely firm performance and technological capability improvements (TTA1), development and survive of ICT technology SME's (TTA2), and economic development (TTA3).

E. Assessing the validity and reliability for a measurement model

To validate the measurement model for Uni-dimensionality, Validity, and Reliability, the study decided to employ the Pooled-CFA whereby the measurement models for all constructs are assessed together at once [12].

The model shows adequate factor loading and hence the uni-dimensionality has been achieved. Generally, there are three types of validity that are required for a measurement model, for instance, Convergent Validity, Construct Validity and Discriminant Validity [12]. Convergent Validity is achieved when the value of Average Variance Extracted is greater or equal to 0.5 [13] This was clearly satisfied as shown in Table 9. In order to achieve construct validity, several fitness indexes must be achieved to the required level. The indexes shown in figure 2 namely, RMSEA, CFI, TLI, and Chisq/df show the fitness indexes for the measurement model achieved the required fitness level.

F. Model Reliability

While, in assessing the reliability, of the measurement model, there are three assessments need to be assessed, Internal Reliability, Construct Reliability and Average Variance Extracted.

Table 6 presented the result of CFA procedure namely the Composite Reliability (CR) and the Average Variance Extracted (AVE) for all latent construct. The Composite Reliability (CR) is used to measure the reliability and internal consistency for a latent construct. The CR

value greater 0.60 is required in order to achieve composite reliability for a construct. The Average Variance Extracted (AVE) is measuring the average percentage of variation as explained by the measuring items for a construct. The AVE values exceed 0.5 is required. As a summary, all constructs in this study have fulfilled the internal consistency and the composite reliability criteria.

Table-4: The CFA report for CR and AVE for all latent constructs

Construct	CR (above 0.6)	AVE (above 0.5)
TTA	.986	.960
TTA1	.923	.668
TTA2	.806	.583
TTA3	.798	.569
TR	.754	.506
TTG	.915	.683
LC	.886	.662
TTE	.890	.671
TE	.910	.772

The measurement model has achieved the required validity and reliability levels as well as uni-dimensionality and the normality distribution of the data were satisfied

5. Conclusion

The ICT international technology transfer model was developed and the affecting factors and sub factors were explored and defined. The developed model was empirically tested in Libyan ICT industry, a questionnaire survey was carried out on the sample targeting ICT companies' employees who have involved in TT processes. The Statistical Package for the Social Sciences (SPSS 21) software was implemented to analyze the receiving data. The outcome of this

analysis is the confirmed model for international TT in ICT projects, which includes a number of refined enabling and achievements variables. Among five enablers (factors) and their 23 sub factors, the analysis retains only 20 and ignores 3 sub factors. The (EFA) grouped the following factors (enablers) in the developed model: TT government support initiatives, transferor characteristics, transferee characteristics, TT environment, learning centers, and their respective sub-factors (variables). On the other hand, the outcome (achievements) construct has resulted with only 3 sub factors and 12 items.

Utilizing EFA, CFA, a five-factor model was developed. The developed ITT model was a confirmed and validated utilizing CFA. AMOS Graphic illustrates the pooled measurement model with the all-necessary and required indices.

Acknowledgement

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2

Extracting Geographic 3D Integral Images Data from Raster Maps

Extracting Geographic 3D Integral Images Data from Raster Maps

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Abstract

Holoscopic 3D imaging (H3D) technology also known as integral imaging is a true 3D imaging technology. It offers the simplest form that is capable of recording and replaying the true light field 3D scene in the form of a planar intensity distribution, by employing Microlens array. Despite it uses the same characteristics of holographic, it records the 3D information in 2D form and display in full 3D with optical component, without the need of coherent light source and confine dark fine. In addition, it facilitates postproduction processing such as refocusing. This makes it more practical approach for real-time 3D image capture and display. In this paper, a new method of extract 3D integral images data from raster maps. The *R2V* is an advanced raster to vector conversion software system is mainly used in order to generate geographical 3D integral images. Experimental results are extremely satisfactory and for the first time it is proved that, Geographic 3D Integral Images is generated. It means that, a new certain approach enables GIS applications of using 3D integral images is now established.

Keywords: Computer graphics; Geographic 3D integral image; Multiprocessor ray tracing system; Raster Maps; GIS

1. Introduction

In addition to the research work, a commercial product called R2V from Able Software is an automated raster-to-vector conversion software package specialized for digitizing raster maps [1][2]. Exploiting the previous work on generating 3D integral images [9-22] and utilize from raster maps. The method is based on a 3D integral imaging multiprocessor ray tracer [11] containing 3D integral imaging parser, 3D unidirectional camera model, and R2V.

2. Integral Imaging

Is a technique that is capable of creating and encoding a true volume spatial optical model of the object scene in the form of a planar intensity distribution by using unique optical components. It is akin to holography in that 3D information is recorded on a 2D medium and can be replayed as a full 3D optical model. However, in contrast to holography, coherent light sources are not required for integral imaging. This conveniently allows more conventional live capture and display procedures to be adopted.

All integral imaging can be traced from the work of Gabriel Lippmann [3], where a micro-lens sheet was used to record the optical model of an object scene. The micro-lens sheet was made up of many micro-lenses having the same parameters and the same focal plane. In the arrangement, the recording film is placed at the focal plane of the micro-lens sheet, as illustrate in Figure 1. Following the film development, a full natural colour scene with continuous parallax can be replayed using another micro-lens sheet with appropriate parameters. The replayed image is spatially inverted as shown in Figure2

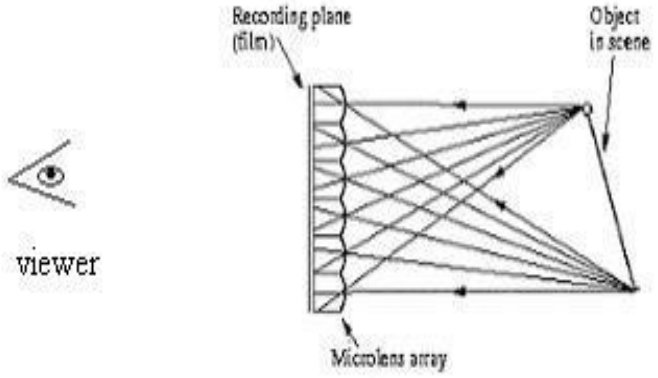


Figure 1: The recording of an integral image [3-8].

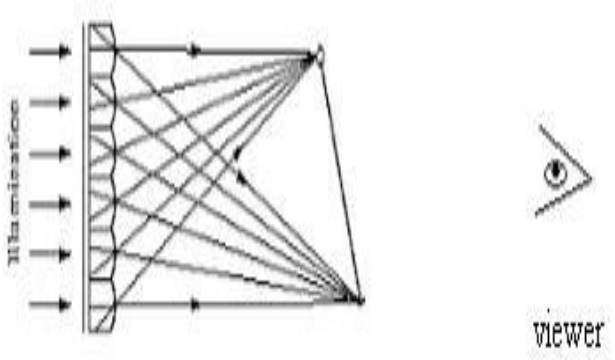


Figure 2: The replay of an integral image (The viewer perceives a spatial inverted 3D scene)[3-6].

To overcome the problem imposed by the pseudoscopic (spatially inverted) nature of the integral image, a modification to the Lippmann system was proposed by Ives 1931, in which a second recording process is introduced before replaying, as shown in Figure 3. When the second-stage photograph is replayed, a 3D image with correct spatial depth (orthoscopic) can be observed, see Figure 4.

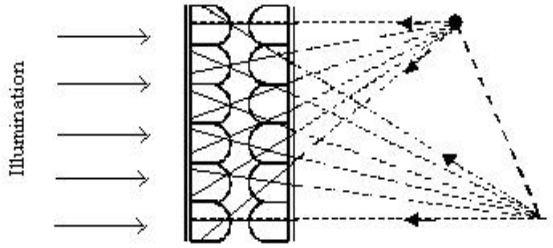


Figure 3: A second stage recording of integral photograph [3-6].

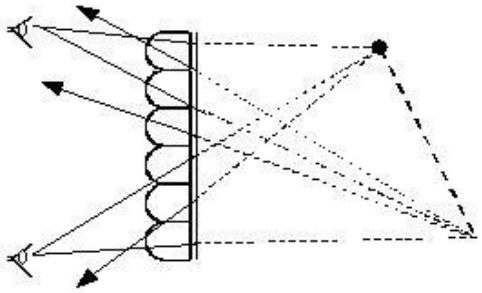


Figure 4: Replay and viewing of the orthoscopic image scene[3-8].

The two-stage recording process can produce an orthoscopic 3D scene with corrected spatial position. However, substantial image quality degradation is introduced due to the distortions introduced by the micro-lenses and film emulsion, stray light, etc. To overcome this problem, a two-tier network as a combination of macro-lens arrays and micro-lens arrays was reported by Davies and McCormick [4-8]. The two-tier network works as an optical "transmission inversion screen" which overcomes the image degradation caused by the two-stage recording process and allows direct spatially correct 3-D image capture for orthoscopic replay. Theoretically, this network is able to capture object space from 0.3m to infinity. In consequence, the integral photographic technique pioneered by Lippmann has been improved. With recent progress in micro-lens manufacturing techniques, integral imaging is becoming practical and prospective 3D display technology and hence is attracting much interest.

3. An advanced Integral Imaging System

The optics of an advanced form of integral imaging system, that is employing a two-tier optical network was developed and has been described in detail [4-8]. The optical arrangement, shown in figure 5, comprises two macro-lens arrays placed equidistantly behind and in front of an auto-collimating transmission screen (ATS). The ATS is made up of two microlens arrays separated by their joint focal distance. The recording plane is a photographic plate whose position coincides with the focal plane of another microlens array.

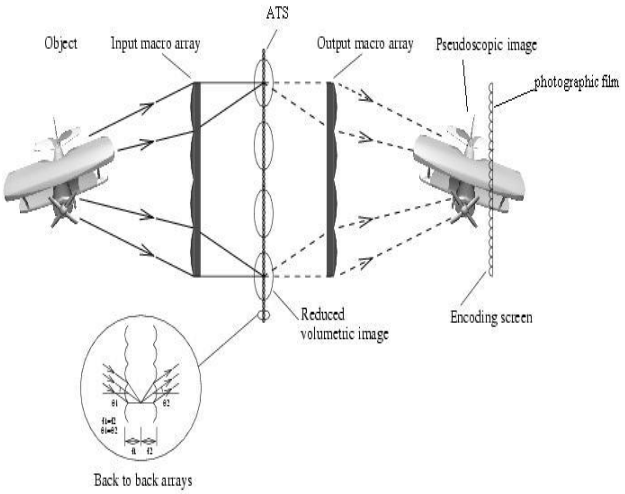


Figure 5: The advanced integral imaging system [3-6]

The optical transmission process of the advanced optical system is illustrated in Figure 6. The input macro-lens array first transmits the compressed object space to or near the central double micro-lens screen (ATS). The screen inverts the spatial sense of each intermediary image and simultaneously presents these spatially reversed 3D optical models to the corresponding output macro-lenses. The output macro-lenses array then re-transposes the optical model to the correct spatial location. The final integrated optical model before

recording, formed by the second macro-lens array, is a true 3D optical 1:1 reconstruction of the original object.

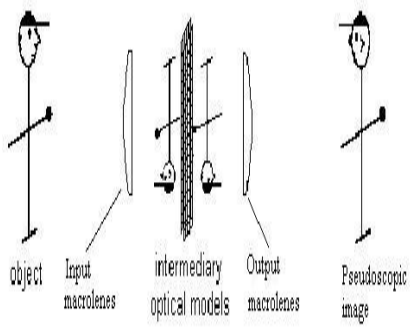


Figure 6: The optical transmission within the advanced integral imaging system [3-8]

The II is recorded on a film using a microlens array put after the two-tier optical network. Each microlens of the recording array samples a fractional part of the pseudoscopic scene, many micro lenses record directional information of the scene from different viewing angles. Therefore, parallax information for any particular point is spread over the recording plane. The angular information is further recorded by a film placed at the focal plane of the microlens array. This recorded II can be replayed by overlaying it with a microlens array having the same parameters.

In the above outlined capture and display processes, microlens arrays are used in both the encoding and decoding of the planar intensity distribution. The arrays used for this purpose typically comprise square-based spherical lens-lets, which are capable of encoding the object scene with continuous parallax in all directions. A section of such a lens array is illustrated in Figure 7a. It is also possible to record and replay integral 3D images using lenticular sheets, which comprise many thin cylindrical lenses, as shown in Figure 7b.

Integral images recorded in this way possess parallax only in one direction. It is worth mentioning that the integral image produced by the lenticular sheet is not the same as multi-view image with lenticular screen display. In the multi-view display system, the lenticular sheet is used merely for spatial de-multiplexing of multiple separate views of an object scene. To distinguish this difference, the term unidirectional integral image (UII) is used in the thesis to represent the image generated by integral imaging technique using lenticular sheet. The term Omni-directional integral image (OII) is consequently used to represent the integral image formed using the square based spherical microlens arrangements in recording.

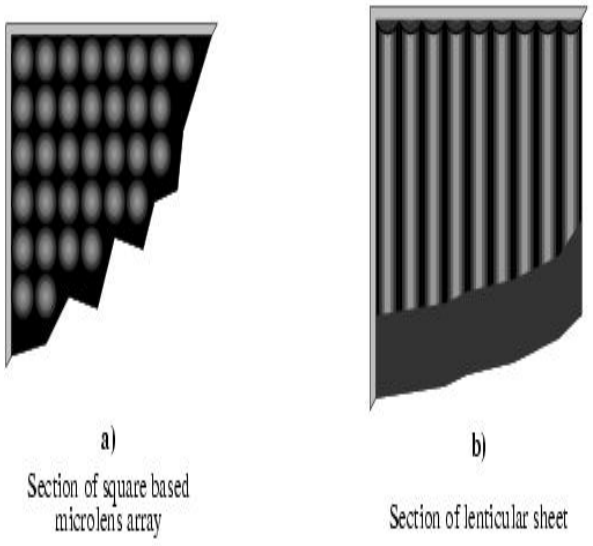


Figure 7: Diagrammatic representation of the lens array [3-8].

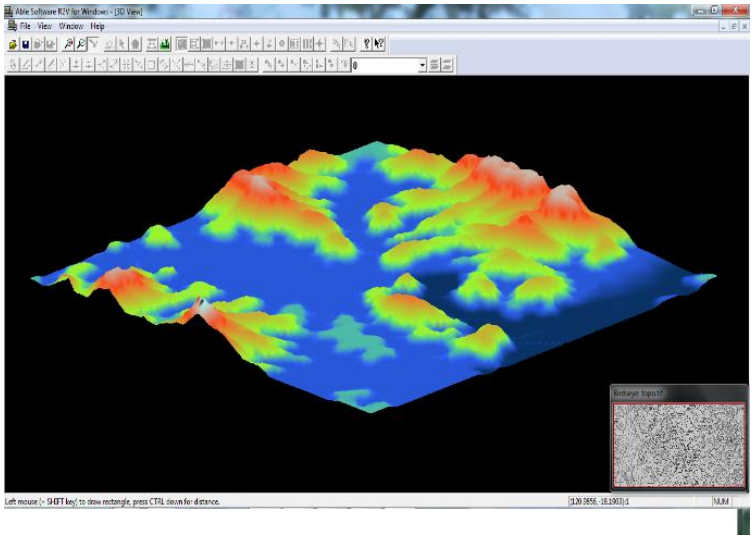
4. Geographic 3D Integral Images For Multiprocessor Ray Tacing System

R2V for Windows is an advanced raster to vector conversion software system. The software is well suited for applications in Geographic Information Systems (GIS), Mapping, Computer Automated Design (CAD), and scientific computing. The entire raster to vector conversion process is fully automatic and needs no human intervention. You display the scanned image on the screen and you select the vectorization command.

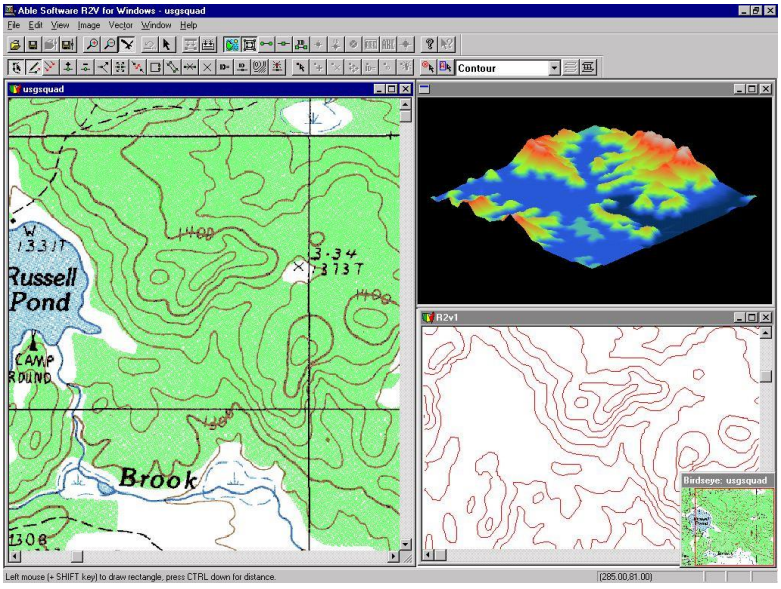
The raster image file formats supported are tagged image file format (*.tif), GeoTIFF (TIFF file with geo-referencing extension), Windows Bitmap (*.bmp), JPEG (*.jpg), GIF (*.gif), PNG (*.png), RLC (*.rlc), and raw image files (*.hdr). The currently supported image types include 1-bit bi-level, 8-bit grayscale, 4-bit palette, 8-bit palette color, and 24-bit true color. 16-bit grayscale images are not supported in the current version. The currently supported formats include: Arc/Info Generate file format (*.gen, *.arc), Shape File format for ArcView (*.shp), MapInfo vector format (*.mif), CAD drawing exchange file format (*.dxf), IGES (*.igs), MapGuide file (*.sdl), and 3D XYZ formats (*.xyz).see figure 8.

One of the biggest challenges is being 3D model file format as there are many 3D modeling application available in the market and support different file formats e.g. .3Ds, .max, .dsf, .ma, .obj, .stl, .dat, .nff, .wrl and many more shown in

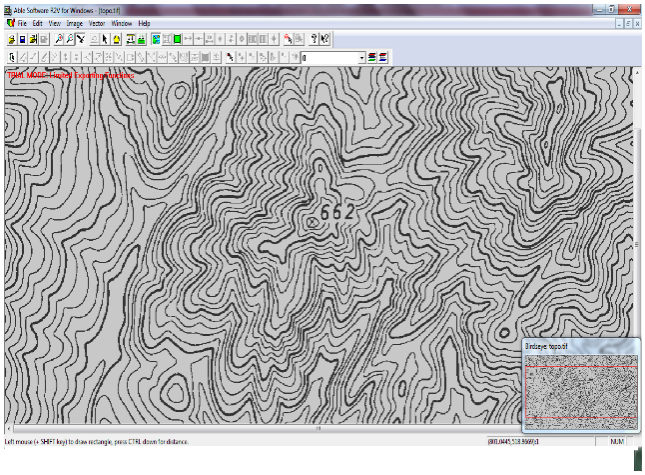
The question is how to support/accept various 3D model file formats and generate Geographic 3D integral images Data. Plug-in tool that will allow interfacing the computer generation of 3D Holoscopic graphics software with commercially available software tools such R2V software. in the environment of C, C++ and Matlab programming languages and the second based *Tachyon* ray-tracing software tool[9][14][16][19-23].



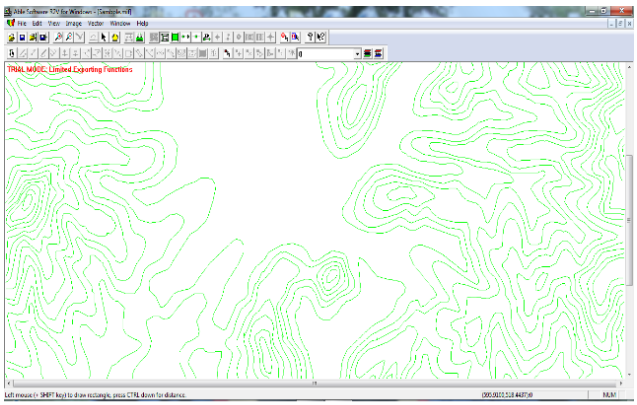
(a)


Able Software R2V for Windows - usgsquad
File Edit View Image Vector Window Help
Contour
usgsquad
Russell
Pond
CAMP
ROUND
Brook
R2v1
Birdseye: usgsquad

(b)



(c)



(d)

Figure 8 a-d: Raster map is generated by R2V software.

5. Experimental And Result

The results are extremely satisfactory and for the first time it is proved that geographic 3D integral images can be generated through multiprocessor integral ray tracer using commercially available R2V software package as second part. In this paper, a unidirectional is used. See Figures 9-11. *699* frames

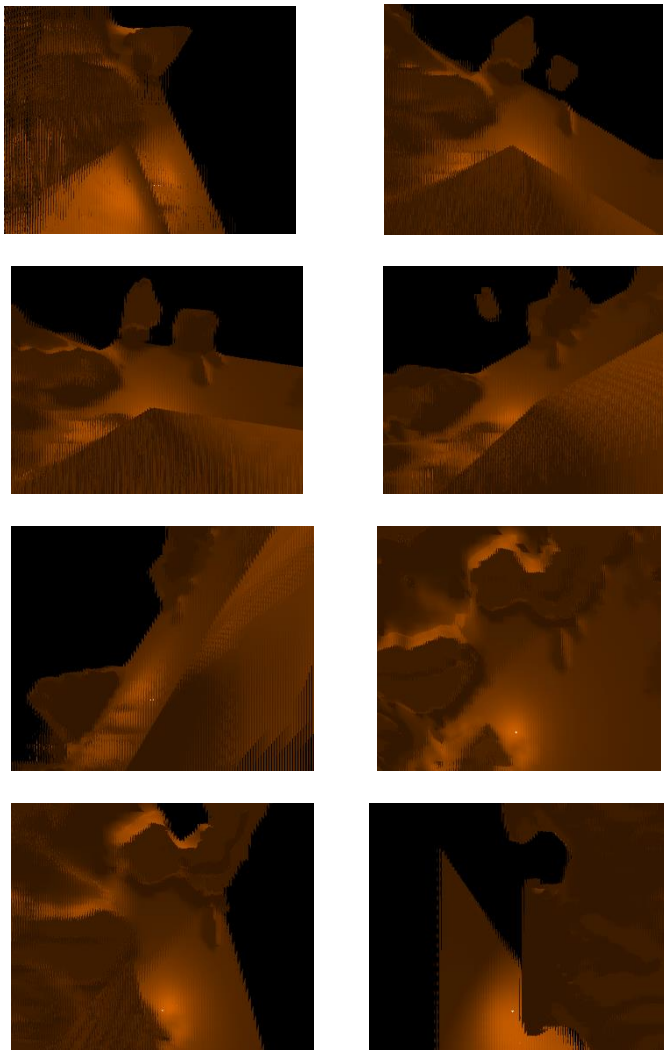


Figure 9: Raster map of Geographic 3D integral images.

```
void camerasetup(camdef * camera, flt zoom,
      apivector center, apivector viewvec, apivector
        upvec)
{
     vector newupvec;
     vector newviewvec;
     vector newrightvec;
     VCross(&upvec, &viewvec, &newrightvec);
     VNorm(&newrightvec);
     VCross(&viewvec, &newrightvec, &newupvec);
     VNorm(&newupvec);
     newviewvec=viewvec;
     VNorm(&newviewvec);
     camera->camzoom=zoom;
     camera->center=center;
     camera->viewvec=newviewvec;
     camera->rightvec=newrightvec;
     camera->upvec=newupvec;
}
```

Figure 10: Pseudo code for 3D integral images camera setup [11, 16].

```
errcode rc = PARSENOERR;
  rc |= GetString(dfile, "BEGIN_SCENE");
   rc |= GetString(dfile, "RESOLUTION");
  fscanf(dfile, "%d %d", &xres, &yres);
  rt_scenesetup(scene, "/tmp/outfile.tga", xres, yres, 0);
  rc |= GetString(dfile, "CAMERA");
  rc |= GetString(dfile, "FOCALLENGTH");
  fscanf(dfile, "%f", &a);
  focalLength=a;
  rc |= GetString(dfile, "LENSPITCH");
  fscanf(dfile, "%f", &a);
  lensPitch=a;
  rc |= GetString(dfile, "LENSPIXELS");
  fscanf(dfile, "%d", &lensPixels);
  rc |= GetString(dfile, "APERTUREDISTANCE");
  fscanf(dfile, "%f", &a);
  apertureDistance=a;
  rc |= GetString(dfile, "SIZE");
  fscanf(dfile, "%f", &a);
  size=a;
  rc |= GetString(dfile, "ZOOM");
  fscanf(dfile, "%f", &a);
zoom=a;
  rc |= GetString(dfile, "ASPECTRATIO");
  fscanf(dfile, "%f", &b);
  aspectratio=b;
  rc |= GetString(dfile, "ANTIALIASING");
  fscanf(dfile, "%d", &antialiasing);
  rc |= GetString(dfile, "RAYDEPTH");
  fscanf(dfile, "%d", &raydepth);
  rc |= GetString(dfile, "CENTER");
  fscanf(dfile,"%f %f %f", &a, &b, &c);
  Ccenter.x = a;
  Ccenter.y = b;
  Ccenter.z = c;
  rc |= GetString(dfile, "VIEWDIR");
  fscanf(dfile,"%f %f %f", &a, &b, &c);
  Cview.x = a;
  Cview.y = b;
  Cview.z = c;
  rc |= GetString(dfile, "UPDIR");
  fscanf(dfile,"%f %f %f", &a, &b, &c);
  Cup.x = a;
  Cup.y = b;
  Cup.z = c;
  rc |= GetString(dfile, "END_CAMERA");
  camera.Setup(zoom, Ccenter, Cview, Cup, focalLength, lensPitch,
lensPixels, apertureDistance, size);
  rt_camerasetup(scene, zoom, aspectratio, antialiasing, raydepth);
  return rc;
}
```

Figure 11: Pseudo code for 3D integral images camera parser [11, 16].

6. Conclusion

This paper presents a method that adapted Multiprocessor ray tracing system in order to first time generation of Geographic 3D integral images based on R2V software as a second part of the complete packaged developed that certainly leads to a new application of integral images that has not been investigated before such Raster maps.

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Integrating Planning Domain Definition Language planner In Multi-agent Systems

Integrating Planning Domain Definition Language planner In Multi-agent Systems

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Abstract

The development of the manufacturing industry to enhance performance and efficiency of the multi-agent systems has increased lately. Consequently, a recent work [1] was targeting the dynamics of the manufacturing lines and auto planning and acting using the Euler Yet another proof Engine (EYE) planner. Similarly, to the aforementioned work [1], we integrated multi-agent systems MAS technologies to enable automated planning and acting in industrial shop floor. In addition, we evaluated and integrated in Multi Agent Systems a set of planners, which are able to interpret the standard

Planning Domain Description Language PDDL, instead of the EYE planner. In which The PDDL planners are considered more efficient than the EYE planner.

Keywords: Multi-agent systems, Automation, Planning and acting, Industry 4.0.

1. Introduction

The world has developed rapidly during the last decade in several aspects including the huge development in the information technology side. In this paper, our focus was precisely directed to Industry 4.0. The term "industry 4.0" was openly brought in 2011 at Hannover Messe, German Exhibition and it gained enormous momentum in recent years. Looking back to the history of this concept, we could find a lot of studies that were done to reduce the boundaries or constraints of this domain. On the other hand, these studies helped to increase the performance, efficiency, and flexibility of industry 4.0. Furthermore, this industry is considered as a result of the industrial revolution that took place in the last decade. in which this revolution caused a huge shift to digitalization in the meanwhile increasing the complexity of systems.

The transformation toward digitization within the manufacturing or production field was a central point that enabled industry 4.0 to be pursued by many researchers. Plus, all the efforts and studies are made to achieve the digital transformation goals in several perspectives such as social and economic sectors [2]. Besides, this transformation assists to increase productivity and creativity and in return it leads to add an economic value. In addition, it provides an infrastructure to control communication and cooperation between both industry and society. Also we find that industry 4.0 depends on some concepts, firstly, Cyber Physical Systems (CPS): a physical

world mixes and collaborates with virtual worlds to accomplish a desired goal or task. Secondly, Internet of things and internet of services which handle connectivity and cooperation. Together, they will have a massive influence on all manufacturing fields [3] [4]. for instance, mechanical machines have become digital controlled machines and vehicles have shifted to autonomous vehicles, where in some cases there is no human interaction or control.

Obviously, the vast development in this area (industry) has reached the production lines and increased the complexity of the systems. As well as, increasing the number of modules that handle the system's functionality. In addition, the needs for automation, scheduling plans, and self-management became significant points that lead to new concepts which refer precisely to manufacturing production on the shop-floor: cyber physical and production systems (CPPS). The CPPS provide the industry with plenty of features such as raise productivity, product quality, and production efficiency, also CPPS accept the challenge of huge on-demand production.

Additionally, there are principles that identify industry 4.0 such as interconnection between devices, machines, sensors, and/or humans by internet of services. Also, Transparency which is represented as an information which is provided by industry 4.0 technologies to the operators to allow making decisions. Plus, the Decentralized principle: a system will be able to make its own decisions and to operate its own tasks autonomously when it's possible. Moreover, the relation between Artificial intelligence and industry 4.0 makes the behavior of the system (i.e. software or physical entities which are called agents) more intelligent, autonomous, and flexible. For instance, vehicles are able to be self-managed, autonomous, and interactive within an environment. Likewise, The environment of the CPPS consists of many agents that communicate, interact, and react among each other to perform a task or to achieve a goal. As an example, the furniture assembly environment contains a set of

sensors, robotic arms, and human workers and all of those actors have a specific role within the environment. In which, the actors communicate and interact using existing communication services to accomplish goals. Further, the emerging multi-agent system (MAS) concept is considered a distributed system within an environment (i.e. set of Agents). In recent work [1], they used the MAS as a part of their implementation to achieve their motivation about repurposing on the fly. By relying on a framework named JaCaMo[5]: it handles Multi-agent systems applications and requirements. Also they use the principle of automating planning and acting by adopting an existing planner EYE [6]: Euler Yet another proof Engine is a semantic reasoner engine, in which this planner synthesize plans from the environment. Generally, MAS and its full/partial autonomous behavior depends on a sequence of planning and acting processes to accomplish desired objectives. Also, these processes vary between industrial domains. Our work will be an extension of the previous work of repurposing manufacturing line on the fly [1]. However, we are focusing on Automated planning and acting using (1) a planner that is able to handle statements expressed using the standard Planning Domain Description Language PDDL rather than the existing planner EYE [6] (i.e. Euler Yet another proof Engine). The latter is a semantic description-planning engine. Besides that, (2) integrating a planner with the Multi-agent Systems that has an interdependence between decision-making and planning.

2. RELATD WORKS

A. Multi-agent system platform

The challenges raised in industry 4.0 are because of the complexity of modularity and the interaction in an environment that seems more dynamic and flexible than earlier. JaCaMo [5] comes to gather technologies that were the core for the manufacturing industry in one

place, to enable multi-agent systems programming and to take the advantages of this concept. The technologies combined within JaCaMo mainly consist of three components or dimensions as mentioned in [5] figure[a], one dimension is used to control agents and to make the system autonomous and self-managed by using Jason [7]: it is used to program agents. The second dimension is made to handle the communication and interaction of agents within the environment by using CArtAgO [8][9]: it is a model used to program the environments (i.e., create artifacts). Last dimension is used to deal with the obligations, structure, and organization process (i.e., the behavior of the agents) by using MOISE [10][11]: it is a model used to program organization specifications Figure.1.

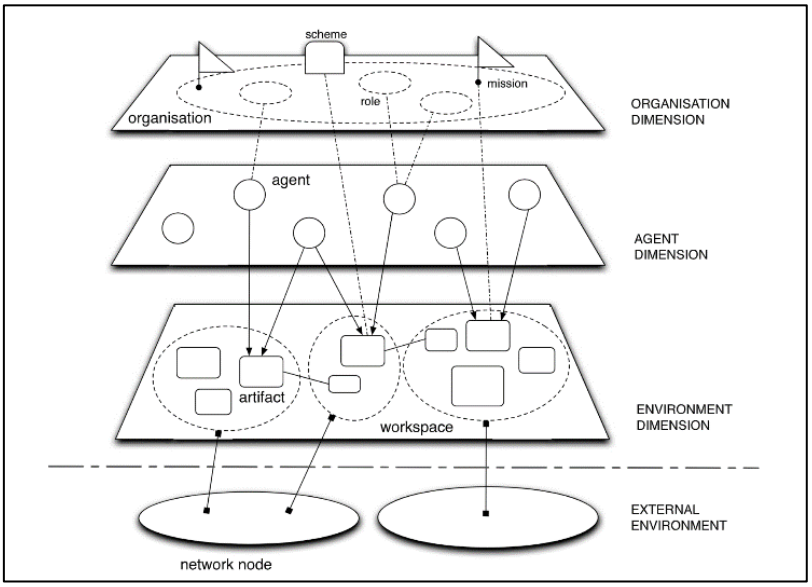

Figure 1: Multi-agent systems abstraction.

B. Shared environment

The added value of CArtAgO model is to provide a shared world among the agents to interact within their environments. As we took the advantage of this model, our planner is made as an artifact which exists in the environment of the agent. CArtAgO consists of many features that are able to be reused while implementing a specific artifact. For instance, it has an observable property, operation, signal, and etc. each of them has a specific functionality to enable the communication between agents or to execute an action.

C. Organizational Specification

The agents often need to be automated, organized, and controlled in a specific manner to achieve the required goals. Therefore, JaCaMo includes a MOISE model [10] to handle the coordinate process and to achieve specific goals. The organizational model has three dimensions, which are the core of organizational specifications. In addition, they are group specification, functional specification, and normative specification.

The automation of planning and acting within the manufacturing environment has gained massive attention. Therefore, developing planners to handle the searching process of the planning and deduce a result based on some preconditions or postconditions. In addition, this planning process motivated many researchers [12]. As a result, a group of researchers have developed a java library [13], containing a set of implemented planners. In addition, these planners are able to interpret an expression in a standard Planning Domain Description Language (PDDL) which proved its worth, performance and quality in the planning process [14] [15].

3. APPROACH

Our approach is based on the forementioned related work and to achieve our motivation we took advantage of these developed related works. As a result, these relevant works increase the scale of the domain, productivity, and ensure efficiency and quality. Regarding the recent work [1] Figure.2 approach, we (1) aim to use a Multi-agent system environment by taking the advantage of the JaCaMo platform to integrate BDI agents with the planner and different layer abstraction Figure(b). Also, we (2) alternate the integration of planner EYE [6] by another planner that focuses on the standard PDDL [15][16][14]. In addition, the latter planner is considered more efficient in planning.

In our approach we focus on the JaCaMo platform to integrate planners (i.e. planners utilize PDDL) in multi-agent systems environments. First we illustrate the use of BDI agent using Jason programming. The following section, implies the CArtAgO model to build a shared environment, tools, and reimplement a planner. Finally, section three contains MOISE model [10][11], which creates organizational specifications.

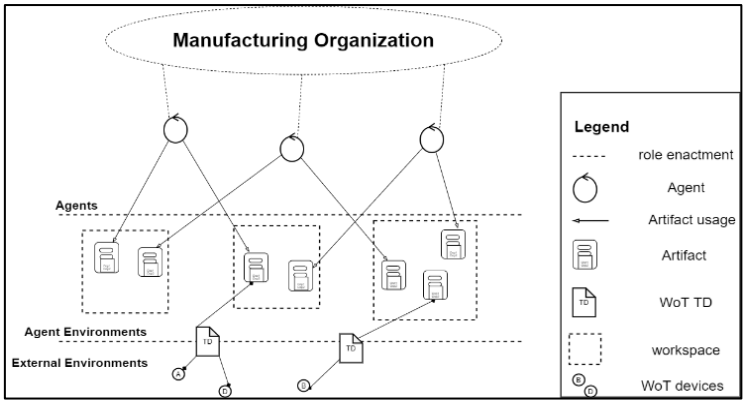

Figure 2: Overview of layer abstraction [1]

A. BDI-agents

The Agent concept relates to the autonomous entities where it can be a physical or software entity. Furthermore, in an environment of multi-agent systems, agents are able to communicate, interact, perform tasks, and act. Thanks to JaCaMo framework [5], in our approach, we used the BDI agent model, which was inspired by PRS [17], to set the agents with artifacts (e.g. planner, robotic arms, or other tools) which are focused-on in the environment (i.e. workspace).

The agent-base is able to call operations of the artifacts once the agent has access to those artifacts by focusing on them. In addition, the ability of the agents to communicate and act between themselves in the shared environment (i.e. CArtAgO model) and the organizational specification (i.e. MOISE model) facilitates the planning process and handling the replanning as well. The planning is considered as executing the plans either as engineered plans or synthesis plans (e.g. our planner result). The synthesis plan is invoked in the library plan of the agents as a result of the planner. While the replanning process is considered as a recovery plan of the failed organizational goals. Say differently, in case a goal cannot be achieved the planner must search for another plan by relying on some precondition. The key to enabling the replanning feature is the use of variables to bind predicates (i.e. binding the failed intentions) Code.3.

```
+!attach_leg1
        : true
    <-
    attach(  leg1  )
    .
```

Code 1: engineered plan existing in the agent base.

```
@l__85[source(self)] +!deliver_leg4 <-

pick(leg4,location1);
move(location2);
drop(leg4,location2).
```

Code 2: result of a synthesized plan, by planner, existing in the agent library.

For illustrative purposes, these are examples of an engineered plan code.1 a synthesized plan code.2, which exist in the agent base and agent library, respectively.

B. CArtAgO

Manufacturing industry consists of different equipment within the same place (environment). Also, the CArtAgO model assists in building a shared environment for the society (e.g. agents and tools) to facilitate communication and achieving goals. In addition, the ability to integrate our planner to synthesize plans or replan failed goals.

a. Robotic arm artifacts

It represents entities of manufacturing production as an artifact, and simulates the process of the industry equipment (e.g. robot arms). Because the real world robot does some functions to achieve the manufacturing goals. In return, the arm artifacts should implement similar functions that match the real world functions as well. Likewise, the robot arm artifacts that have operations (i.e. one of CArtAgO implemented features) need to be executed when the agent triggers them. To give an example by figure.3, the robot arm artifact which is responsible for deliver_leg1 has a set of actions needed to perform and to achieve this goal (deliver_leg1).

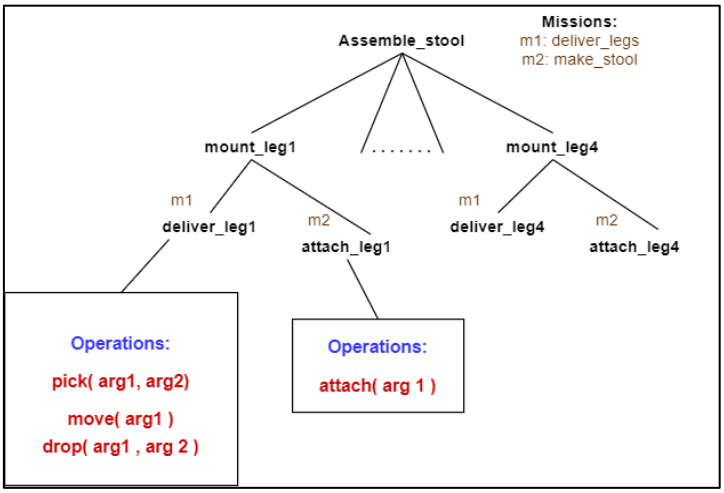

Figure 3: Plan to assemble stool

b. Planner artifact

Planning and acting is the central point of industry 4.0 and in Multi-agent systems in particular. Therefore, the planner assists in searching for a solution to adapt the requirements to achieve goals within the shareable and dynamic environment. In our approach, we adopt an existing planner thanks to the International Conference on Automated Planning and Scheduling (ICAPS). According to the ICAPS[1], the planners used in this competition interpret a standard PDDL for the searching and planning process.

To use PDDL, it requires two main elements to enable the planner and to perform the planning process. First, a domain file or syntax definition (i.e. string structure) which contains a definition of the domain environment. This domain file needs to exist within the agent-base or in the environment of the agent: the planner artifact is able to

[1] ICAPS: "the premier forum for exchanging news and research results on theory and applications of intelligent and automated planning and scheduling technology".

access the domain file wherever. Second, a problem file or syntax definition, which has its own structure and it, consists of the states of the world (i.e., objects, initial state of the world, and goal state). Furthermore, the planner artifact is made to generate the problem definition automatically by relying on the inputs of the agent. The implementation within the artifact planner is restricted to the PDDL conventions. Once the syntax of the problem file is successfully issued then the existing planners will handle the searching process.

c. Organizational specification

The need of organizational specifications is to not only coordinate and organize the flow of the execution, but it is important to automate our planning and (1) replanning when there is a failed plan that needs to be recovered. There exists recent work [18], which extends the features of the agent organization model MOISE [10]. In which the extension enables exception handling and increases the flexibility of the system. In our approach, we used the MOISE model and its specifications to adapt them to our manufacturing purpose (stool assembly). These specifications are XML-base files in which we follow the conventions of the MOISE model. Fortunately, this xml file is generated by default once instantiate the JaCaMo project as a very basic structure.

Furthermore, our agent organization (i.e., XML file of MOISE) is made to be as dynamic as possible for manufacturing. Additionally, the agent organizational specifications have a set of necessary functions, which are called dimensions as we mentioned in relevant works.

In our approach, we used a specific industry to handle production cell functionalities, furniture manufacturing. Based on this plan (see Figure.4), the implementation of functional specification is required to match the industry plan in terms of priority or concurrency. In addition, we adopt the leaf goals to be assigned to missions. In other words, the structure of the scheme of functional specification is required to match the plan either Figure.2 or Figure.5, where only the leaf goals are

required to set for a mission. Thanks to the MOISE implementation, the parent goals are achieved when the subgoals are successfully achieved.

4. IMPLEMENTATION

Our implementation is based on the features of JaCaMo platform [5] (e.g. CArtAgO, Agent, Organization models) and other technologies to achieve the integration of planners in MAS. by taking the advantage of the existing planners to interpret the PDDL expression to build a plan with its actions in order to accomplish a determined goal.

From the recent work: Repurposing the manufacturing line on the fly [1] in the CPPS, our implementation will be similar except we are going to use a different planner instead of EYE reasoner [6], in which the latter is considered a semantic engine. The implementation scenario will be based on the plans in figure.2-3 which are related to the recent prototype [1]. Also, all the implementation code will be available on Gitlab.

Based on the approach, in our implementation we used several technologies which were developed to handle industry 4.0 requirements for the purpose of increasing productivity and quality. Our implementation was built upon a specific manufacturing production line which is a stool assembly scenario. At the beginning, to achieve goals of customizing furniture production there will be plans to be taken into account ,as well as, a course of actions figure.4-5.

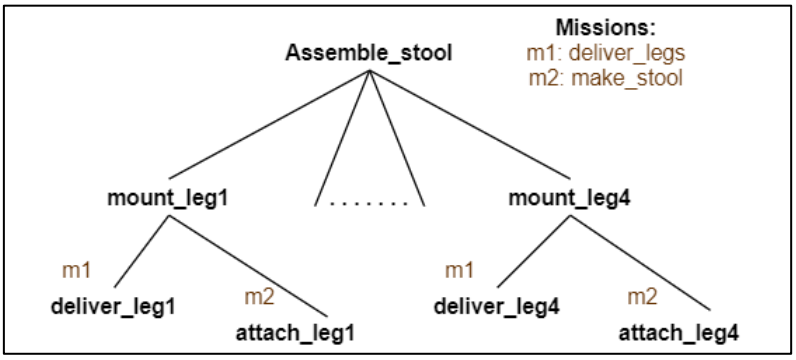

Figure 4: plan contains only deliver and attach.

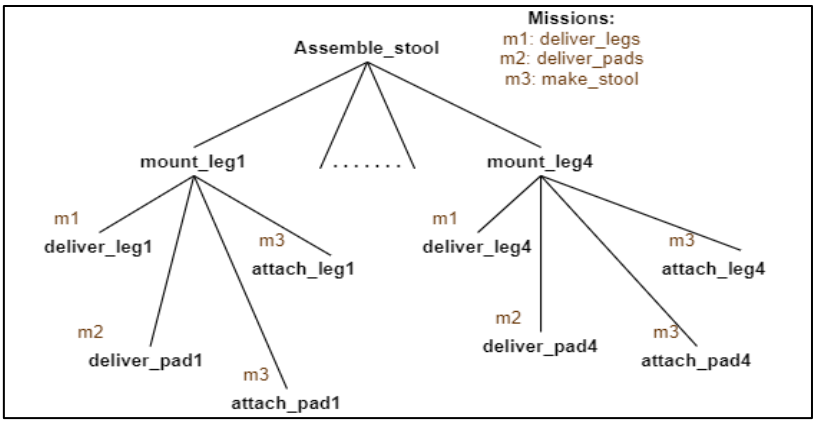

Figure 5: Extension the plan figure.4 by including pads

As we mentioned, JaCaMo is made to handle and process multi-agent systems by its combination models. Therefore, we implement agent-based manufacturing by programming an agent using the Jason programming model [7][13]. The agent is responsible for executing goals, plans, and actions. As well as it is responsible about how interaction will be performed based on other factoring (e.g., other agent's intention). In addition, the agent will use either a plan, which is programmed by an engineer, or a plan that is synthesized by a planner.

The latter plan will be added to the agent's library to make the agent aware of that added plan. On the other hand, we set an intention to take a predicate as a variable thanks to the Jason [7] feature that allows us to bind a variable to the predicate in order to match an existing predicate. Therefore, the failed intention of the organization's achieved goal will be targeted by this variable. Note that the intention can be executed only if the achieved goal (i.e., goals assigned to missions in MOISE) of the organizational specification has failed. Then the role of the variable (see Code.3) will come right after and it will be executed.

```
!GoalFailed[code(GoalFailed[scheme(ResSchm)])]
     <-
     !recover(GoalFailed).
```

Code 3: Show variables bind an failed intention in order to execute a recovery goal (!recover).

The recovery plan (+!recover), code.4, is meant to use the planner to synthesize a new plan based on some precondition states related to the domain file definition: these preconditions will be the content to generate a problem file definition. In addition, the precondition can be retrieved from an agent-based belief or from an external environment (e.g. semantic thing description, RDF, or web services). Our reimplemented planner (buildPlan) within the agent-base takes the precondition and the domain file as arguments to return an agent plan (i.e. Jason language) as output of the planner. As a result, this plan will be added to the library plan.

```
+!recover(Goal) < ?(problem_precondition(Goal,
objects(Obj), init(Init),
goalState(GoalState)));
buildPlan("domain.pddl",Goal, Obj,Init,
GoalState, Plan);
.add_plan(Plan).
```

Code 4: the structure of the recovery plan including the planner operation.

The agents are required to have access to the environment in order to take full advantage of the environment. To achieve this requirement, the agents join the workspaces that connect to the environment and its tools. Within the environment, we make a set of artifacts that represent robot arms and a planner:

1. Robot Arms

The use of robotic arms artifacts are to execute the commands received from the agents, which focus on these artifacts (i.e. artifacts joined the workspace) and to perform actions. Each robotic Arm has at least one action (i.e., one operation), and each operation can have as many arguments as needed. For instance, robo1Arm has an operation called pick/3, move/2, and drop/3 and robo2Arm has the following operation: attach/1. In which numbers refer to the number of arguments assigned to that specific action. Furthermore, these operations match the plan's actions in which these plans are either an engineered plan or a synthesized plan.

2. Planner

In this case, it is different from the robotic arms artifact. We used existing planners that were able to handle the statements expressed in PDDL. The PDDL mainly depends on two files: Domain and Problem. The interesting file is the problem file because it has the objects and the states of the problem. As a result, it is required to map everything

received from the agent to the PDDL problem file. The mapping was achieved Thanks to the PDDL4J library [13]. The latter consists of several planners which are already implemented (e.g. HSP: heuristic search planning, FF: Fast Forward, FFanytime: Fast Forward anytime, and HCanytime: Hill Climbing anytime)[13][12]. It is possible to switch between these planners by setting the planner's name to one of these planners, Code.5.

```
final Name plannerName =
AbstractStateSpacePlanner.Name.HSP;
final AbstractStateSpacePlanner planner =
                    stateSpacePlannerFactory.get
Planner(plannerName);
```

Code 5: To enable different planners in PDDL4J library.

Furthermore, the domain file is required to be validated with the problem to get a result. The simplicity of using PDDL syntax makes the planners more accurate and constrained to predefined elements such as (requirements, predicates, actions followed by params, preconditions, and effects). In our implementation of the assembling stool industry, we used the online platform tool Planning. Domains[2] and pddl4j implementation to validate the domain and problem file.

Following our reimplementing planners in Multi-agent Systems (JaCaMo platform), we set an assumption related to the notation of the operation (i.e., actions of the plan). The assumption is, if the argument of the result of action contains one name of the object related to the artifact actors (robo1Arm or robo2Arm). As a result, the notation of the

[2] Planning. Domains: A collection of tools for working with planning domains. Also it contains many datasets of PDDL files (domain and problems) that are ready to run and test. http://planning.domains/

operator will be set as a notation of that action code.6. However, if the result contains more than one actor (i.e. robotic arm name artifact) or none code.6, then the notation will not be added. And it will be up-to the default JaCaMo choice.

```
+!deliver_leg4
                <-
                    <!-- pick has no
artifact arm -->
                    pick(leg4,location1);
                    <!-- move has two
artifact arm -->
                    move(robo1Arm ,
location2, robo2Arm);
                     <!-- drop has one
artifact arm -->
                    drop(robo1Arm,
leg4,location2)[source(robo1Arm)].
```

Code 6: For illustrative purpose only.

Thanks to the library pdd4j which consists of several planner implementations (e.g., HSP, FF, FFanytime, HCanytime) [12]. These planners are able to interpret the expression of PDDL to create a plan for our production line. The artifacts that represent the robots consist of operations that the robot can perform when it calls. In our scenario, we create two robots to handle our requirements, the RobotArm1 to handle the action of the plan such as pick, move, and drop as shown in figure.3. Moreover, the robotArm2 to perform the attach action see figure.3. These artifacts will be executed once the agent focuses on these artifacts and it calls within the plan that needs to be in the agent library. Note, the execution of these actions happen, when the organizational goal is executed.

The planner handles the interpretation of the expression of the domain and the problems, which are related to the manufacturing industry. In our scenario, the planner artifact will generate at the beginning the problem context as defined in PDDL standards [15][16] based on predefined conditions states existing in the environment either internal or external via web services. Once the problem context is successfully formed the planner will pass the domain and the problem file to parse them searching for a solution. Because of that process, the planner artifact will add the generated result as an agent plan within the library plan. However, the EYE planner synthesizes the plan from the semantic descriptions taking the advantages of the rules, which are not constrained as much as the planners that depend on the PDDL.

In our implementation, the flow control of the planning process was handled by the MOISE model [10], to parse the organizational specification by XML-base specification. However, the recent work [1], utilized a custom extension of the MOISE framework [10] for interpretation of organizational specifications in RDF. The definition of the organizational specification depends on the industry plan structure as in figure.4-5.

Following the plan [1] structure, we implemented two roles (deliver Legs, attach Legs) within the group specification to assign them to missions thanks to the normative specification to link between them. The missions require a set of goals to execute, and these goals deduced from the scheme include both missions and goals. We focus to assign only the leaf goals to the missions because it depends on how we divide our manufacturing problem. In our assumption we made each leaf as a domain problem, by means we have 8 problem files as PDDL for the plan figure.4, and 16 problem files for the plan figure.5. Because if we would like to assign the parent goals of the leaves to the missions it means we have to define them similar to the goal leaves.

4. Conclusion

The need for Multi-agent systems MAS within the manufacturing industry increased rapidly compared to the past. Therefore, the high requests for flexible and efficient distributed systems gained a huge momentum. whereas, every environment contains a set of autonomous agents required to handle and automate a planning and acting process in a highly efficient way. As a result, we integrated a set of developed technologies which serve the requirements of the Multi-agent systems within the manufacturing Industry.

Additionally, we took advantage of the JaCaMo platform which proved to be well-formed to provide tools and architecture for MAS. In addition, we aimed to integrate planner to synthesis plans which can be executed by agents. Our integrated planner is able to handle standard Planning Domain Description Language PDDL. Moreover, A planner deals with PDDL, considered theoretically better than the EYE planner in which EYE is a semantic reasoner engine. However, the evaluation of our planner compared to the EYE planner is set as a future work.

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4

Effective KPIs for Optimizing the Usage of Internal and Commercial Web-based Products

Effective KPIs for Optimizing the Usage of Internal and Commercial Web-based Products

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Abstract

At some point, each organization needs to evolve Key Performance Indicators to have exhaustive data, which leads to evaluating their business and measuring how to choose optimal strategic decisions. This paper presents an analytical process for extracting KPIs that are used to measure and evaluate web products of companies. Starting with a definition for important performance indicators of different kinds of products, and then followed by an understanding of the different categories of these KPIs and finally, after analyzing the usage, the study is concluded by recommending classic KPIs for actual usage and strategic KPIs for long-term usage stability.

Keywords: Effectiveness, KPI, Loading time, Optimisation, Performance, Product usage, Web products

1. Introduction

Digital products and systems always impose a new reality and an unprecedented challenge, in terms of maintaining a high competitive advantage with the most prominent players in the market. It is essential to understand the structure and the norm of the products and to grasp their lifecycle from building, development, deployment, and maintenance in order to review the state of their usage. Finally to direct them for the purposes of maintaining the loyalty of existing clients and /or attracting new subscribers.

This paper answers, what are the measurements that calculate the effectiveness and performance of online accessed products. This investigation will set up certain Key performance indicators for different modules of online applications to measure their impact usage by the clients. The classification of these KPIs will be in two levels, first class is Classic KPIs that are used to calculate the efficacy of a web product in terms of B2B (Business-to-Business) commercial usage, not considering the internal usage. The second class of KPIs are strategic KPIs, which are for internal effective usage. By the end of this work, a conclusion will indicate a certain number of KPIs that will be used by the companies to be considered as catalysts for product usage. The final versions of these KPIs will be divided into two main classifications, a group to improve the product's usage in the present time, which will enable customers to maintain their involvement in current products. The second group of indicators is to support the hosting organizations to discover the future obstacles so that they can be analysed and developed to enable them to improve product usage strategies, thus survive in the future .[1]

A web product is a complete digital solution based on cloud services that serve a specific sector. Most service providers prefer these online access applications based in the cloud than the traditional

applications to increase productivity. Many companies improve their online portals to be as an ERP management tool, which can cover the entire related chain in the domain of their functionalities and business. Nowadays, many companies are seeking to reach sustainability in markets. Performance indicators are one of the measurements for business improvement in order to reach sustainability. They measure the effectiveness of the organisations through the quality of services that are given by their products. These KPIs can help organisations to identify the origin causes of measured defects, which can be found and corrected.

This subject touches the core of one of the sensitive problems faced by companies, which is finding measures to evaluate the effectiveness of online accessed applications. Understanding how such a concept has developed over time is one of the main routes to answer the problem by finding at what point the last researchers stopped to take it as a starting point. One of the concerning issues is the availability of resources that can be considered as references. Therefore, most of the references will be taken in the last 7 years. This selection of time came after preliminary analysing most of the problems related to the same topic, as we found that the development of KPIs did not occur until the aforementioned years. Thus, this paper work addressing the following question:

What are the Effective KPIs for optimizing the usage of internal & commercial web-based products?

KPIs are important performance measures of a product that thanks to them the user can improve his business toward a better result. KPI focuses on practices based on operational activities and not on methodological aspects. KPIs provide an analytical vision, which helps managers to make proper decisions. It uses to dedicate what are the marketing attentions for the business to be improved. However, the results of KPI are not considered as one of the branches of

business intelligence strategies. Active managers and innovators should understand the effect of all main factors of their business by representing them into several KPIs, because the ambiguity and lack of awareness of such things can hold back all the forward steps into the improvement.

2. Related work

In a research study done by Bright Gauge [2], they create metrics of classification with different types of KPIs and advanced metrics in order to facilitate the understanding of their usage. Moreover, these KPIs can help companies to create a good-designed evaluation system to improve their business processes. Moreover, these metrics shall be selected to measure the business progress and quality. The organization will survive therefore at the market in the future [3]. The project of finding performance indicators for web-based products shall be done with a comprehensive mechanism that includes an understanding of needs, deep study of the product state and consideration of possible future changes. All these variations are important in order to get a precise result. Because any analysis which is used to evaluate the effectiveness depends strongly on the detailed usage of products. A well-proposed KPI will adapt with variables that have a direct impact on each indicator, therefore, we can almost say that KPIs are a component of the global strategy of the company [4].

"The efforts which are invested in any KPI project represent the basis of the measurements used to analyse the performance of any online investments" [5]. KPIs are only relevant if they can show us the path to success, a path with many different actions with the aim of trying to improve a sustained effort of optimization. Optimisation is defined as the continual improvement of results that are obtained by different activities such as those that are evaluated in the framework of a strict measuring process. We believe that there is a slight risk in trying to chase small percentage points without having any performance indicators as a reference. It will become necessary to transfer all optimisation efforts and channel them into KPIs, which are essential reference points.

Previous literature has also taught us that from a certain stage, the margin for improvement is inevitably reduced; marginal profit gain is close to zero for a given type of intervention. Web analysts may lose their ability to intervene on an operational indicator, which in turn will lose its influence on the KPI [6]. “Thankfully, there tends to be more than one way in which performance indicators can be influenced, each indicator is part of a real work plan"[7]. We feel that it is also necessary to highlight the fact that there is a limit to how each of the optimisation points can be improved. We have also seen the effects of cancellation where the increased efficiency of a particular action seemed only to occur at the expense of another action. Finally, we arrive at the point where the limits of web analytics can only be surpassed thanks to the marketing brain.

Based on previous literature, several KPIs were classified to make them easier to understand. Results were deduced that most resulting KPIs can be classified correctly either as classic or strategic KPIs. Nevertheless, most classifications were not relevant to web-accessed products in both statuses.

3. Methodology

The method starts with a literature review to identify and classify several research results on KPIs for web products. The research wave focused on searching by the keywords extracted by a data mining method of one topic. Several works that have been done, in relation to the topic, were performed based on paper identity, agency and research results [8]. After doing investigations and analyzing related research works, about tens of general references were found by using search keywords: KPIs and Online products. However, when we added more linked keywords, related to the concept of our research, the search filtering gave only about 15 resources that have similar results. In this case, ERP and Performance were added to the previous keywords.

One of the effective common ways to find key performance measurements and to review any online product performance is by questioning clients, users and business teams. Here, the measuring will directly touch the product’s usage, which leads to tangible results.

Furthermore, in our work, we searched for the behavior as a user comportment during interaction with web products. Hence, when we collected clients' data, we also considered behaviors. In this case, i.e. online product analysis, the screen interactive practices (between users and web products) are considered as behaviors.

A- Data Mining to Extract Keywords

To extract keywords from relevant articles and similar research projects, we use a data mining method. A software platform called Iramuteq [9] has been used to study what are the popular keywords that are related to a given subject, leading to keywords that we mentioned at the beginning of this work. Using these keywords, most of state-of-the-art literature was found in three main publication databases: Web of Science, ScienceDirect, and the library of UGA (University of Grenoble Alpes). In addition, we relied on articles from many other reliable scientific journals that were published in the last 7 years. To analyse and understand the data, it is important to use the aggregation practices; therefore, they can be used for different analyzing purposes.

B- Analysing Collected Data From Previous Literature

The obtained data are used to find qualitative data to determine how to create KPIs for web-based products and to evaluate them. Furthermore, we focused on authors who extracted and discussed how a good KPI contributes to building an innovative and successful business environment. We found that there is a relation between other keywords such as measurements, strategy, and innovation [10]. We also found that most KPIs designers, especially for online applications, started their concepts by identifying the related preliminary measurements before going far to the final indicator's version. These measurements are rooted from systems that have big collected data. By this iteration analysis, they separated the mentioned measurements into two categories [11]:

- Quantitative sets that represent real numerical values by readable numbers. These values are stored to be analysed as its direct meanings, and not subjected to be modified or adjusted. Ex, net profit, number of clients, etc.

- Qualitative sets that represent non-numerical values. These values are stored in a form after being modified, interpreted, and sometimes transformed from non-numeric values to numbers. Ex, experience classification (good or bad), a result of tests (valid or not valid), etc.

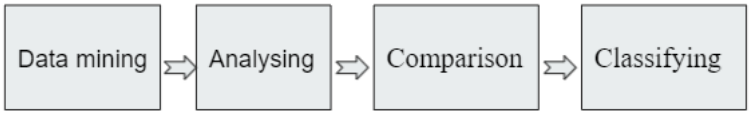

Figure 1: METHODOLOGY OF THE RESEARCH

Obviously, Fig.1 shows four steps to extract and use KPIs. Hence, from the previous literature we shall compare between process KPIs that are used within these steps. To measure the effectiveness, we are focusing on four main objectives that are designed to cover the four levels of the lifecycle of each product feature as following:

- Following the state of production
- Monitoring the product usage of users
- Monitoring the effectiveness of the product
- Identify the help needs of users

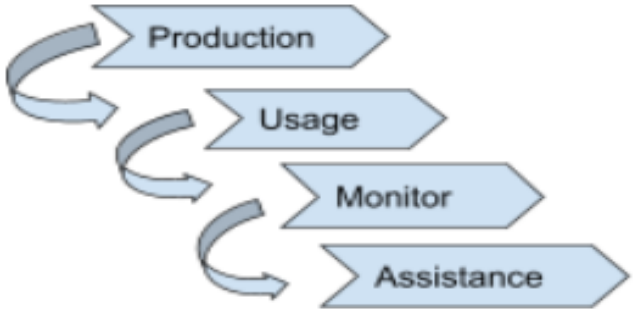

Figure 2: LEVELS OF AN ONLINE ACCESSED WEB-PRODUCT

Fig.2 shows the good practices and steps of each level for the process of extracting KPIs from the strategy that enables companies to meet the changing demands of the market.

4. Comparative Analysis

This section highlights a comparative analysis between operational and strategic KPIs for each concerned part of an online product. By finding the proper indicators, performance would be controlled, monitored, and ensured according to prescribed rules and desired goals. In general, we put in mind that KPIs will guide the company to the good implementation of the desired strategy to achieve goals, e.g. profit and return on investment, and help to make right decisions. Hence, KPIs should be adapted as the product and the circumstances change [12]. To find out the proper KPIs, it is important to understand and consider the following elements:

a) Business strategy of the company
b) Each KPI must be an easily measurable value.
c) KPIs can be used in short-term and long-term plans.
d) KPIs should have direct relationships with the business direction.

Therefore, we distinguish the category of strategic KPIs, which are used to evaluate the progress/weaknesses of any online accessed product in the long-term. However, this approach leads us to think of what types of KPIs that we need to measure the effectiveness of any web product. In result, we found indicators classification as per example in [13]:

1. Quantitative Indicators

A measurable characteristic gives only numbers as a result. In our case, we use these quantitative measurements to cover the measurements of time, e.g., loading time, the time needed to receive a confirmation, etc.

2. Qualitative Indicators

An indicator that is not measured by numbers. A qualitative KPI is a characteristic of a decision, opinion, or feedback, e.g. satisfaction survey.

3. Lagging Indicators

These indicators are designed to classify the obtained results of a task period or for a historical record. e.g, total times of downtime in 6 months, total help demands in a month, etc.

4. Process Indicators

Process indicators are used to measure the usage performance of an action. It gives a measurable report about the usage of the product. e.g., rate of help tickets opened, rate of product usage, etc.

5. Output Indicators

It measures the success or failure of business activity. It is important to show the global effectiveness of a product/company. e.g., rate of new customers acquired per dedicated promotion budget.

6. Directional Indicators

It is to evaluate some improvement in an organization, to check if they are good, bad, declining or no improvement. e.g., measuring spent time fixing issues and troubleshooting problems.

7. Actionable Indicators

This measure reflects the company’s commitment toward a product and its effectiveness to implement innovations and introduce new changes. This indicator helps to determine the company's ability to drive the required development of a product within specified time limits.

8. Results and discussions

The main results are listed into two KPI groups, Strategic KPIs and classic KPIs. Each of them serves a certain domain of work.

A. Strategic KPIs

Here, we show several business KPIs to keep tracking the business to be in continuous progress and achieve business long-term performance. A classification established in 2011 presented by ISO/IEC 9126[14], related to online service portals, defines features of web-based products. This standard lists some quality characteristics, i.e. measurable features by any organisation, for their online products. These characteristics are:

- Quality
- Easy to use
- Easy to maintain
- Highly protected
- Mobility
- Accuracy
- Workable [15]

These measures are not fixed, and they can be changed, i.e. modified or added features. It is important to place these service portals and their metrics in the context of continuous improvement. In order to achieve this, we proposed a list of strategic KPIs that should be considered as important for our work:

- **Availability of client service application**

There is a little difference between the availability and downtime of an online product. Unavailability happens when clients cannot access the web system by issues of the network, DNS, misconfiguration, etc. This indicator is considered as a measurement from the client perspective. It is measured as the percentage of uptime in a year. This indicator shows how much the product performed over the year. The concerning thing in this KPI is how many times the product may be not available, and the duration of each case. The optimal percentage for the availability for web-based products should be not less than 99.99% in a period of a year. That means not more than 55 min unavailability per year in total.

- **Downtime of internal user application**

Simply it is when the system breaks down, excluding the planned downtime, which leads to hazard consequences such as failing to do

the daily backup. It is one of the most important Key indicators for measuring the stability of a product. This indicator is considered as a measurement from the internal user perspective. The concerning thing in this KPI is not only how far the product can be shut down, or how many times it can be per a specific period, but also how long is this downtime if it happens. The optimal stability system rate is zero breakdowns. However, most of the companies consider that a one-time breakdown per year for a long of 30 min maximum is an acceptable rate.

- **Customer satisfaction service**

One of the effective ways to measure the services provided by a company to let their clients be satisfied is to ask them periodically by a simple clear survey.

- **Rate of customer satisfaction**: [16]

To know this rate, it is normally by doing a small calculation about the answers to a simple question, it is «Are you satisfied with our services? ", the number of participants in the survey will define the resulting rate as the number of Yes answers divided by the number of participants in the survey.

- **Effort Score**:

It is by measuring the activities of a client in order to implement a specific action, including the effort of buying the product until the Ask-help service. A valuable high score is when the client does little effort.

- **Effective response time**:

It is the time spent between a client's request and obtaining the result he needs, and not only replying to his request.

- **Rate of client's retention/loss**:

This rate is important; it touches the core of the business of the company. This indicator is calculated annually, it relates to the mechanism of how to maintain or lose a customer. It is measured by counting the newly acquired clients divided by the lost ones. This rate should be above integer 1, otherwise, the company is in the red margin.

- **Customer Acquisition Cost [17]**

Simply, it is the average cost of winning a new client. It is the global cost of the marketing and the related cost used to attract new

customers. This KPI should indicate a rate that can be calculated by the total related marketing budget for a year divided by the number of new clients for the same period.

- **Scalability**

By this KPI, we are measuring how our web-based product is able to host newly developed ideas to be integrated on it in parallel with having the ability to withstand increased demand pressure without a loss in quality of services.

- **Profit**

One of the main indicators for knowing how well your product is performing is profits earned at the end of each business year cycle. There is a direct relationship between the net profit for a product and the performance. The increase in profit is proof of an increase in product performance.

Table1: Presentation of final results

Strategic KPIs	In order to obtain
●Availability ●Downtime ●Customer satisfaction service : ○ Rate of customer satisfaction ○ Effort Score ○ Effective response time ○ Rate of client's retention/loss ●Customer Acquisition Cost ●Scalability ●Profit	● Quality of service ● Easy to use ● Easy to maintain ● High protected ● Mobility ● Accuracy ● Workable

B. Classic KPIs

The high-level indicators, for measurements of external usage effect (i.e., outside companies), are shown. An investigation will set up certain KPIs for different modules (i.e., product subparts) to measure

their impact usage by the clients. Companies, as catalysts for progress levels, should consider these operational indicators. Most important KPIs for this section are KPIs that touch the core modules main objectives as [18]:

Table 2: Classic KPIs

State of production	Module usage	Module efficiency	Need help
● Rate of bugs per month per module ● Rate of recurrence of errors ● Rate of recurrence codifications ● Rate of discovering new errors ● Final version simplicity ● Testing before release	● Page load time (Load speed) ● Average spent time for one action ● Criteria used for filter ● Identify the least/most visited module/feature ● Ability to data e-filing system including e-signature. ● flexibility to exchange files by emails ● Usage rate per user per module ● How fast can Alerts be sent ● Users rate per role (manager, accountant, ...) ● Mode of use (mobile vs desktop) ● Identify the most visited module /feature	● Time to carry out a given action ● Scalability ● How long the data is saved in the system. ● Capability to analyse historical data (BI).	● The Time between asking for help and the resolution. ● Identify the most visited help pages. ● Identify the most searched keywords. ● Identify unsuccessful searches. ● Identify the most common way to ask for help.

9. Recommendations

KPIs need accurate detection solutions to evaluate the effectiveness of any online service or product portal. These indicators are critical for maintenance, improvement, and development. Companies who run web-based solutions must take steps toward achieving a strategic transformation to remain a competitive provider. They should make great efforts to maintain a high position and efficiency as a provider of web platforms [19]. However, maintaining the health of the application is not an easy task. After a deep study of online products like Powimo [20], as a sample, we had recognised that at some points companies should work on developing their policy of maintenance.

Another solution, of actual best solutions, is to work on extracting performance indicators for each part of the web product to see where these products are set in the evaluation scale. However, some limitations make these processes difficult, especially when the functionality of these mentioned products may vary at different times during a day, season or year. In other words, it is difficult to create a unique KPI when there are significant time fluctuations. For this reason, we recommend important KPIs that can help mitigate the above-mentioned limitations:

- To consider both kinds of KPIs which mentioned on Table1 & Table2
- Online service providers should focus on the clients satisfaction surveys, that leads to know the state of the product in an easy, direct and fast way
- Adding E-chatting robots in order to deliver real-time support and to provide help during vacations.
- Adding "Ask a demo" on the product website to facilitate contacts and attract new clients who visit the website.
- Invest in a quality help service with search capabilities to keep customers satisfied and to avoid unnecessary interactions.

10. Conclusion

This paper shows important Web KPIs that are used to improve companies' strategic vision for their online products and services. We found different applicable KPIs to accomplish a company's goals in offering reliable web products, i.e. in order to get a benefit and to prevent producing metrics just because we should establish them. Thus, KPIs need to be adaptable and updated at specific periods. Besides, this work proposes two categories of KPI sets. The first is strategic KPIs, whereas the second group is classic KPIs. In addition, we highlight important recommendations to enhance performance through KPIs evaluation. In the future, we shall prepare a questionnaire to collect stakeholders' opinions, inside companies, about these proposed classical and strategic classifications and to measure their satisfaction about each category's purpose.

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5

Design of Smart Street Light System Based on IoT

Design of Smart Street Light System Based on IoT

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Abstract

Our world is full of different kinds of light sources some are natural sources while others are artificial. The artificial sources have two modes of operation that is switch on and off, this leads to wastage of electricity and at the same time, a manual control to these lights is not effective in the modern era. In this paper, it has proposed to design an advanced light control system, which is capable of replacing the old generation light one. This system consists of three main units; a sensing unit including Light Dependent Resistor LDR sensor, and Infra-Red IR sensor, which controls the lights according to the vehicles, pass. Depending upon the sunlight during some day, illumines of the proposed system will be adjusted. These signals are interpreted by Microcontroller, which is the second unit of our system represented by Arduino Uno, the output gives the response of the

designed system as GUI interface displaying on the LCD screen or on smartphone device wirelessly in the station room to give the status of the system using Bluetooth module HC-05. A simulation will be done by using Proteus software due to its flexibility and simple installation on Arduino. The research results have proven that to save 40% of energy consumption using smart system. Another objective is to detect the fault when one of the streetlights is obsolete by sending a message to mobile. Application of such a system can be implemented in workstations, park lights, street lighting system, headlights of automobiles and much more.

Keywords: IoT internet of things - LDR sensor – IR sensor – Bluetooth sensor – smart street system.

1. Introduction

An important component of power consumption worldwide is street lighting. Global trends in street lighting show that 18-40% of the overall energy bill goes towards street lighting and so this is often one domain that needs major attention if we glance at improving efficiency of power consumption with an objective of saving energy. LED lights are 40 to 60% more energy efficient than traditional lighting technologies. just by using LED luminaries, it's possible to produce better quality lighting, lower energy consumption, and reduce CO2 emissions. That a state can save US$6 billion annually. [1, 2] In our country there is a main dependent on existing lighting system, manual switching off/on of street lights, more energy consumption, high expense, more man power. All of these made us to solve this problem by reducing the wasted energy and think to design such smart system that controls to the street lights automatically. This smart system provides high energy efficiency and saves time, effort, labor and money. It reduces cost and gives more reliability.

In [3], Authors suggested to style residential street light system by using sensor technology, ZigBee and GPRS wireless communication technology network. to appreciate intelligent lighting parameters adjustment, coordination control method of assorted forms of used sensors. The system through multiple ZigBee nodes topology network to gather street light's information, each subnet through the ZigBee coordinator and GPRS network to transmit data. the road lamps is placed on or off, or be adjusted the brightness automatically in keeping with the encircling environmental illumination [3]. As stated in [4, 5], researchers demonstrated the concept of controlling the road light supported traffic density. Considering real-time adaptive conditions of the lighting scheme, which detects the presence of vehicles and pedestrians dynamically, this method showed the savings in power consumption but because the entire system may be a wireless network based, the system is expensive and important to take care of [4, 5]. In [6], the author has proposed low power consumption LED Street light based on smart control system. In this system he used sensors to measure sun light intensity, day/ night condition and traffic on a road. The intensity of LED street light varies with these parameters. he has used two sensors that are LDR sensor and motion sensor. This paper proposed state of art system which consists of micro controller, LDR sensor, motion sensor, LED driver and Computer [6].

2. Materials and Methods

Any smart lighting system consists of three main parts: sensing unit (input), Processing Unit Microcontroller and the output unit (Response) as shown in figure 1. An additional unit is inserted that used to control the output is communication module (wireless sensor network).

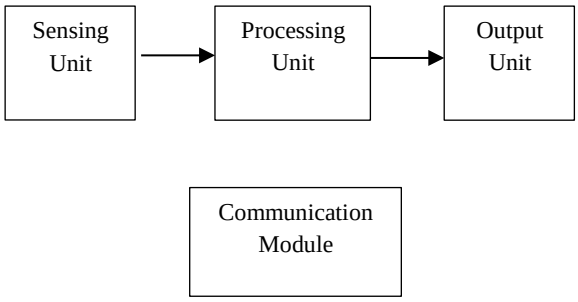

Figure 1: Construction of Smart Light System

A sensor could be a device that detects and responds to some varieties of input from the physical environment. the precise input may well be light, heat, motion, moisture, pressure, or anybody of a good number of other environmental phenomena. The output is mostly an indication that's converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing [7]. A processing unit represents the microcontroller which is that the main part to process, the input is very depending upon the analyze input from Sensors. A microcontroller (MCU microcontroller unit) may be a small computer on a computer circuit (IC) chip. Its basic job is to receive input and supply the suitable output [8]. Arduino is one type of microcontroller that is able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. As per the output obtain for that output the system has to give the light control response [9]. The output is appeared as design of GUI interface on smart phone or displaying on the monitoring screen using Bluetooth module. To optimize the control of the system, the smart light management system must support bidirectional communication between the user and therefore the system. This management system is implemented employing a communication system and an impact protocol for the lighting. The

communication system will be wired or wireless. The wired communication systems that are normally used include Ethernet-based systems and people supported fiber optics or power-line carrier (PLC). As wireless standards, GSM/GPRS, RF, Wi-Fi, IEEE 802.15.4 and ZigBee. The latter two are liable for the rise of wireless sensor networks (WSNs) [10].

The formula of equation (1) is to calculate the estimated energy saving by street light was obtained from [11].

$$\text{Estimated Energy saving} = \frac{\text{Energy saving}}{\text{Energy consumption full brightness}} \qquad (1)$$

A. Used Sensors

- Light detector resistor LDR sensor:

The LDR will basically check if it's day or night which can be accustomed activate the ON/OFF switch. If the LDR detects light in night and also the IR sensor senses some object at the identical time then the road lights become activated else they continue to be shifted. The theoretical concept of the sunshine sensor lies behind, which is employed during this circuit as a darkness detector. When the LDR detects light, its resistance will get decreased, thus if it detects darkness its resistance will increase. The LDR is a resistor as shown in figure 2 [12].

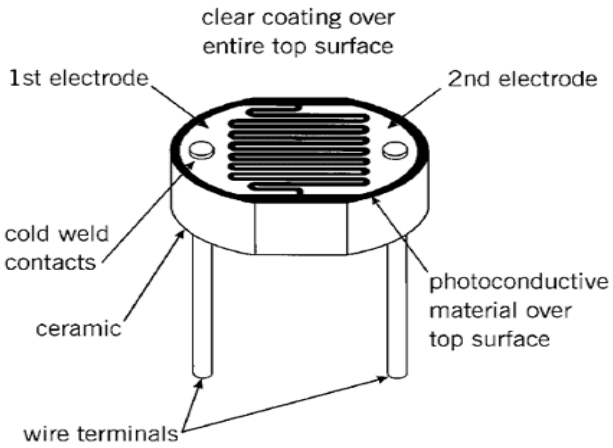

Figure 2: Construction of LDR

- IR (Infrared) Sensor:

The infrared Obstacle Sensor Module includes a built-in IR transmitter and IR receiver that sends out IR energy and appears for reflected IR energy to detect the presence of any obstacle ahead of the sensor module as shown in figure 3. The PCB of this electronic circuit includes a potentiometer. That onboard potentiometer lets users adjust the detection range. The sensor features have an excellent and stable response even in ambient light or in complete darkness [13].

The fundamental concept of an Infrared Sensor which is employed as Obstacle detector is to transmit an infrared signal, this infrared signal bounces from the surface of an object and therefore the signal is received at the infrared receiver. An IR sensor consists of an IR LED and an IR Photodiode; together they're called as Photo Coupler. The basic principle working of IR sensor is shown in figure 4 [13].

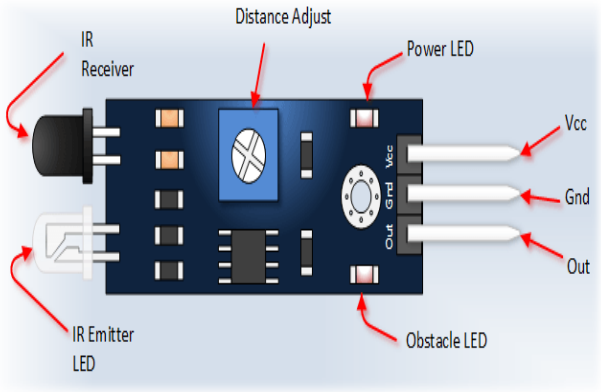

Figure 3: IR Sensor

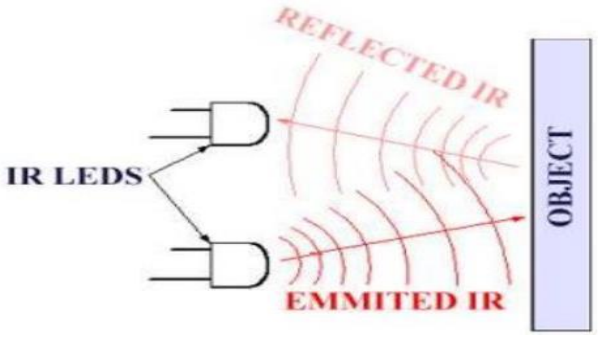

Figure 4: Principle Work of IR Sensor

- The Bluetooth sensor module:

The Bluetooth HC-05 chip is used to create a wireless communication between the system application device and the sensors circuit as shown in figure 5 [14].

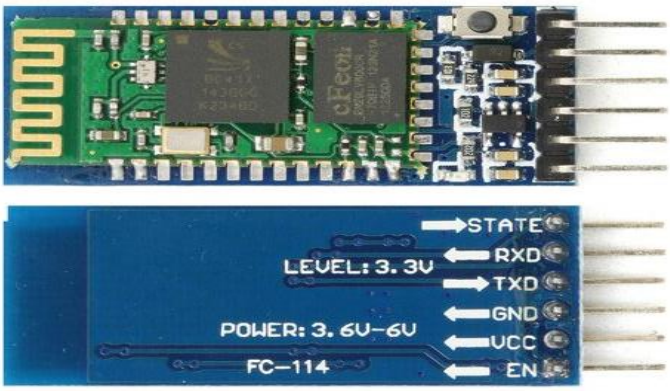

Figure 5: Bluetooth HC-05

- GUI interface:

To send command to the Arduino based system, it's used a user friendly Android App MIT App Inventor. The user just needs to drag and drop the blocks according to the functions he/she needs and then generates a block wise algorithm. Using the Android App, any appliance can be switched on/off. The App sends the corresponding command to the microcontroller board via Bluetooth module. Then, microcontroller encodes the command and performs necessary actions to implement the command.

B. Algorithm software

Figure 6 shows the flowchart of Street Light System. The system starts initializing. Initialize all variables to zero. Then, the light sensor (LDR) will detect the light intensity if the light intensity is low, the light intensity will be low brightness, then the next step is to use the infrared sensor to detect movement in the street. Once motion is detected on the street, the light intensity will be at its full brightness (100%).

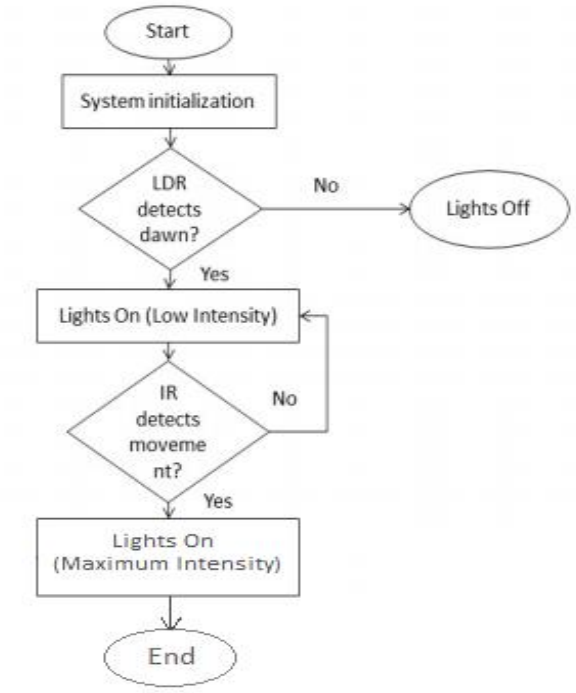

Figure 6: Flowchart of Smart Street Light System

3. System Design

A. Hardware design

The proposed system is designed by using Light Dependent Resistor sensor (LDR), Infrared sensor (IR), Battery and LEDs. All of these components are controlled by Arduino UNO as a microcontroller as shown in figure 7. The dimming of the lights depends on the objects motion in the street, such as pedestrians, cyclists and cars. The higher motion in street, the greater level of light intensity. The response of our system is based on sending instruction to your smart system via Bluetooth Module HC-05. The interfacing with your smart phone to

get an alarm notify that the status of the system. All of the commands from the LDR and IR sensors will be sent to Arduino Uno and the normal function will occur depending on the signals received from the sensor. Finally, the output of the state system will be displayed on phone or on computer to monitor the system and detect the faults.

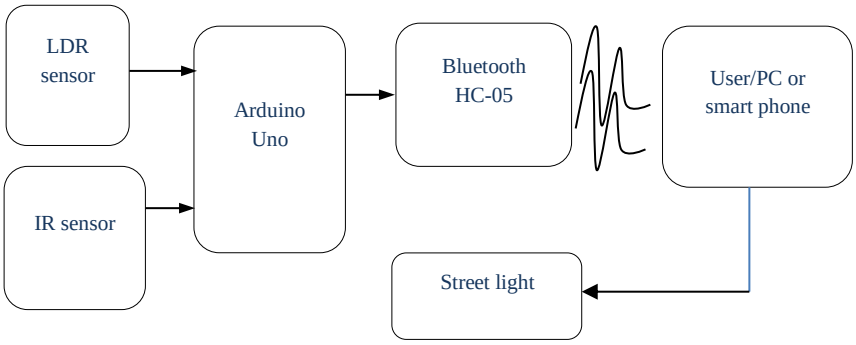

Figure 7: Blook Diagram of Street Light System

B. Simulation design:

It's used Proteus software to simulate the system design. The Proteus Design Suite could be a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. it's then co-simulated together with any analog and digital electronics connected to that. this allows its use in a broad spectrum of project prototyping in areas like control, temperature control and program design. It is also convenient to use as a training or teaching tool [15, 16]. Figure 8 shows the connection system design.

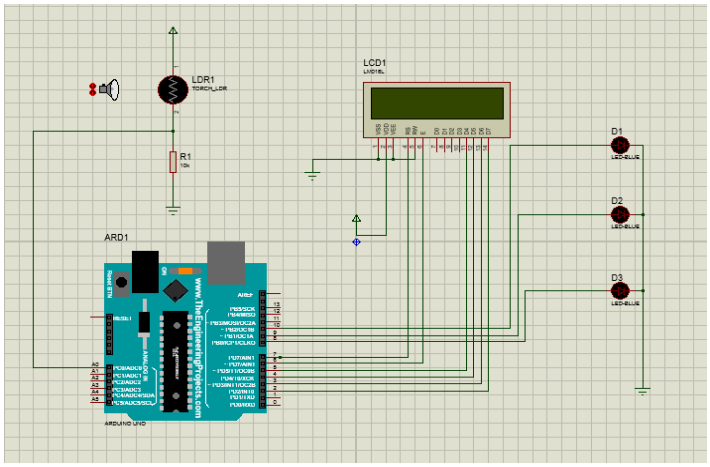

Figure 8: Connection System Design

4. Results and Discussion

A. Practical Results:

This part is arranged to three states categories according to long day, Morning to evening case, evening to night case and the last case will focus in the night period that cars movement and pedestrians are low.

Case 1 :

This case represents the state of lights outside from morning till evening, another meaning there will be no public lights in the street as long as the sun is shining until the sun falls down. At this point the smart system will operate and send alarm to LEDs to be on but at low level of light intensity where there's no movement as shown in figure 9.

Case2:

This part is designed to show the state of smart street is lighting with low level when the street is free of people and vehicles. See figure 10.

Case 3 :

This case will show the state of smart system in the mid night when there's cars passing and people are crossing the street, we notice that the LED bulbs are ON with high level. See figure 11.

Figure 9: A Simple Model of Smart Street Located in Benghazi Showing the Street Lights are Off During Monitoring

Figure 10: Smart Street When There's no Movement Outside Shows Dimming Lights

Figure 11: Smart Street System when There's Cars Movement Shows Lights are Maximum

In order to reduce the power consumption, in our design we have used LEDs bulbs with 9W power consumption. LED street lamps power is about 36W or more [17]. Since this system used 9W LED power, therefore the energy consumption will be 9Watt per hour ≈0.009kWh. This calculation of power energy consumption by street lights is estimated for a month. Therefore, the full intensity of LEDs for a month will be 0.27kWh. The intensity value and the calculated energy consumption and estimated saving between the traditional existing system and smart light system is tabulated in table 1.

$$\text{Estimated Energy saving} = \frac{1.4442}{3.24} \times 100\% \quad (2)$$

$$\text{Estimated Energy saving} = 44.57\% \quad (3)$$

It is shown that the estimated energy saving for 12 hours is 44.57%. By using LDR and IR sensor as proposed in this paper. Therefore, the system can save up to 40 to 45% for a month. See figure 12.

From the graph, it's found that maximum energy dissipation using smart system is at night and is decreasing at evening and morning, while in the existing system, there is a lot of power consumption with

the same rate along the day regardless if it's at morning or evening or even at night.

B. Simulation Results

The response of system was displayed on LCD screen as LED is on during night period as in figure 13.

Table - 1: hour wise power consumption

Time Duration	Intensity (%)	Trad. Sys. Energy cons. (KWh)	Smart sys. Energy cons. (KWh)	Saving Energy (KWh)
7pm-8pm	100	0.27	0.27	0
8pm-9pm	100	0.27	0.27	0
9pm-10pm	100	0.27	0.27	0
10pm-1pm	80	0.27	0.216	0.054
11pm-12am	70	0.27	0.189	0.081
12am-1am	60	0.27	0.162	0.108
1am-2am	50	0.27	0.135	0.135
2am-3am	40	0.27	0.108	0.162
3am-4am	10	0.27	0.027	0.243
4am-5am	15	0.27	0.0405	0.2295
5am-6am	15	0.27	0.0405	0.2295
6am-7am	25	0.27	0.0675	0.2025
	Total	3.24		1.4442

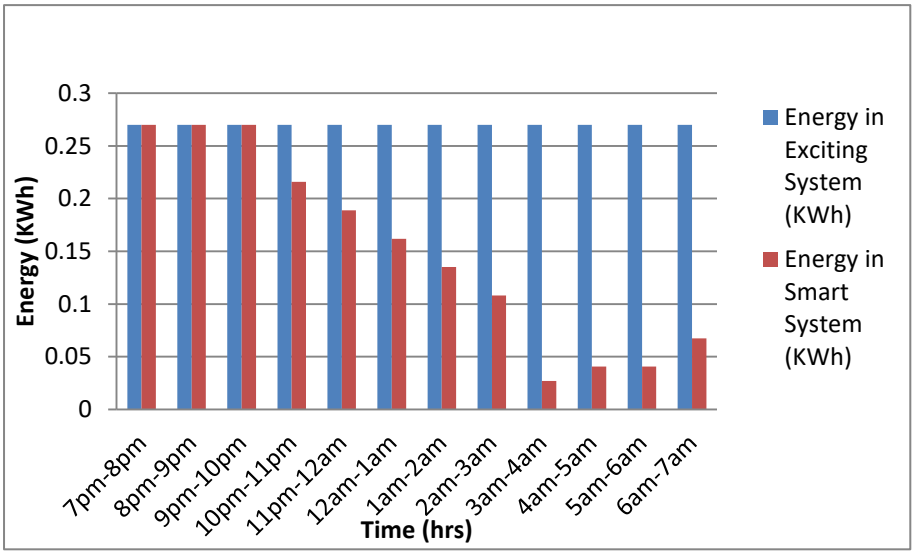

Figure 12: Shows the Energy Consumption Using Existing Traditional system and Smart System

While the message was lights Off when sunshine as in figure 14.

5. Conclusion

This paper discusses the technical aspects of smart street light system and the possible energy saved by designing and implementing this proposed system in Benghazi. Two sensors were used in this proposed smart street light system which is IR Sensor and LDR sensor. By using IR sensor to detect motion in the street. LDR sensor can control the light intensity level resulting in energy saving. Due to the advantages of using intelligent lights can be considered one reason to save the energy. Through the results, it's possible to save energy by up to around 40%-50% per month. The choice of Arduino is based on its flexibility and easy to use, in addition it depends on C-language which is simple and open source. In communication side, it's suggested to use Bluetooth sensor because it's available in my country and it has

useful properties of low power consumption and high of data rate transmission and it's considered as cost less than others. it's great to design such smart system can be used to illuminate automatically and warning the station room in case of out of service, it's also designed to prevent air pollution to reduce carbon dioxide (CO2) emissions by LED bulb.

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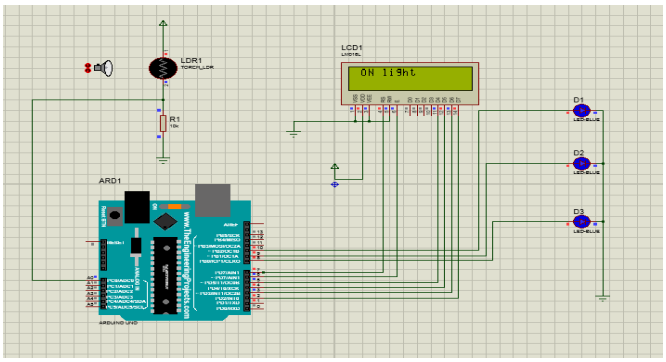

Figure 13: Shows the Simulation Run of Proteus Program During Night and The Lights are On

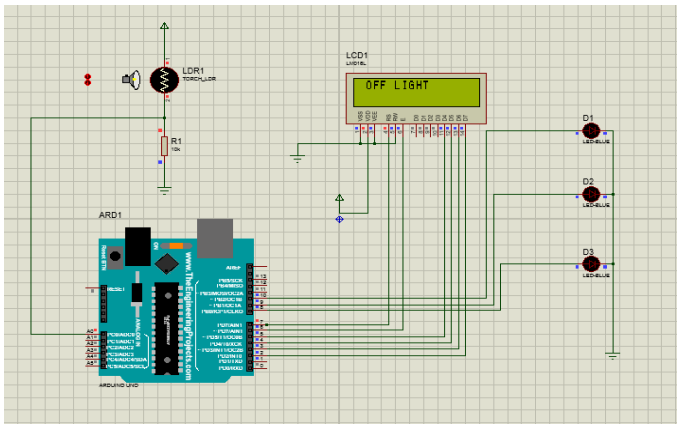

Figure 14: Shows the Street Light System are Off at Sunrise

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6

License Plate Recognition System Using KNN Method

License Plate Recognition System Using KNN Method

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Abstract

Nowadays tracking vehicles is a very cumbersome task due to their voluminous numbers. As a consequence, an automatic identification system becomes a matter of practical necessity. To achieve such an objective, we propose an automatic car License Number Plate Recognition System (LNPRS). The system consists of three parts; the first has the role of preprocessing the image and prepare it for later stages. The second logically segments the license plate sub-image from the original front image of the vehicle. The third part deals with the sub-image that encompasses the license number, for recognition through a set of recognition algorithms based on Knn-Nearest Neighbor method. The final outcome would be the Vehicle Identification Number, VIN. Accordingly, the status of every vehicle would be easily tracked. Experiments on our system produced an overall 91% recognition rate.

Keywords: License Number Plate Recognition System LNPRS - KNN K-Nearest Neighbor - VIN Vehicle Identification Number.

1. Introduction

Typical vehicles tracking system would consist of a camera, a computer contain recognition software. The system acquires the image of the tracked vehicle –from the front or the rare, analyses the image, and obtains the license-plate number or Vehicle Identification Number, VIN.

The quality of the acquired images is a major factor in the success of the LNPRS. LNPRS as a real-life application has to quickly and successfully process license plates under different environmental conditions such as indoors, outdoors, day/night time.

Automatic License Plate Recognition is a computer vision technology that efficiently identifies cars number plates from images without the need for human mediation.

In recent years, it has become more and more important, this is due to the following main factors :-

The growing number of vehicles on the roads, traffic law enforcement, and crimes resolution, as it helps to identify the vehicles of the offenders, difficulty managing busy parking cars area in terms of entry, exit and security.

2. Related Works on LNPRS

In general, License-Number Plate Recognition System, LNPRS, in its essence is more or less a numeral recognition system with added capability for recognizing isolated symbols. Thus, research on the subject is relatively abundant. We shall trace the most resent activities. In [1] researchers provide a typical License-Number Plate Recognition System. The system is composed of the four well-known stages; namely, Image Acquisition, Plate Localization, Character Isolation, and Character Recognition. Each step might include further processing possibility due to the diverse nature of the acquired plate image. They mentioned that LNPRS emerged in the 1980's and

currently there are multiple commercial license plate recognition systems available in the markets. In [2] the authors present a state of the art of the research specifically on LNPRS. They mentioned, among others, that the plate rectangle is detected by different techniques including geometrical attributes, Sobel filters to detect edges of color transition, block-based methods, and Hough transform. Some techniques opted for localizing characters directly in the image of the car using local features [3]. Fuzzy rules are also used to extract texture features from the entire car image to recognize characters [4]. In the recognition phase, they mentioned several recognition methods. These methods include template matching after resizing the character shape to a standard size, and features extraction through feature vector. Classification can be performed by different classifiers including those of neural networks and multistage classifiers [5]. Experimental results of practical LNPRS showed 90% overall success in a data set of 16800 images [2].

3. The Method of KNN Nearest Neighbor

KNN is a non-parametric classification algorithm proposed by Cover and Hart in 1968 [6]. The most used measure in finding the K nearest neighbors is the Euclidean distance [7]. Practically, K nearest neighbors are found by calculating the Euclidean distance between the stored templates and the would-be classified example. Euclidean distance is both easy to program and very efficient. The classification of any given example to a certain class is determined by the highest number of votes of the labels of the k-near neighbors, where k is always a small integer [8].

For instance, if example 1 *x* has *k* nearest examples in the template space and a majority of them have the same label 1 *y*, then example 1 *x* belongs to 1 *y*.

Euclidean distance is calculated as follows:

Having two vectors $x_i$andx_j, where

$$x_i = (x_i^1, x_i^2, \dots, x_i^n),$$

$$x_j = (x_j^1, x_j^2, \dots, x_j^n),$$

The distance between $x_i$and$x_j$is:

$$D(x_i, x_j) = \sqrt{\sum_{k=1}^{n} (x_i^k - x_j^k)^2}$$

The Realized System

Our realized system is composed of the following stages:
As shown in figure 1, below

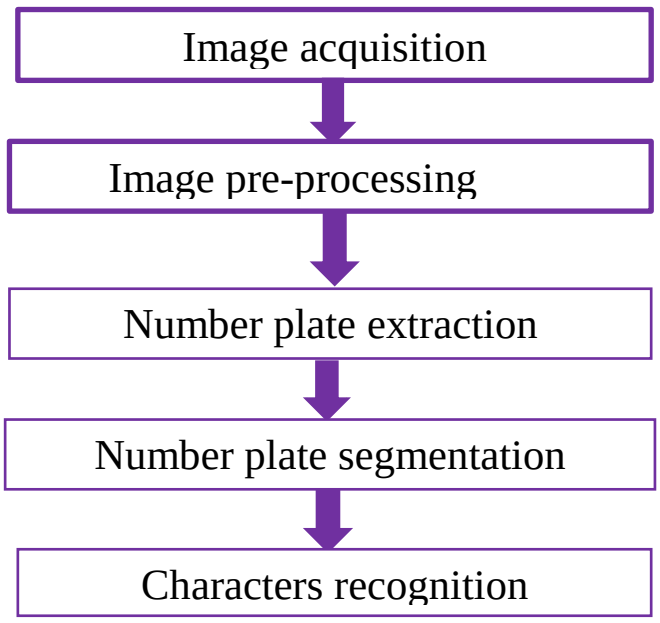

Figure 1: Stages of the LNPRS

Preprocessing

In this stage two basic operations are performed. The first is converting the 24-bit color image to 8-bit grayscale image [9]. The second is removing noise on the grayscale image. These noises appear on the original image in the form of isolated spots or blobs due to physical stains. The purpose of noise removal is to facilitate edge detection, and consequently trace contours. Elimination of noise is usually performed by filtering, our choice was Gaussian filter, a Gaussian filter is a low-pass filter that helps in removing spurious noise, and thus smooth's images. This is done by convolving the image with a low-pass filter kernel. The kernel is a square array of pixels (a small image so to speak), as shown in Figure 2 Gaussian kernel (5, 5).

$$\frac{1}{273}\begin{bmatrix} 1 & 4 & 7 & 4 & 1 \\ 4 & 16 & 26 & 16 & 4 \\ 7 & 26 & 41 & 26 & 7 \\ 4 & 16 & 26 & 16 & 4 \\ 1 & 4 & 7 & 4 & 1 \end{bmatrix}$$

Figure 2: Gaussian Kernel (5, 5)

Each pixel in the image gets multiplied by the Gaussian kernel. This is done by placing the center pixel of the kernel on the image pixel and multiplying the values in the original image with the pixels in the kernel that overlap. The values resulting from these multiplications are added up and that result is used for the value at the destination pixel.

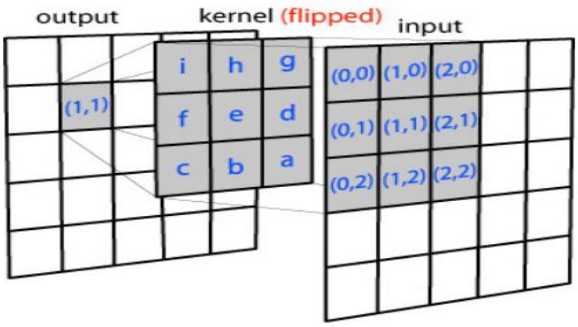

Figure 3: Effect the Gaussian Kernel

The gray-scale image is further converted, to a binary image by a suitable threshold value. In order to obtain a binary image. Thresholding is a procedure of transforming an input gray scale image into a binary image, by using a specific threshold value. The goal of thresholding is to mark pixels that belong to the foreground with the same intensity, and those of the background with different intensities.

Localization of the plate

The objective of this stage is to perform the logical cut-off of the license plate from the entire car image. The basic idea for detecting the license plate in the car image is to search the entire image for the very distinctive shapes of numerals [10]. Once any shape is found, the process is repeated for the adjacent area of pixels until we find no more shapes. By the end of this step all character-like regions represent the borderless plate. Since the numerals in the license plate is usually of black on white background (or the opposite), tracing the contour of these objects is easily achieved [11]. However, to eliminate the contours that do not appear to be characters, we subject the contours to more rigors test. In this test the detected contour should have a minimum area of 100 pixels, a minimum width of 2 pixels, a minimum height of 8 pixels, a minimum aspect ratio of 0.25, and maximum aspect ratio of 1.0. We set a condition that the sequence

must be greater than four characters, because license plates usually consist of more than four letters or numerals. Therefore, any sequence of numerals that are less than this value will not be considered as license plate, even if all the previous conditions are fulfilled. However, if the largest sequence is obtained, and all conditions are met, then the region of the image can be considered as the license plate. The last step is to determine the frame of the license plate In order to segment the characters. This is achieved by applying these measures:

Height of the plate = height of tallest character × 1.3,

Width of the plate = (sum of width of all characters) × 1.5,

(1.3, 1.5 are padding factors) determined by experimentation.

The plate frame is highlighted with red color and cut from the main image as seen in figure 4(c).

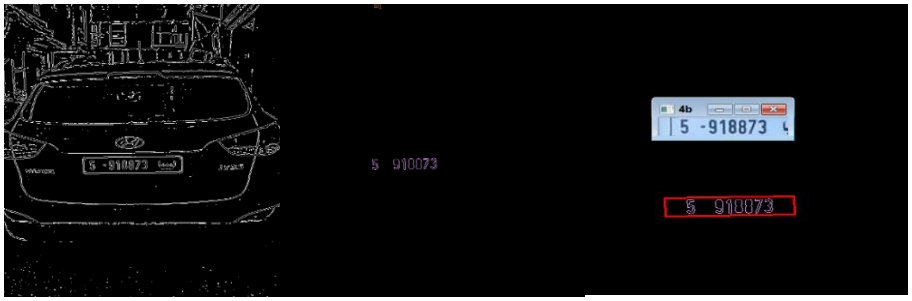

Figure 4: (a) Multiple Contours Detected, (b) Contours of Numbers, (c) Plate Frame.

License Plate Segmentation using Character Contours

Image segmentation is the process of dissecting an image into different regions based on the characteristics of the pixels. By dividing the image into segments, we can make use of the regions of interest

and limit our processing effort to these regions. The final purpose of segmentation is to identify objects or boundaries within the image that help in analyzing it.

Segmentation is one of the most difficult tasks in image processing. The important thing here is to know the location of an object in the image, the exact shape of that object, and what pixels belong to it. To perform segmentation of the characters within the license plate sub-image we use the contour method again to find the borders of each character. Beside that must applying several processing steps to distinguish such contour from other possible contours. These steps are called the morphological operations and their purpose is to clarify further the boundaries of the characters.

Figure 5: Segments of Contours of Numbers

Figure 6: Isolated Small Boxes of Numbers

Recognition of the Characters

Recognition is the last stage in the entire process of automatic license plate recognition, ALPR. It also predated by several steps or sub-stages, namely image resizing or scaling and recognition process.

1- Scaling numeral images

As preparation for the recognition stage all small images of numerals will be scaled to a standard size. The standard size should have a height of 30 pixels and a width of 20, which means the new size will have 600 pixels. The scaling is important for the matching process.

2- The stages of the recognition process

The recognition process of numerals using the k-Nearest Neighbor algorithm is done in two stages:

First stage in which we train the algorithm, where we enter five different shapes for each numeral. Each time we enter one of these small images, we tell the algorithm the identity of the numeral represented by the small image.

Second stage is where recognition takes place. Here the algorithm takes the segmented and resized image of the numeral (input image) for comparison with the images stored in the images file. Because we chose k= 3 in the KNN algorithm, the input image is matched to the three closest images in the image file [12].

Figure 7 illustrates how the algorithm works with the different k values.

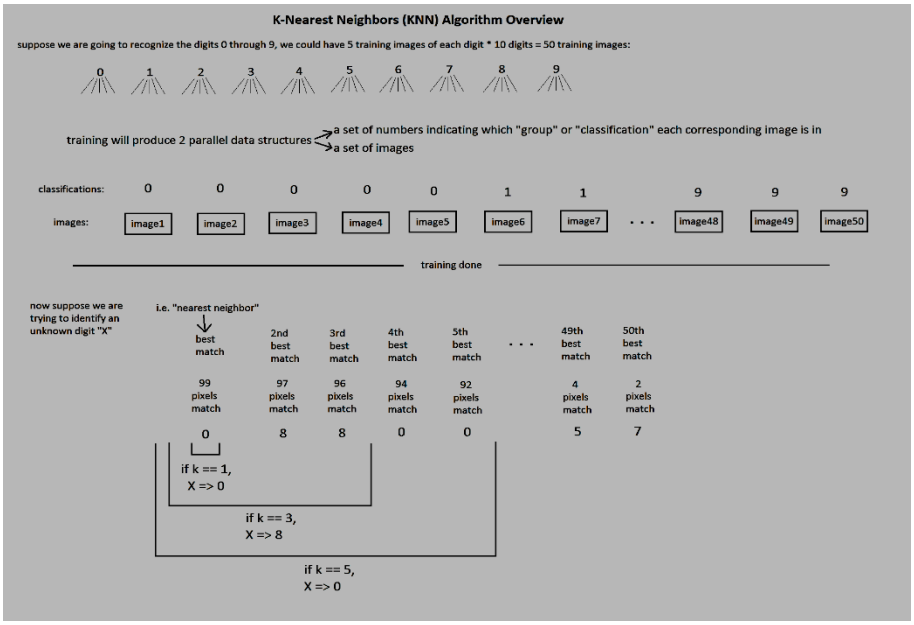

Figure 7: Performance of KNN Algorithm with Different k Value

4. Experimental Results

The method described in previous section is applied to localize and recognize the license plates of 100 various images which were license plates characters.

The method achieved accuracy over 97% for localizing plates. The recognition system implemented by KNN algorithm after segmentation of characters which get accuracy over 94% in image plate, after that identify numbers and achieve an accuracy over 91%.

In the following show a group of pictures with the steps for recognizing them and the final results of the recognition.

These images were selected from 91 images that were identified with succeed.

The pictures have poor quality, deformed, variable lighting, and images have some distortions, images with pins, image with dirt and dust or some oils covering the lower half of the numbers or the plate, and they have been successfully identified.

Figure 8(a) shows a poor-quality picture, while picture 8(b) shows the process of extracting the plate then segment it and identifying the numbers correctly.

Figure 9(a) shows a deformed picture, while picture 9(b) shows the process of extracting the plate then segment it and identifying the numbers correctly.

Figure 10(a) shows images with pins, while picture 10(b) shows the process of extracting the plate then segment it and identifying the numbers correctly.

Figure 11(a) shows image with dirt and dust or some oils covering the lower half of the numbers or the plate, while picture 11 (b) shows the process of extracting the plate then segment it and identifying the numbers correctly.

Figure 8(a) Poor Quality Picture, (b) Results

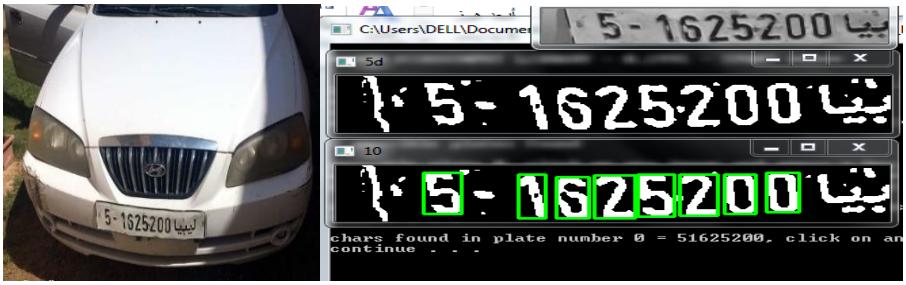

Figure 9(a) Deformed Plate Picture, (b) Results

Figure 10(a) Shows Images with Pins, (b) Results

Figure 11(a) Image with Dust or Some Oils Covering the Lower Half of the Plate, (b) Results

5. Conclusion

We presented a license number plate recognition system, LNPRS, based on the KNN classification method. We tested the system by a sample of 100 images of car fronts of different car types. The camera took the images in a rather casual way, which means the real operating conditions would be either the same or better. The correct localization of the license plates of the sample images was 97%. The correct segmentation of characters within the plate reached a rate of 94% while the final recognition of numerals was 91% in normal operating conditions. However, if we control the process of image acquisition and guarantee the cleanness of license plates, the correct localization would easily be raised to almost 100%, while the correct recognition of numerals, out of the localized plates could achieve 98%. Misrecognition was mainly due to stains in the plates that forced the system to consider numeral 3 as 8 and sometimes 6 as 5. It can be inferred easily that keeping the quality of the plates is the best way for raising the recognition rates. Having done that, it would let the system jump to almost 100% in localization and not far from that for recognition.

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7

Study and Investigation of The Effects of Shielding Failure and Lighting Arrester Position in A 220 kV Substation on Lighting Strokes

Study and Investigation of The Effects of Shielding Failure and Lighting Arrester Position in A 220 kV Substation on Lighting Strokes

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Abstract

Direct lightning strokes is one of the most severe causes of overvoltage and back flashover in high voltage transmission system. Occurring direct lightning strokes near the high voltage substation can leads to severe destruction to substation equipment and extreme outages in the electrical system. The lightning wave arriving in substation can be influenced by factors such as substation building, lightning arresters' position, the lightning strokes waveform and its location as well as tower footing resistance. This paper describes the effects of the Shielding Failure and Lightning Arrester Position in A 220 kV Substation (in line entrance and transformer bay) for protection against the direct lightning strikes by using An Alternative Transient Program / Electromagnetic (ATP / EMTP). A 220kV substation with its components where exposed to the 200 kA direct lightning current hits on top of first tower of transmission line near the substation or shield wires, seldom hits with a transmission line conductors directly in case the shielding failure. The results showed that in the case of absence of lightning arresters in line entrance and transformer bay is going to happen breakdown of the substation, In addition in case of absence of lightning arrester in transformer bay and its presence in line entrance. Whereas find in case Putting the lightning arresters in the line entrance and near the transformer

decreasing overvoltage and back flashover at transformer bay to 478.88 kV and 436.46 kV respectively.

Keywords: lightning arrester position - shielding failure - overvoltage - back flashover - high voltage substation - ATP/EMTP.

1. Introduction

An electric networks component the most exposed to the direct lightning strokes, due to the transmission lines height and length of high voltage system, that strikes the phase conductors of the lines or the towers adjacent to a substation [1,2]. When lightning collides with shield wire or the phase conductors of the lines, the injected current on tower to soil and cause's overvoltage and back flash over, which causes many outages and insulators failure of substation components such as transformer, this effects the power quality and the reliability of the system. [3,4]. Lightning over voltages is classified as Fast Transients, which cover a frequency range from 100 kHz up to 100 MHz [5].

The study of the lightning effects and the design of an suitable protection system against lighting strokes is analyzed on many factors the like: towers' surge impedance, pulse surge impedance of the grounding network, the polarity of the pulse and line's span [6]. design of the transmission line and substation structure and tower footing resistance value, lengths and cross sectional areas of high voltage cables, the location of the lightning stroke on transmission system. Added to this, the installation or not of lightning arresters at various positions of the substations has a significant impact on the magnitude of the developed over voltages and the expected outage rate[7-9]. The protection of substations against the damaging effects of lightning strokes may be realized by using highest insulation levels, taking into account the financial cost, or by installing overhead ground

wires in order to intercept the back flashover [10,11]. In [12,13] it was specified About study the effect of separation distance of Porcelain and Silicone Polymer Lightning Arresters under Direct Lightning Strokes for A 400KV Substation Protection, The results showed that in case porcelain arrester if the increased separation distance at transformer (15m) is going to happen breakdown of the substation, Whereas find that in case silicone polymer arrester if the increased distance at transformer from 5m to 30 m be a good transformer protection, As well as showed that silicone polymer arrester is better and more acceptable than the porcelain by lighting current (300 kA) for the same studied network, In [14] was to study the range of the effect of tower footing resistance in 220kV substation for protection against lightning strikes, The results showed that better value for the tower footing resistance are 15Ω and less. occurs transformer insulation breakdown if the value of the basic insulation level (BIL) is less than 20%. To improving the transformer protection, reduce the first tower footing resistance near the substation less than 10Ω.

In the present paper, the effects of shielding failure and lightning arrester position for A 220KV Substation protection against the directly lightning strikes have been presented based on lightning currents simulation by using program (ATP) with positive polarity. The paper is organized as follows: test system including the studied tower and lightning arrester and insulator string & substation equipment are evaluated in section 2. Result of system model included in the paper is mentioned in section 3 and finally the most important results are elaborated in section 4.

2. Test System

A 220 Kv network composed of three towers and the 220/30 kV substation. The 220kv double circuit transmission line has double bundle conductors. Tower footing resistance of this system (10) ohms, with the changing lightning arresters' position between transformer

bay and line entrance of substation respectively, and the lighting current value (200 kA) on shield wire and phase conductor (shielding failure) directly for first tower near the substation by applying waves with positive polarity. The figure 1. Shows the structure of the studied tower, and figure 2. Shows test system for a 220 kV network using a program ATP. The parameters of the transmission lines and geometrical limits of the tower are given in table's 1-3 [14-18].

Table 1: the parameters of the transmission line

Line Voltage	Conductor	GMR (ground wire)	GMR (conductor)
220kV	AAAC	1.89mm	13.715mm

Table 2: geometrical limits of the tower

Parameter	H total m	H1 m	H2 m	H3 m	H4 m	B m
Value	46.85	11.72	6	6	23.13	6.4

Table 3: tower parameters

Resistance	value	Inductive	Value	Impedance	Value
R1 Ω	24.26	L1 mH	0.00722	LINE Z1 Ω	220
R2 Ω	12.42	L2 mH	0.00388	LINE Z2 Ω	220
R3 Ω	12.42	L3 mH	0.00388	LINE Z3 Ω	220
R4 Ω	34.48	L4 mH	0.01046	LINE Z4 Ω	150

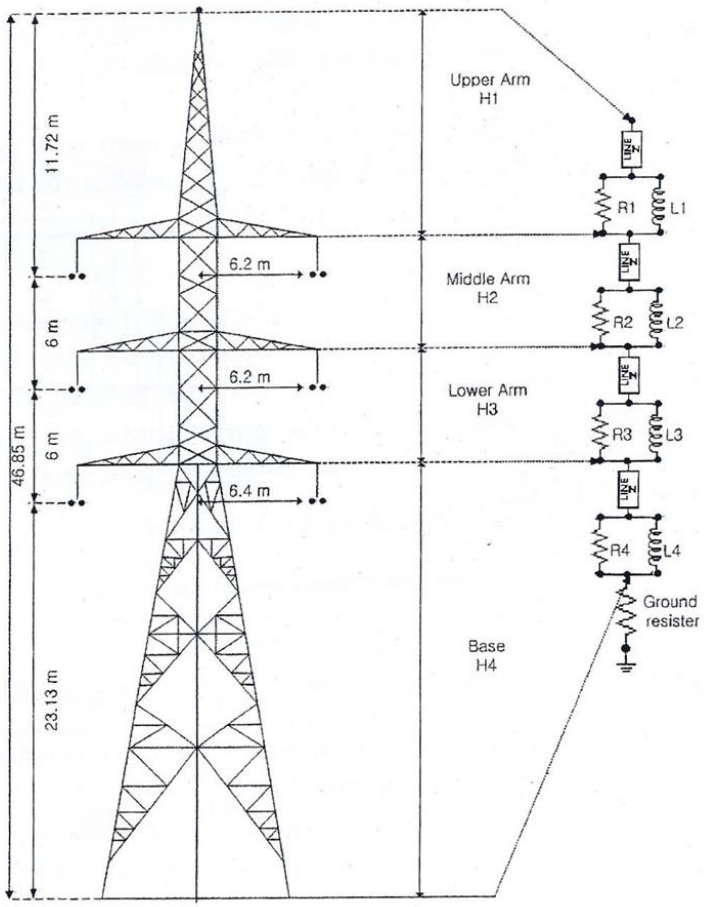


Figure 1: 220 kV Tower for Test System

In this model, system components of the considered system are introduced, Tower surge impedances(Z) are calculated using equation (1), and the tower footing resistance (Ri) is at high impulse current may be estimated by "(2)" [21-23].

$$Z = 60 \cdot \{ \ln(\frac{H}{R}) - 1 \} \qquad (R<<H) \qquad (1)$$

$$R_i = \frac{R_o}{\sqrt{1+\frac{I_R}{I_g}}} \qquad (2)$$

Where Ro is footing resistance measured with low current, IR is the lightning current through the footing resistance, Ig is the current required to produce a soil gradient, E0, at which soil break down occurs. This current is given by "(3)".

$$I_g = \frac{1}{2\pi} \frac{\rho E_o}{{R_o}^2} \quad (3)$$

Where ρ is the soil resistivity (Ω-m) and E0 is the soil breakdown gradient, assumed as 400 kV /m.

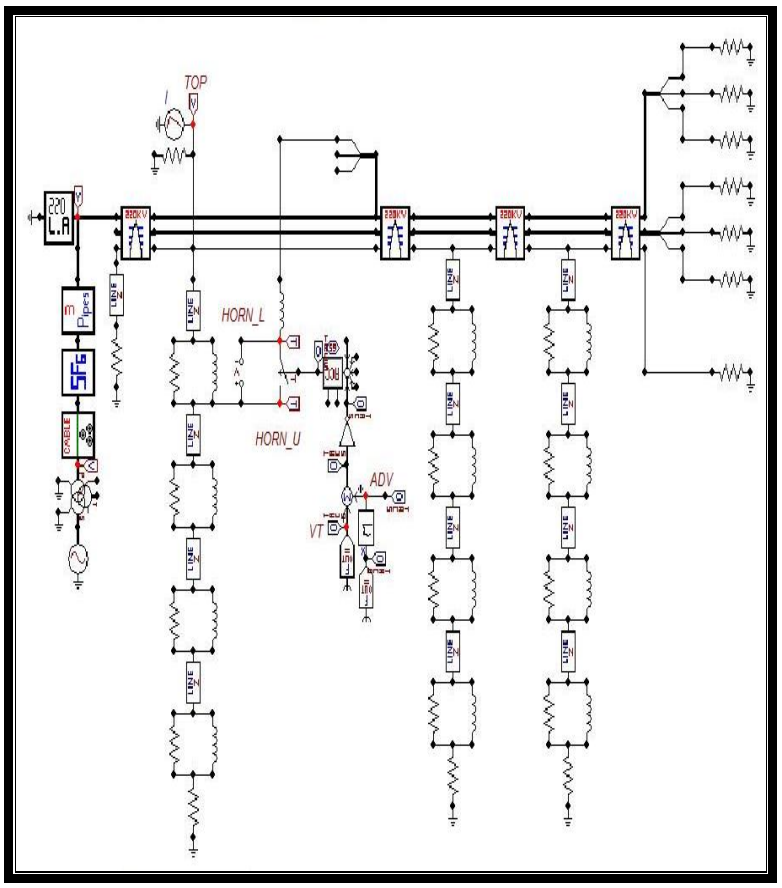
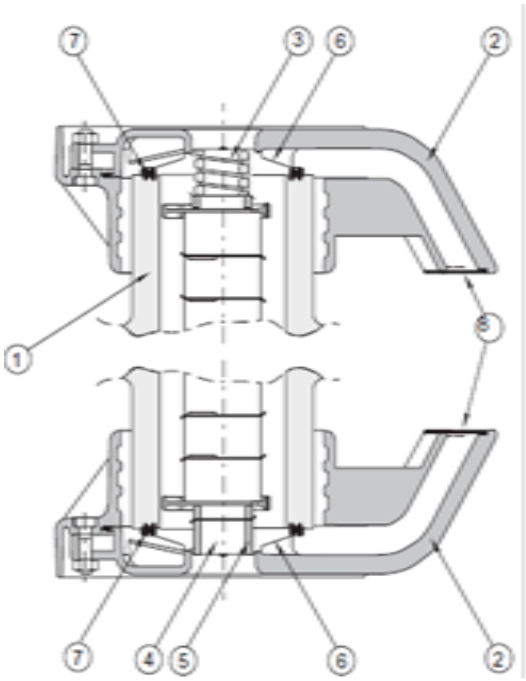


Figure 2: Structure of 220 kV Test System [12, 24]

A. Model of Porcelain Lightning Arrester

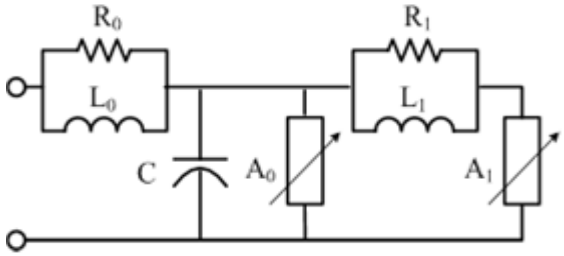
Lightning arresters used at substations and at line ends for Protection of transformers, switchgears, such as protective elements (circuit breaker grading capacitance), power transmission elements (conductor to earth capacitance, cables capacitance, bus bar capacitance, coupling between double circuit lines, capacitor banks), isolation elements (bushing capacitance) or measurement elements (capacitive voltage transformers). Additionally, low resistance systems in high voltage systems against direct lighting strokes and switching surges, discharge the lightning over voltages and insulation string flashover, these are capable of discharging 10 to 20 kA of long duration surges (8/20 µsec) and 100 to 300 kA of the short duration surge currents (1/5 µsec) [11,12]. The Metal-Oxide Surge Arrester (MOSA) made from Porcelain, with resistors made of zinc-oxide (ZnO) blocks [13]. The figure 3. Shows the structure of the studied arrester which is determined through nonlinear resistance A0, and A1 , as well as other values, respectively L0, L1 induction and R0, R1 resistance, the model of MO arrester according to IEEE standards. is shown in figure 4 [19-22].



1. Porcelain insulator
2. Flange cover
3. Spring
4. Desiccant bag
5. Copper sheet
6. Sealing cover
7. Sealing ring
8. Indication plate

Cutaway view of a typical EXLIM unit showing the internal arrangements designed to minimize partial discharge

Figure 3: Shows the Structure of Porcelain Lightning Arrester



Where

R0 = 100d / n [Ω], R1 = 165d / n [Ω], L0 = 0.2d / n [μH], L1 = 15d / n [μH], C = 100 n / d [pF]
d is the estimated height of the arrester in meter. n is the number of parallel columns of MO in the arrester.

Figure 4: Model of MO Arrester According to IEEE Standards

B. Insulator String Model

Characterizes insulator string as an electrical switch, which closes when the voltage exceeds a defined limit. Over voltages stress the insulators of the line, resulting in a flashover in case of exceedance of the BIL (figure 5). The flashover depends on the voltage level due to different insulation clearances and various reasons, such as the form of the insulating disk, the pollution of the surface of the discs etc.

The flashover voltage characteristic of the insulator string is time dependent. The insulator flashover will start when the actual terminal voltage of the insulator exceeds the flashover critical voltage [23,24]. Choosing a correct value of flashover voltage is important, since it influences on the overvoltage wave moving toward substation. The flashover voltage of insulator string is calculated using "(1)" [24,25].

$$V_{fo}=(400+710/t^{0.75}).L \quad (4)$$

Where Vfo is flashover voltage (kV), t is flashover time (μs) and L is insulator string length (m). The surge current is given by a double exponential equation:

$$i(t) = I \cdot (e^{-\alpha t} - e^{-\beta t}) \quad (5)$$

where: α, β are constants, dependent on the surge current wave shape. Generally, the annual number of direct lightning strokes in a substation is given by the equation:

$$D = 10^{-6} \cdot W \cdot L \cdot N \quad (6)$$

where: W and L are the dimensions of the substation (width and length) and N is the number of flashes to earth per square kilometer per year.

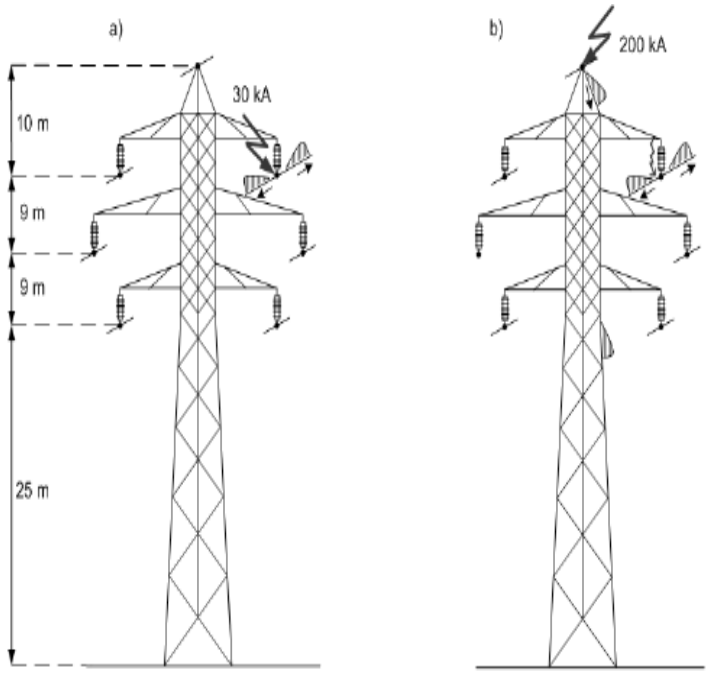


Figure 5: Direct Stroke (a) and Back-flash (b) Phenomenon Representation

C. Substation Equipment Models

Electrical equipment, such as the circuit breaker, capacitive voltage transformer, disconnector, etc., can be as capacitors in the case of surge strikes. Equal capacitances of equipment used in substation are brief in table 4. Bus bar and interconnections between the substation equipment should be modeled by lumped inductance, its unit value being 1 μH/m, the lengths less than 15 m, The impedance measured for bus bar is 250 Ω [2,3].

Table 4: equivalent capacitance of substation equipment

Substation Equipment	Equivalent Capacitance (pF)
Power transformer	2000
Current transformer (CT)	200
Capacitive voltage transformer (CVT)	5000
Disconnector	150
Circuit breaker	500

3. ATP Analysis of 220 kV Test System

Two cases were done to test the system under study, will study the resulting voltage from a stroke by lightning current has a rang 200 kilo amperes on ground wire and the transmission line directly with changing the lightning arrester position between transformer bay and line entrance of substation respectively.

A. Lightning Strokes in Ground Wire

When ground wires are stroked by lightning current has a rang 200 kA, the overvoltage produced by back flashover necessity to be analyzed. Lightning strikes to the tower top or ground wire can cause back flashover due to line insulation string flashover between the

tower arm and the line phase conductor, and can enter the substation and propagate inside according to the substation equipment design [26-27]. Putting the lightning arresters in line entrance and transformer bays increasing substation protection against direct lightning strokes.

In this case, the effect of absence and presence of arresters in line entrance and transformer bay is investigated. Figures 6-9 show the effects of lightning stroke on ground wire to the first tower which is 50 m from substation for cases are without arresters and their presence in the line entrance and close to the transformer. In each step, it calculates the basic insulation level of the transformer BIL by the equation:

$$\%BIL = \frac{BIL - \max overvoltage}{\max overvoltage} \times 100 \quad (7)$$

Where: (BIL) equal 850 kV [17-19].

(max overvoltage) is the maximum voltage on the primary side 220kV for transformer.

When be the transformer overvoltage due to back flashover is 1485.3 be BIL: Then:

$$BIL = \frac{850 - 1485.3}{1485.3} \times 100 = -42.77\%$$

The values of the overvoltage due to back flashover for various cases in line entrance and transformer bay are presented in table 5.

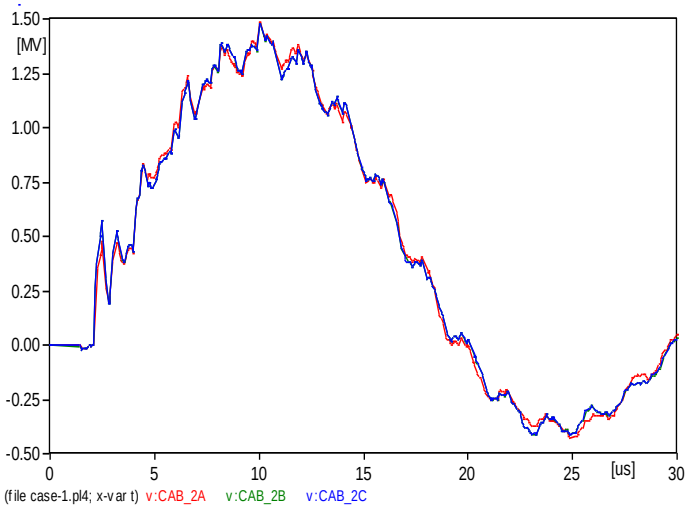


Figure 6: Effect of Lightning Stroke to Ground Wire on Transformer Voltage at Absence of Arresters in Line Entrance and Transformer Bay

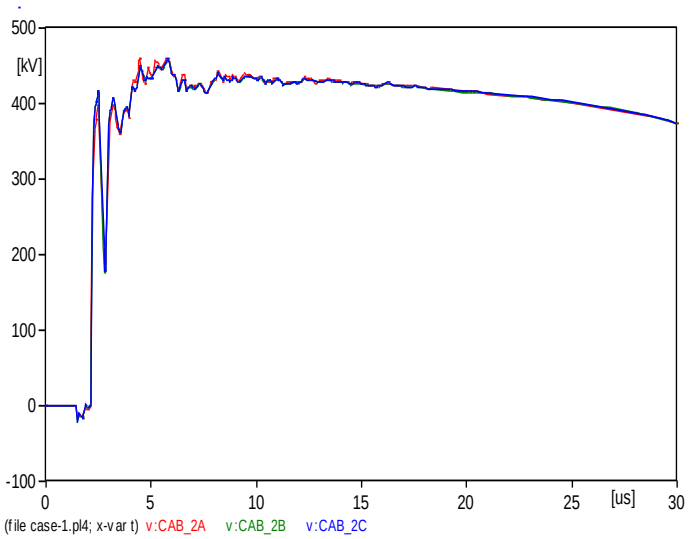


Figure 7: Transformer Overvoltage at Presence of Arrester in Transformer Bay and its Absence in Line Entrance

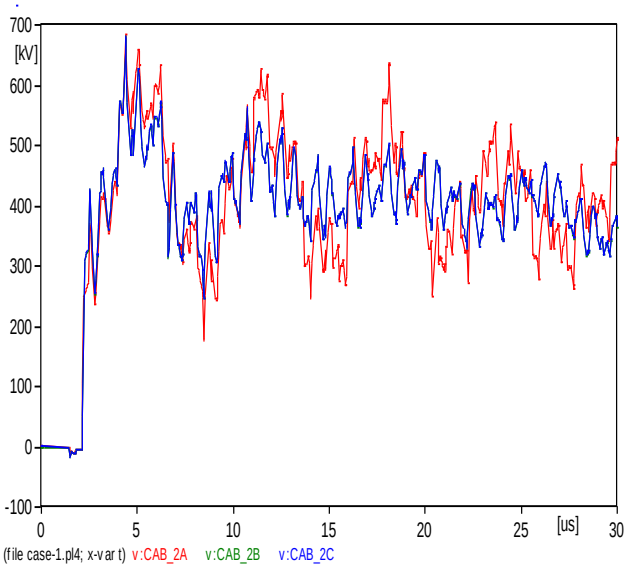


Figure 8: Transformer Voltage at Presence of Arrester in Line Eentrance and its Absence in Transformer Bay

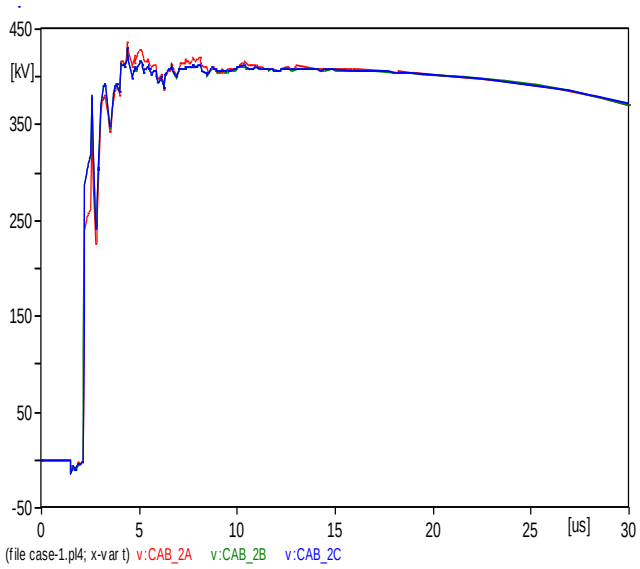


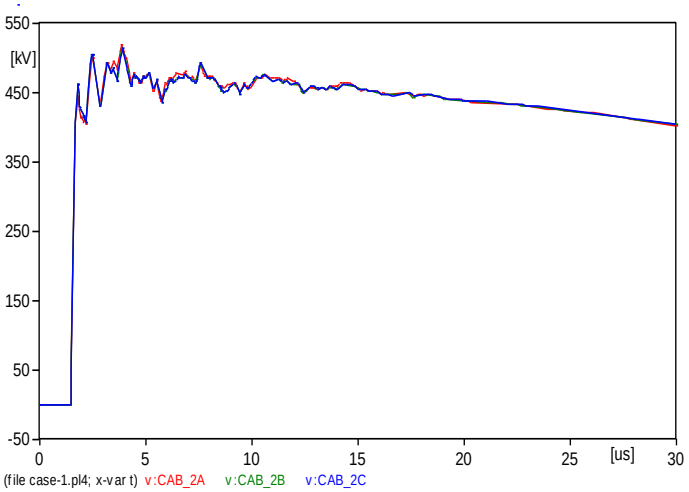
Figure 9: Transformer Voltage at Presence of Arresters in Transformer Bay and Line Entrance

Table 5: the values of overvoltage due to backflashover for various cases

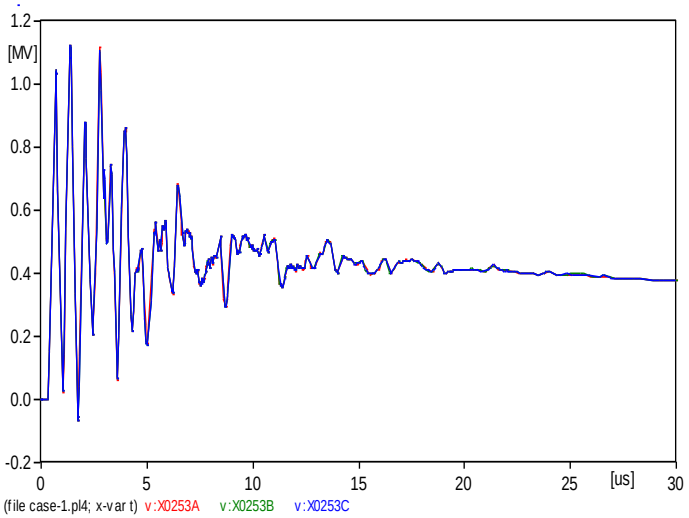
Surge arrester position	Maximum Overvoltage on Equipment (kV)		Basic insulation level of the transformer
	Line Entrance	Transformer	BIL %
Absence of surge arrester	1454.18	1485.30	-42.77
Close to transformer	718.17	460.53	84.56
Line entrance	477.31	684.28	24.2
Close to transformer and Line entrance	422.00	436.46	94.7

B. Lightning strokes in phase conductors

In case of lightning strokes into the phase conductor the external phase (A), It is more possible to be hit, as it is less shielded by the ground wires. the effect of absence and presence of arresters in line entrance and transformer bay is investigated by ATP program. As it is shown in (figures 5a,10). an overvoltage wave is injected into the phase conductors and propagates into the system. The values of the line entrance and the transformer overvoltage for various cases are presented in table 6.



(a) Transformer Voltage



(b) Voltage in Line Entrance

Figure 10: Effect of Lightning Stroke to Phase Conductor at Presence of Lightning Arrester only in the Transformer Bay (a) and (b)

Table 6: the values of the overvoltage for various cases

Surge arrester position	Maximum Overvoltage on Equipment (kV)		Basic insulation level of the transformer
	Line Entrance	Transformer	BIL %
Absence of surge arrester	2484.70	2530.80	-66.44
Close to transformer	1124.10	520.22	63.40
Line entrance	522.93	976.11	-12.9
Close to transformer and Line entrance	447.78	478.88	77.50

4. Conclusion

In this paper, the effects of a lightning arresters position in A 220kV substation under direct lightning strokes is simulated and analyzed by the ATP program, and by applying waves with positive polarity on the ground wire and transmission line directly. The basic insulation level(BIL) of the transformer in this study is 850 kV. According to results, in the case of absence of lightning arresters in line entrance and transformer bay, at lightning stroke to shield wire on first tower near the substation cause appearance of excessive overvoltage on transformer its value (1485.30 kV) due to back flashover on insulator string. In addition, in the case of presence of lightning arrester only in the line entrance, it produces 684.28 kV on the transformer. In the worst case of lightning stroke spot on phase conductor on first tower near the substation at absence of arresters that produce excessive

overvoltage on transformer its value (2530.80) kV which exceeds the BIL. Putting the lightning arresters in the line entrance and near the transformer decreases this value to 436.46 kV, In cases when insulator string flashover occurs between tower arm and phase conductor near the high voltage substations, short circuit currents can have high magnitudes that enters the substation and causes insulation stresses on winding the transformer. The installation of lightning arresters in line entrance and transformer bay can minimize operation of the circuit breakers and improves the overvoltage protection of the entire substation.

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8

Predicting of Students Final Score in An Academic Courses using Machine Learning Algorithms

Predicting of Students Final Score in An Academic Courses using Machine Learning Algorithms

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Abstract

The application of Artificial Intelligence in teaching and learning process became an essential element to achieve the objectives learning quality. This paper presents the application of machine learning techniques to predict the performance of students at the Libyan academy. The aim of this research is to investigate the application of several machine-learning techniques such as General Classification, Logistic Regression, Neural Networks, Decision trees and Support Vector Machines, Linear and Multi Linear Regression, in predicting student's grades based on historical information collected from the department of electrical and computer engineering department at the Libyan Academy of post graduate studies. This paper will carry out a methodology for collecting and preprocessing student's data, and then the algorithms will be trained on the prepared data. The obtained models will be tested using testing data collected from the same

domain. Results analysis will produce a comparison of the algorithms, which will indicate the value of the different algorithms.

Keywords: machine learning, prediction, student's performance, support vectors, decision trees, neural networks, Classification, Logistic Regression, Linear & Multi Regression.

1. Introduction

Education is a fundamental human right, which is stated in different statements that it should be granted universal access with equal quality [1]. In order to improve education, it is important to find other effective and efficient ways. Considering education, higher education institutions have started to build blended learning approaches into their traditional teaching mechanisms to enhance learning and teaching in terms of instructor- generated as well as learner-generated content [2]. Innovations done in technology and multi-disciplinary fields provide new opportunities to change the nature and delivery of teaching without increasing teachers workloads. It is believed that quality in higher education is increased. One of the fields of AI is Artificial Neural Networks (ANN) are used to understand ، differentiate and improve learning strategies of the students by Providing detailed educational information to the teachers to improve students' learning strategies [2].

Additionally, popularity of Massive Online Open Courses (MOOCs) has increased dramatically recently. As it is stated in [3], researchers are allowed to address problems, which were not accessible few years ago. Recently considering the educational system. Different researches in the literature analyse and verify Development and evaluation of AI tools that improve teaching and learning [4]. Several detailed methods are proposed to simulate student's behaviour to guide teachers. These behaviour can be listed as complex student responses and learn as they operate; to perceive where and why a student's

understanding has gone, to offer hints to help students understand the material.

According to the educational studies in the literature ،AI tools enhance contribution to the theory of learning. Those techniques are needed for almost every phrase in the definition of intelligent tutors mentioned above [4]. Artificial Intelligence (AI) in teaching and learning processes has a surprising evolution. New technologies in education are preferred to help people achieve better educational goals [1 to 7]. AI enabled educational tools have gained importance to attract attention also to improve education quality and enhance traditional teaching and learning methods [5].

As stated in different researches, AI technology has developed computer tools for carrying out a number of tasks, simulating the intelligent way of problem solving by humans [6]. The AI technology has also been suggested in the field of special educational needs (SEN) as one of the most valuable applications considered [6].

Although the benefits of AI in education have been acknowledged for many years, usage of AI tools within special education has not considered effectively [6]. The benefits of AI techniques have been gradually used to improve the life of those people with special educational needs [6].

AI make valuable contributions to address long-term educational goals. AI tools have new opportunities to analyse vast data sets of instructional behaviour collected from rich databases, containing elements of learning, affect, motivation, and social interaction [7]. Traditional educational environment is considered as fixed classrooms، repeated lectures and static printed textbooks are not sufficient and effective in today's technological world. Especially, people who use technology on daily basis are not interested to classrooms and printed textbooks.

Apart from the learning strategies, AI techniques can guide Educators to improve their teaching strategies. For instance،

Sometimes teachers may not be aware of gaps in their lectures and learning materials, because of different students have different learning styles, abilities, interests and needs [8]. Homework and classes could be customized based on these characteristics. Classes could be customized based on these characteristics. In their research [8], author stated that Coursera, which is a massive open online course provider, has already started to apply. It is believed that this type of applications can help both teachers and students to explain uncertainties, and to ensure to build the same conceptual foundation respectively. This will help educators workload in terms of time and increase student`s performance and positive feedback [8].

Machine Learning (ML) is expected, in the near future, to provide various venues and effective tools to improve education in general, and Science-Technology-Engineering-Mathematics (STEM) education in particular. The Gartner Analytics Ascendancy Model requires the use of four types of data analytics to be considered comprehensive: descriptive, diagnostic, predictive and prescriptive data analytics [9].

Different machine learning algorithms are useful and effective for different kinds of problems as prediction and classification. Any educational data can be predicted or classified by machine learning algorithms and obtained results might be improved by considering different kinds of data selection and machine learning algorithms [10].

This paper will use the machine learning algorithms Several times to analyse the efficiency of five techniques based on their prediction, the Techniques are: General Classification, Logistic Regression, Linear and Multi Linear Regression, Decision trees, Neural Networks, and Support vector machines algorithms for Regression and Classification and give answers to the following questions:

Q1- How can we predict the student's final score given Historical information with other features in Mandatory course taken in at the material study stage during the program plan in Libyan Academy and Identifying failed students early?

Q2- What are the reasons that led to students' failure in the course?
Q3- Do Background knowledge have an effect on the outcome of the student and his level.

2. MACHINE LEARNING ALGORITHMS

In this paper, six machine learning algorithms for Regression and Classification ; namely General Classification, Artificial Neural Network (ANN), Support Vector Machine (SVM)
Logistic Regression (LR), Decision Tree, Linear and Multi Linear Regression have been used in order to predict student performances and two of these algorithms; General Classification and Logistic Regression, which is classification, are also considered in the classification experiments .In addition to these algorithms، Linear and Multi Linear Regression (L-M-R)) is implemented in
Regression phase.
Artificial Neural Network is a supervised neural network, which is used for both prediction and classification of data. It uses Identity and Logistic as Activation Function during the learning and propagates back the error to update weights and minimize error value.
Decision Tree is another type of algorithms, which used to regression and classification.
Support Vector Regression is the prediction type of Support Vector Machine, which assigns support vectors in order to separate features.
In classification phase, increment of classes may cause the reduction of success rate in SVM however; it can be used effectively for 2-class problems [10].

3. BULIDING THE MODEL

A. DATA COLLECTION

Transcripts data for students who graduated and continues in study program from the department of electrical and computer engineering at the Libyan Academy from the year 2013 to year 2019 were

collected from the database management system and the total number of students was 80 students. The collected data organized in CSV file is 20 students. Each student record had the following attributes: student ID, age (date of birth), year of graduation (obtaining a bachelor's),GPA of Bachelor, and scientific experience after obtaining a bachelor's in the same field, Living or Address (distance between housing and the place of study), the social situation), and the courses taken by the student including the course' grade.

The collected data was organized in Microsoft Excel sheet and saved as CSV file to deal with it in programming language .A student should get a minimum of 65% in the Subject to pass it and anything less than that is considered as fail. The data set is pre-processed according to the Academic rules and the marks obtained by the students are converted into binary classification and Continues value in regression form for the purpose of research. Table (I) below shows the evaluation system in Libyan Academic.

TABLE I: CLASSROOM EVALUATION SYSTEM

Percentage		Letter Grade	Grade Points
From	To		
85	100	A	4
81	84	A-	3.7
78	80	B+	3.5
75	77	B	3
71	74	B-	2.7
68	70	C+	2.5
65	67	C	2
61	64	C-	1.70
57	60	D	1
53	56	F	0

Table (II) shows the conversion of numerical values into binary values for classification.

TABLE II: BINARY VALUES OF THE TOTAL MARKS

Marks scored	Outcome
Score between 0-64	0
Score between 65-100	1

Table (III) shows the conversion of nominal values into Continues values for Regression

TABLE III: CONTINUES VALUES OF THE TOTAL MARKS

Marks scored	Outcome
A-	82
B-	72
A-	81
A	86
B+	78
B-	73
B	76
B+	79
A-	83
A-	84
F	54
D	60
C-	62
C-	61
C-	63
C-	64
D	58
C-	61
C-	62
F	55

B. TOOLS USED

Tools used to apply the Machine Learning Algorithms, there exists well-established packages, and we used several software systems such as Python Software 3.7, Spyder Console, Jubyter Notebook, SKlearn Library with methods & Classes, Numpy, Pandas, MatplotLib, Seaporn, Scipy.io, Tree.DecisionTreeRecgresor &Classification, SVM.SVR, SVM.SVC, Neural_network.MLPRegressor &Classification.

C. DATA PREPARATION AND PRE-PROCESSING

During this phase, we applied some pre-processing for the Collected data to prepare it for prediction and classification. At beginning, we eliminated some irrelevant attributes, e.g. student name, nationality. We also removed all the data related to the general and elective courses to focus only on the program mandatory courses. Then, we re-arranged. Table IV so that each student has the following attributes: GENDER, AGE, MS, final GPAOB, GAPGBEM, EXPERIENCE, ADDRESS, and the course grades student took during his study program. In the final step, we discretized the numerical attributes to categorical ones. For example, we grouped the final GPA into four groups: excellent, very good, good, and poor. In the same way, we discretized the students' grade in course into A+, A, B+, B, C+, C, D+, D and F. The following Table (IV) demonstrates a sample of the data that we worked on.

TABLE IV: SAMPLE OF DATA

	GENDER	AGE	MS	GPAOB	GAPGBEM	EXPERIENCE	ADDRESS	target
0	15	29	4	75.13	2	18	2	0
1	16	29	4	65.11	2	19	9	0

D. DATA VISUALIZATION

After loading the data to Python Software, we got some primary useful knowledge about the attributes before applying any method by using the visualizing technique in the software. There are basic features that help us to identify whether they have an impact on the level of the student by showing the features, and the final Score of the student in the training, and test periods used in this research to predict the final score as shown in figures classification of age, and Final score (1), Gap and final score (2), GPAOB and Final score (3), Address and Final score (4).

Observed that have three cases of students who successfully passed the course.

- Students whose age is equal to thirty years.
- Students over the age of thirty years.
- One student was under thirty years old.

On the other hand, we observed that have two cases of students who did not successfully pass the course.

- Two students, were under thirty years old
- In addition, eight students who were over thirty years old.

For instance, we discovered that age, is considered one of the mental abilities associated with ability to learning and focus for the student in course, has an effect on the student's performance as shows in Fig. (1)

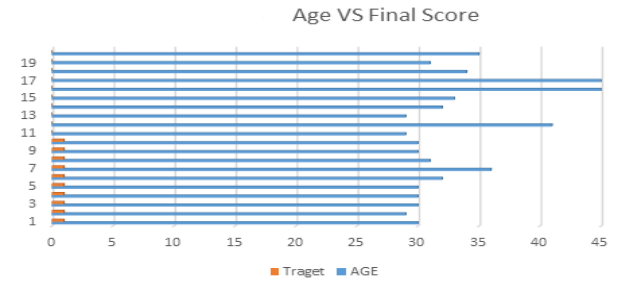

Fig 1: Age VS Final Score

Observed GAP and final score that we have two cases of students who successfully passed the course.

- Students whose GAP is equal to one year.
- Students with GAP over one year.
- One student with GAP up to two year.

On the other hand, we observed that two cases of students who did not successfully pass the course.

- Students whose GAP is equal to two year.
- One student with three years GAP.
- In addition, two students who were over three years.

That is, GAP, is considered as one of the financial status, and has a role. When the Gap is increased then the student would be fail that course, the effect of age on the student's Performance in the course as shows in Fig. (2)

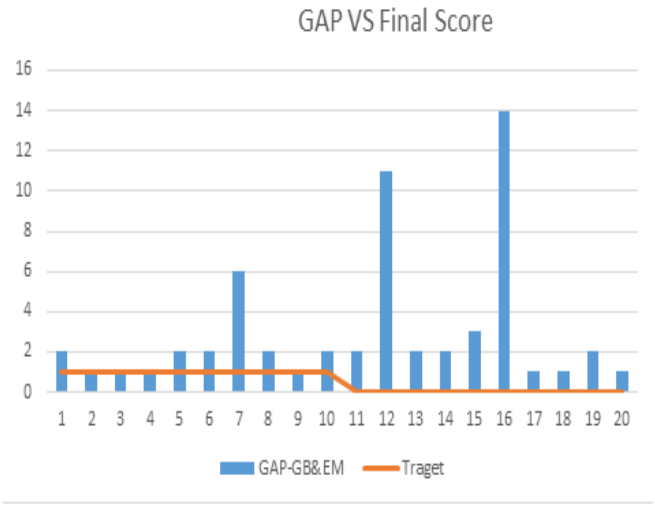

Fig 2: GAP VS Final Score

GPAOB - GPA of bachelor's graduation College and universities may use different grading systems Based on numeric values of student total final GPA. Observed from below figure three cases of GPAOB were observed in this research.

- Very Good
- Good
- Poor

Very good, that means students who got 75 to 84 % as Graduation student performance from University, Good for students who got 65 to 74% and Poor Who got 50 to 64 %. The observed GPA of bachelor's graduation has no effect on students' performance because there are equal cases in Student performance as Shows in the Fig (3).

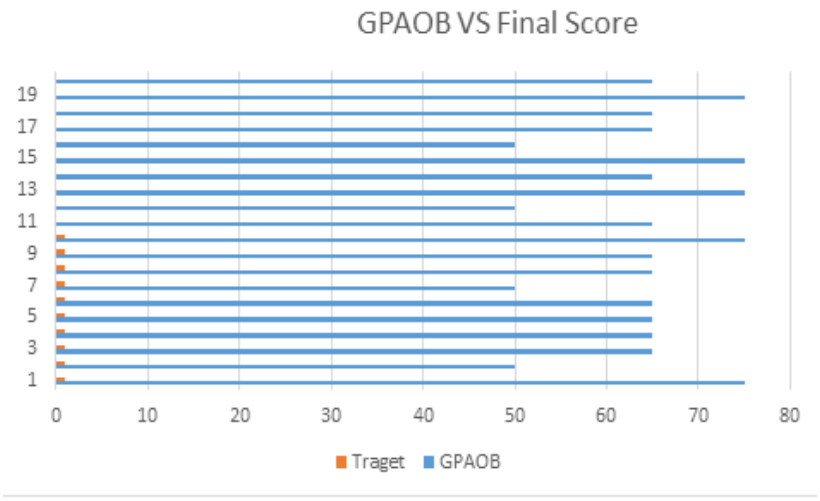

Fig 3: GPAOB VS Final Score

The Address -Living (distance between housing and the Place of study) we observed from below figure, for that All student live near

the place of study passed the course However, four cases in other hand did not pass the course, may other features is effect on their performance, and other student who is living far away from place of study did not pass the course. Therefore, Address is considered as an effect feature on student performance as show in Fig (4).

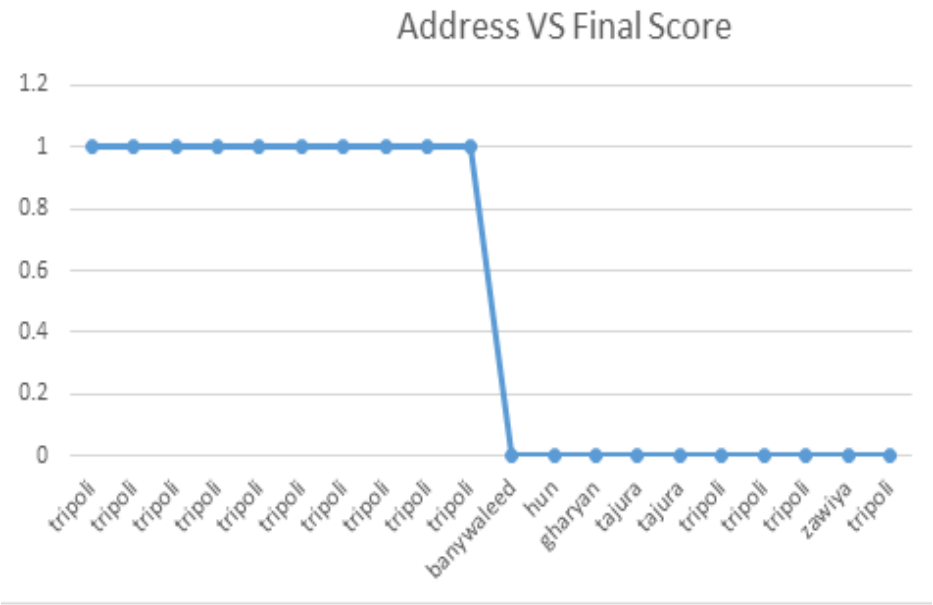

Fig 4: Address VS Final Score

4. EXPERMENTS AND RESULTS

In this section, performed experiments will be explained in details and obtained results will be presented. As it is mentioned above, different datasets for classification and regression are considered in this research. Experiments are divided into two categories according to their Outputs, as Regression and Classification Experiments.

TABLE V: REGRESSION RESULTS FOR COMPUTER NETWORKS COURSE OF ALL ALGORITHMS AND TESTING RATION.

Algorithm	30% of Testing ration	
	MSE	Accuracy Score
NNR	6.44	0.54
LR	12.76	-0.90
MLR	8.43	-0.24
SVR	8.04	0.42
	20% of Testing ration	
DTR	3.5	0.90

TABLE VI: CLASSIFICATION RESULTS FOR ALL ALGORITHMS AND TESTING RATION

Algorithm	Testing ration of all data for GC	
	Classification Accuracy	Zero one loss value
GC	0.50	0.5
	30% of Testing ration	
	Classification Accuracy	MSE
LR	1.00	0.0
	20% of Testing ration	
	Classification Accuracy	MSE
NNC	0.80	0.08
SVC	0.68	0.25
DTC	1.00	0.01

Includes student's performances as output for Computer Networks course according to seven attributes، (0, 1) in Classification and Continues values in Regression with similar attributes. There is different values input depends on algorithm we used according to attributes conversion.

A. REGRESSION EXPERIMENTS

In Regression Experiments; NNR,LR,MLR ,SVR,DTR algorithms are used both for 30% and 20% of testing ratio of instances and evaluation is performed according to criteria as Mean Square Error (MSE), Accuracy Score, which are the main indicators of the success of predicted results. Evaluation is performed according to the MSE of the obtained results, which can be seen in below metrics equation (1), and Fig (5).

$$\frac{1}{n}\sum_{i}^{n} =1 | y_i - \hat{y}_i | \quad (1)$$

In the Regression Experiments, 30% of testing ratio (70% of training of all instances except DTR is 20% in test and 80 in training) for Computer Networks course is used and optimum scores for MSE, Accuracy Scores are obtained by DTR which is followed by SVR . Big MSE rate is obtained by NNR, LR, and MLR.

For 20% of testing ratio of Computer Networks course, which is the regression experiment, results, are obtained as in 20% of testing ratio and highest prediction rates are achieved by DTR and lowest by LR (Linear Regression). Table V shows all results of regression experiments.

B. CLASSIFICATION EXPERIMENTS

In these experiments, GC(General Classification) ,LR (Logistic Regression) ,NNC,SVC and DTR algorithms both are used for all data with theta value in GC and 30% of testing ratio of LR(Logistic Regression) and 20% of testing ration of NNC ,SVC and DTC. Evaluation is performed according to the MSE and Classification accuracy score of the obtained results, which can be seen in (Eq. 2), and Fig (6).

Accuracy = **(TP+TN)/ (TP+TN+FP+FN)** (2)

Where TP and TN are True Positive and True Negative respectively and, FP and FN are False Positive and False Negative values of obtained results respectively.

By considering all data with best theta values in GC achieved 0.50 with 0.5 Zero One Loss Value and 30% of testing ratio of instances, LR achieved 1.00and 0.0 MSE, and 20% testing ratio of instances in NNC,SVC,DTC achieved 0.80, 0.68, 1.00 and MSE is 0.08, 0.25, 0.01 of classification rates respectively both for test data .

For 20% of testing ratio, higher results are obtained for DTC, NNC and SVC as 1.00, 0.80, and 0.68 respectively. Table VI shows all results of classification experiments.

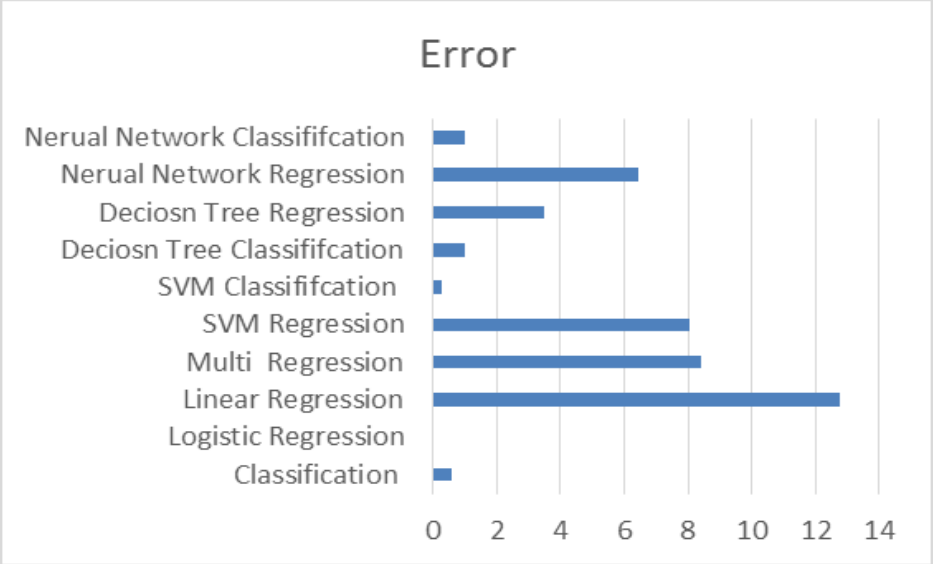

Fig 5: The outcomes of ML algorithms benchmarking for Prediction of Student total final score in an academic course

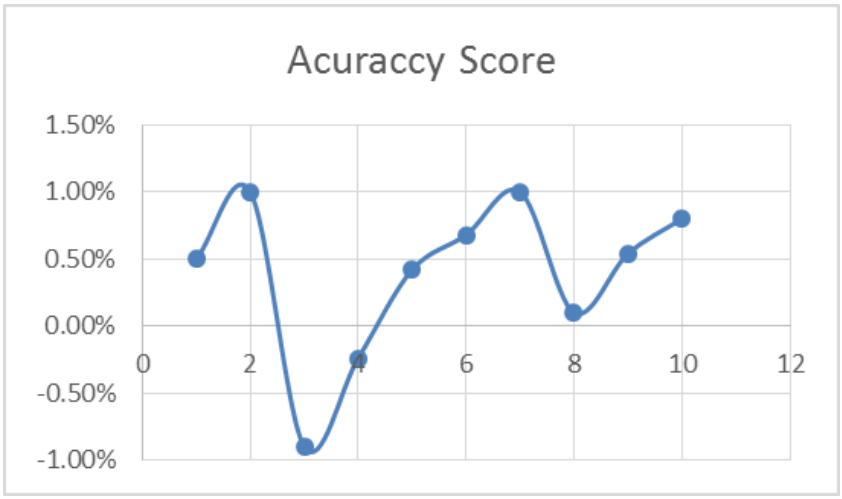

Fig 6 Accuracy score of ML algorithm

5. CONCLUSION

This paper presents the ability of Machine Learning Algorithms (MLA) on the prediction or regression and classification final score in particular course using data of previous historical information such as background knowledge and Geographical data; such as results of a number of students in the academic course from the Department of Electrical and Computer Engineering, Division of Information Technology.

1- The classification model were used for prediction of all student based on general classification to compare cost function before and after using the Gradient Descent to minimize Cost Function based on writhen equation in python , the cost function , accuracy of prediction, Zero One Loss Value are used to evaluate the classification model. The result for this model are not encouraging because the model was unable to predict all student correctly and predict only half of total number of students, and the cost function was 0.6 and the accuracy score was 10% , the loss value is 0.5 in general classification . It is not

suitable for a large number of features without specifying the size of the test sample, also not useful for small size of data and prediction to final score.

2- The Logistic Regression Algorithm model (Classification) were used test size 0.3 and after scaled data and used Log as a scaling function, the accuracy score and Zero One Loss Value are used to evaluate the model. The result of Logistic Regression model are encouraging because the model was able to predict all student correctly in test data, and the accuracy score was 1.0 with 0.0 loss value.

3- The Linear Regression Model (LRM) using one variable and Multi Regression Model (MRM) using multi variables were used, the Accuracy score and average of Mean Absolute Error (MSE) used to evaluate the models .The results of Linear and Multi Regression also were not encouraging to predict the target value. The accuracy score in Linear Regression was -0.90 and Multi regression -0.24 with 12.76 average of MSE in Linear and 8.43 in Multi regression. In addition, there was no improvement in results after data rescale via Standard deviation. Therefore, results obtained in the linear and multi linear regression were not suitable for small size of data to predict the final score.

4- Support Vectors Machine Regression (SVMR) and Classification Model used accuracy score and MSE to evaluate the models. The result was 0.42 as accuracy score and 8.04, as average of MSE in regression model and 0.68, 0.25 respectively in classification. From the result, we observe that SVMC is much better than SVMR in prediction of the final score.

5- In Decision Tree Regression (DTR) and Classification Model (CM), the result was 0.1 in accuracy score and 3.5 average of MSE in regression and 0.8 accuracy score and 1.0 loss value from confusion

matrix in the classification. The Decision Tree Classification is better than regression model in prediction.

6- In Artificial Neural Network Regression and Classifier Model, the result of both models clarified that accuracy score and MSE is 0.54, 6.44 respectively used identity as an activation function in regression model, in the other hand the result in the classification model was 0.8 in accuracy score and 1.0 loss value from confusion matrix and used Logistic as an activation function. Therefore, Neural Network Classification (NNC) was better than Regression.
The comparison of the different algorithms to predict final score indicated that the best model in regression algorithms is LR, and NN. The regression models are not appropriate to solve this problem. The best model in classification is Logistic Regression, and Decision Tree Classification algorithms.

In regards to questions raised in section 2 of this papers.

A1- By evaluating models results observed can predict and classify problem and identify a failed student early via select sample of data to test after training and comparison between true values and predict value for final score.

A2- Some characteristics have an impact on the level of the student. The features of age, Address, GAP, have an effect on the student's performance in the course there are many reasons for students 'failure in the course, some of which

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9

Robust Control of Two wheeled inverted pendulum vehicle Using Linear Quadratic Regulator - feedback error learning Control Approach

Robust Control of Two wheeled inverted pendulum vehicle Using Linear Quadratic Regulator - feedback error learning Control Approach

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Abstract

This paper introduces an efficient controller for two wheels mobile vehicle system. This controller is a feedback error learning controller benefits from both Linear Quadratic Regulator and adaptive controller properties. Hence, the proposed control strategy consists of an adaptive neural network operates in parallel with Linear Quadratic Regulator controller based on feedback error learning architecture. The Linear Quadratic Regulator controller is used to stabilize the system and the adaptive controller uses neural network designed based on back propagation method in order to deal with uncertainty and unknown dynamic of the system. The simulation results show the effectiveness of proposed controller in terms of robust tracking performance of the vehicle, which is significantly better than traditional controllers.

Keywords: Feedback Error Learning (FEL); Adaptive Control Neural Network (ANN); Two wheeled inverted pendulum vehicle (2WIPV); Back-Propagation Algorithm; Linear Quadratic Regulator (LQR) controller.

1. Introduction

With the development of the technology, two wheeled inverted pendulum vehicles (2WIPV) increase their importance in the engineering field. They have been popular as a human transporter in the automotive field and a significant system in robotic applications until today [1]. Day by day, two-wheeled vehicles become commonly take part in daily life as a human transporter which employed in the factories, shopping malls, airports, urban transportation and similar environments. Fig.1 shows a model of small-sized two wheeled inverted pendulum vehicles which have been in demand for short-distance travel in narrow and busy urban areas.

Fig 1: Two wheeled inverted pendulum vehicle (2WIPV) system

These types of systems are very interesting subject in both scientific research and practical applications. In practice, the most important requirements for such vehicles is its suitability for the different sizes (tall and weight) of drivers in order to have a stable balancing control

performance. There are many types of controllers that able to use in stabilizing and controlling such system. This paper presents a combination of two controllers in parallel form. This combination uses of classic controller that performs in parallel with an artificial neural network ANN trained online.

This kind of architecture for neural controllers is known as feedback error learning FEL as shown in Fig 2.

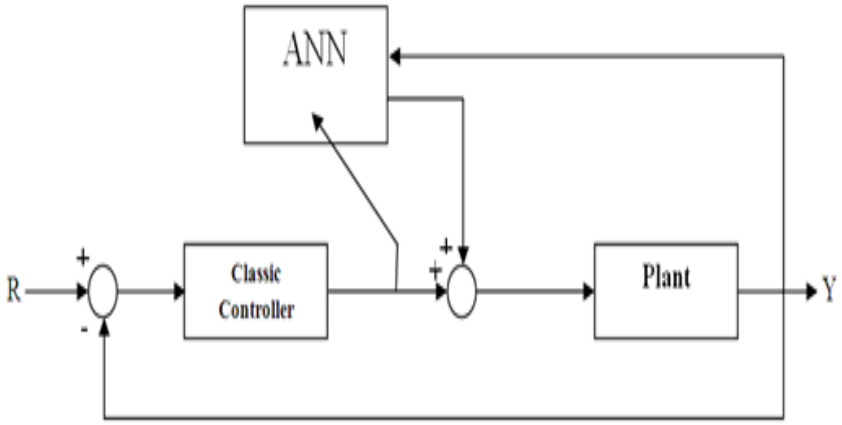

Fig 2: Principle of Feedback Error Learning controller

The output signal of classical controller is used for training the net and it is back propagated for learning purposes. The classical controller utilized here is LQR and the neural network part is a multi-layer perception net (MLP).

One of the best choices to deal with nonlinearity and uncertainty (different sizes of drivers) is artificial intelligence technique, which could be useful in some cases when classical controller is not robust and inadequate to represent the system with sufficient accuracy. Neural network can provide a nonlinear map only by input and output data of the system [2]. There are different types of neural models used in control field such as radial base function (RBF) and MLP [3], [4].

2. Physical System Setup

Two wheeled inverted pendulum vehicle (2WIPV) is an electromechanical vehicle with 2 wheels. The main goal is trying to stabilize the system by considering the motion in x-axis (ignoring the yaw motion). The overall schematic diagram of the system is shown in Fig 3.

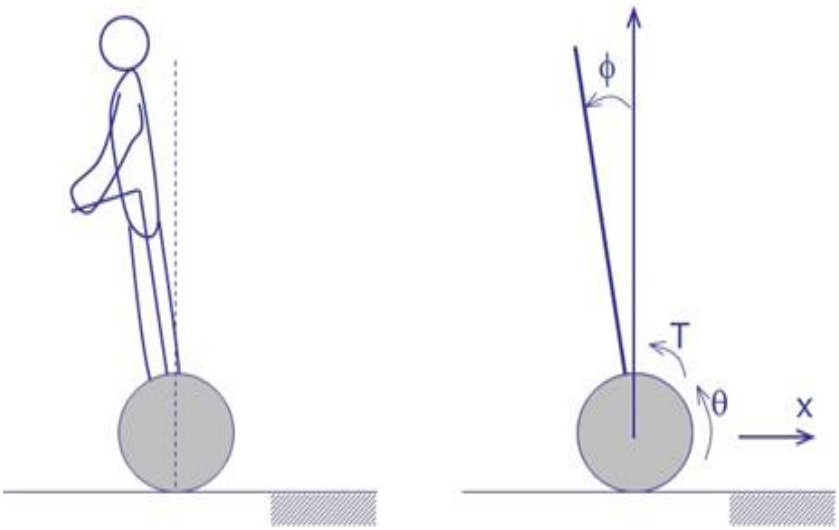

Fig 3: Overall schematic diagram of (2WIPV) system

The parameters and variables of 2WIPV System considered in this study are listed in Table I.

TABLE I: PARAMETRES & VARIABLES OF 2WIPV SYSTEM

Parameter	Symbol	Parameter	Symbol
wheel angular position	θ	Mass of body	M
Body Angular position	φ	Mass of wheel	m
Linear displacement in x axes	x	Wheel radius	r
Body linear displacement in x axis	x_b	Acceleration	a
Body linear displacement in y axis	y_b	Friction factor	b
Body moment of inertia	I_b	Force in x axis	F_x
Wheel moment of inertia	I_w	Force in y axis	F_y
Length of body to center of gravity(cog)	L	Traction force	F_t
Gravitational acceleration	g	Normal force	N
Angular position of motor shaft	θ_m	Frictional torque	T_f
Length of rope in inertia test setup	L_i	Gear ratio	n
Hanging distance in inertia test setup	R_i	DC Motor torque	T_m
Back EMF constant	K_e	Torque constant	K_t
Motor terminal resistance	R	Applied voltage	v
Period in inertia test setup	T_n	Terminal voltage	V_e
Motor armature current	i	Motor inductance	l

The constructed mathematical model of 2WIPV system is derived mainly based on Newton 2nd law of motion. To design the controller, pitch and longitudinal dynamics are analyzed for stabilizing the system.

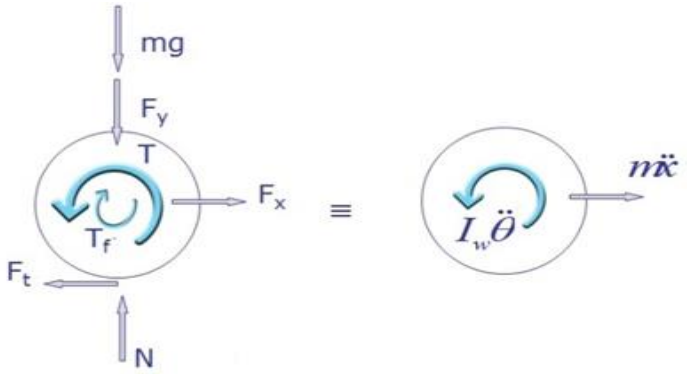

Fig 4: Free body diagram of Wheel

From Fig.4, the following equations are obtained.

$$\sum F = ma \tag{1}$$

Resultant force in x-axis equals to;

$$m\ddot{x} = F_x - F_t \tag{2}$$

Resultant force in y-axis equals to;

$$0 = N - mg - F_y \tag{3}$$

When the rotational motion is considered;

$$\sum M = Ia \tag{4}$$

$$I_w\ddot{\theta} = T - rF_t - T_f \tag{5}$$

Where $T_f = b(\dot{\theta} - \dot{\phi})$.

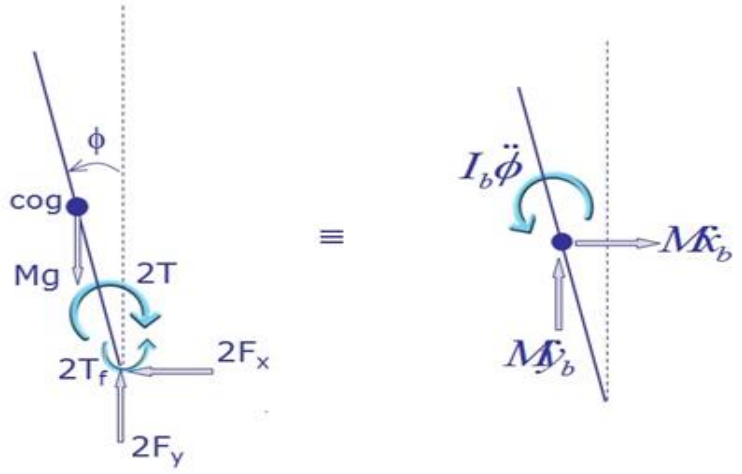

Fig 5: Free body diagram of human body

According to Fig.5, resultant forces and moments in x direction equals to;

$$M\ddot{x_b} = -2F_x \tag{6}$$

Similarly, resultant forces and moments in y direction equals to;

$$M\ddot{y_b} = 2F_y - Mg \tag{7}$$

When the rotational motion is considered;

$$I_b\ddot{\phi} = -2T - 2F_x Lcos(\phi) - 2F_y Lsin(\phi) + 2b(\dot{\theta} - \dot{\phi}) \tag{8}$$

Kinematic equations related to wheel is given below:

In x-axis;

$$\begin{cases} x_b = -Lsin(\phi) \\ \dot{x}_b = \dot{x} - \dot{\phi}Lcos(\phi) \\ \ddot{x}_b = \ddot{x} - \ddot{\phi}Lcos(\phi) + \dot{\phi}^2 \mathrm{Lsin}(\phi) \end{cases} \quad (9)$$

In y-axis;

$$\begin{cases} y_b = Lcos(\phi) \\ \dot{y}_b = -\dot{\phi}Lsin(\phi) \\ \ddot{y}_b = -\ddot{\phi}Lsin(\phi) - \dot{\phi}^2 \mathrm{Lcos}(\phi) \end{cases} \quad (10)$$

Furthermore, the relation between linear and angular motion is defined as follows:

$$\begin{cases} x = r\theta \\ \dot{x} = r\dot{\theta} \\ \ddot{x} = r\ddot{\theta} \end{cases} \quad (11)$$

Now, the equations of motions of the system can be derived using equations (1 to 11) as follows:

$$I_w\left(\frac{\ddot{x}}{r}\right) + r\{-0.5M[\ddot{x} - \ddot{\phi}Lcos(\phi) + \dot{\phi}^2 \mathrm{Lsin}(\phi)] - m\ddot{x}\} + b(\dot{\theta} - \dot{\phi}) = T \quad (12)$$

$$I_b\ddot{\phi} + 2\{-M[\ddot{x} - \ddot{\phi}Lcos(\phi) + \dot{\phi}^2 \mathrm{Lsin}(\phi)]\}Lcos(\phi) - 2\{M[-\ddot{\phi}Lsin(\phi) - \dot{\phi}^2 \mathrm{Lcos}(\phi)] + Mg\}L\mathrm{sin}(\phi) - 2b(\dot{\theta} - \dot{\phi}) = -2T \quad (13)$$

The torque **T** is applied to the system by a DC Motor. Hence, the following function is required

$$T = f(v) \tag{14}$$

Where **v** is the input voltage. The relation between armature current and torque is given as:

$$T_m = K_t i \tag{15}$$

Where $\mathbf{K_t, i}$ are motor torque constant and armature current respectively. Furthermore, Eq. 16 shows the relation between armature current and voltage.

$$V_e = V - R_i - L\frac{di}{dt} \tag{16}$$

Where $\mathbf{L\frac{di}{dt}} \cong \mathbf{0}$. Also $\mathbf{V_e}$ is related with the back EMF voltage.

$$V_e = K_e(n\dot{\theta}_m - \phi) \tag{17}$$

Hence, by arranging Eq. 16 and Eq. 17 the following equation is obtained.

$$i = \frac{V}{R} - \frac{K_e}{R}\dot{\theta}_m \tag{18}$$

Substituting Eq. 18 in Eq. 15 we get

$$T_m = K_t\left(\frac{V}{R} - \frac{K_e}{R}\dot{\theta}_m\right) \tag{19}$$

where $\dot{\boldsymbol{\theta}}_{\mathbf{m}}$ is shaft rotation which is can be also written in terms of pith angle of a body and rotation of wheel as follows

$$\theta_m = n\theta - \phi \tag{20}$$

$$\dot{\theta}_m = n\dot{\theta} - \dot{\phi} \quad (21)$$

The torque applied on the motor shaft is considered from now on. However, for the system, the torque applied to wheel should be considered. Thus,

$$T = nT_m = \frac{nK_tV}{R} - \frac{nK_tK_e}{R}(n\dot{\theta} - \dot{\phi}) \quad (22)$$

When Eq. 22 is substituted into Eq. 12 and Eq. 13 the following equations are obtained.

$$I_w\left(\frac{\ddot{x}}{r}\right) + r\{-0.5M[\ddot{x} - \ddot{\phi}Lcos(\phi) + \dot{\phi}^2\mathrm{Lsin}(\phi)] - m\ddot{x}\} + b(\dot{\theta} - \dot{\phi}) - \frac{nK_tV}{R} + \frac{nK_tK_e}{R}(n\dot{\theta} - \dot{\phi}) = 0 \quad (23)$$

$$I_b\ddot{\phi} + 2\{-M[\ddot{x} - \ddot{\phi}Lcos(\phi) + \dot{\phi}^2\mathrm{Lsin}(\phi)]\}Lcos(\phi) - 2\{M[-\ddot{\phi}Lsin(\phi) - \dot{\phi}^2\mathrm{Lcos}(\phi)] + Mg\}L\mathrm{sin}(\phi) - 2b(\dot{\theta} - \dot{\phi}) - 2\frac{nK_tV}{R} + 2\frac{nK_tK_e}{R}(n\dot{\theta} - \dot{\phi}) = 0 \quad (24)$$

The nonlinear system is simulated in this study using Eq. 23 and Eq. 24.

3. Controller System Design

There are various types of controller that able to control and stabilize two wheeled mobile vehicle. Two focal factors are considered in control problem of this system, first is to maintain linear displacement of transporter according to human inputs and second is to maintain stabilization of the system without exceeding human safety limits.

In this section, the design of Feedback Error Learning (FEL) architecture with Linear Quadratic Regulator (LQR) control scheme for 2WIPV system will be explained. In terms of the transportation mode of 2WIPV system, position (x) is not critical for the system while translational velocity, pitch rate, and the pitch angle have a vital

role in the stability and good performance of the system. Hence, just velocity part of the system was considered.

A. LQR Design

Optimal control allows to directly formulate the performance objectives of control system and produces the best possible control system for a given set of performance objectives.

Consider the system $\dot{\mathbf{x}} = \mathbf{Ax} + \mathbf{Bu}$. If system's transient energy is defined as a total energy when the system is undergoing the transient response, then a successful control system must have a transient energy, which quickly decays to zero. By including the transient energy in the objective function, an acceptable response can be specified. The control energy must also be a part of the objective function that is to be minimized. Therefore, the objective function for the optimal control problem must be a time integral of the sum of both transient energy and control energy. Thus, the objective function can be written as follows:

$$J(u) = \int_0^\infty (x^T Q x + u^T R u)\, dt \tag{25}$$

Where $\mathbf{u} = -\mathbf{Kx}$.

The optimal control problem consists of solving for the feedback gain matrix, K, such that the scalar objective function $\mathbf{J}(\mathbf{u})$ is minimized.

$$K = R^{-1} B^T P \tag{26}$$

Here, P is the positive definite matrix solution of the following control algebraic Riccati equation:

$$PA + A^T P + Q - PBR^{-1}B^T P = 0 \tag{27}$$

2WIPV system described above has 2 inputs, one is the voltage that applied to the motor (**v**) and the other is the body lean torque (**f**) which is can be thought as a disturbance to the system. So the state space representation of the system can be written with three states as follows:

$$\dot{x_c} = A_c x_c + B_c u + D_c f$$

Where $x_c = \begin{bmatrix} \dot{x} \\ \phi \\ \dot{\phi} \end{bmatrix}$, $A_c = \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ 0 & 0 & 1 \\ A_{31} & A_{32} & A_{33} \end{bmatrix}$,

$B_c = \begin{bmatrix} B \\ 0 \\ 0 \end{bmatrix}$, $D_c = \begin{bmatrix} D \\ 0 \\ 0 \end{bmatrix}$, $u = v$

Choosing of weight matrices Q and R usually involves some kind of trial and error, and they are usually chosen as diagonal matrices, so weighting matrices can be chosen as

$$Q = \begin{bmatrix} 100 & 0 & 0 \\ 0 & 10 & 0 \\ 0 & 0 & 1 \end{bmatrix} , \qquad R = 1.$$

Finally, MATLAB's Control System Toolbox provides "lqr" function for the solution of the linear optimal control problem with a quadratic objective function, which is directly used to design a state-feedback gain matrix, K as flows:

K = [22.7644 -192.5138 -40.7907]

B. LQR Design with Artificial Neural Network (ANN)

According to the performance exhibited by an experienced human operator, it is believed that the controller should be designed to have abilities to learn from experience and to use the knowledge gained during the training process. That is why artificial Neural Networks (ANNs) have been applied to several cases of control systems which

have proved their ability to approximate arbitrary nonlinear maps and the availability of methods for adjusting their parameters on basis of input and output data [5]. This study presents a tracking control design using conventional LQR controller. However, this controller is sensitive to parameter uncertainties and unsatisfactory tracking performances. To overcome this problem, an adaptive neural network is added to the structure of the system. Hence, the nonlinear model of 2WIPV was combined with feedback error learning (FEL) architecture and the LQR controller. The FEL approach is characterized by the ANN inserted in the feedback path to capture the nonlinear characteristics of the system since the ANN weights are tuned on-line [6].

From the point of view of control systems, there are a few neural network types that are used in these kinds of applications. Multi-layer perception (MLP) network as shown in Fig.6 consists of three main layers which are input layer, one or more hidden layers and output layer.

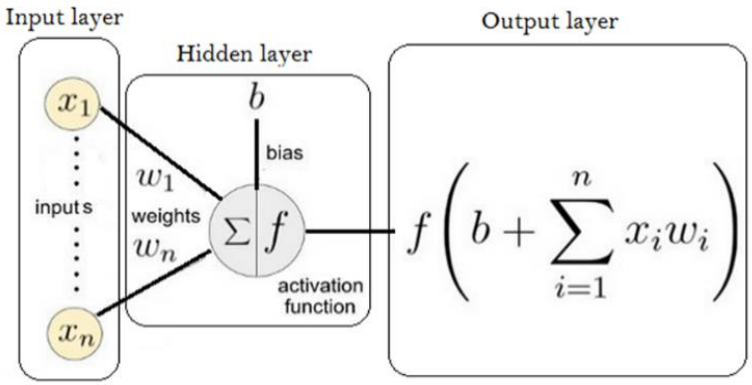

Fig 6: General Structure of MLP-NN

Such a network comprises parallel systems that are composed of Processing Elements (PE) or neurons, which are assembled in layers and connected through several links or weights. The input data are fed to input layer and passed on by the network through hidden layer (s) until an output signal is produced at the output layer. Each neuron receives numerous inputs from other neurons through some weighted

connections. The weighted inputs are then summed and a standard threshold is added, generating the argument for a transfer function (usually linear, logistic, or hyperbolic tangent) which in turn produces the final output of the neuron [7]. Two important characteristics of the MLP are its nonlinear processing elements which have a nonlinear activation function that must be smooth (the logistic sigmoid function and the hyperbolic tangent are the most widely used) and its massive interconnectivity (i.e. any element of a given layer feeds all the elements of the next layer). The two main activation functions used were sigmoid function and hyperbolic tangent, and are described as follows [8,9,10].

$$\varphi(y_i) = \tanh(w_i) \;\; and \;\; \varphi(y_i) = (1 + e^{-w_i})^{-1} \qquad (28)$$

where $\mathbf{y_i}$ is the output of the ith node (neuron) and $\mathbf{w_i}$ is the weighted sum of the input synapses.

In the MLP, the back-propagation algorithm is used not only to update the weights of the input, but also to update the parameters that define the shape of each neuron. Error correction learning works in the following way: At any iteration (**k**), the instantaneous error **ei** (**k**) is defined for a given input pattern by the different between system response $\mathbf{y_i}(\mathbf{k})$ and the desired response $\mathbf{d_i}(\mathbf{k})$[11-13]:

$$e_i(k) = d_i(k) - y_i(k) \qquad (29)$$

Using the theory of gradient descent learning each weight in the network can be adapted by correcting the present value of the weight with a term that is proportional to the present input and error at the weight.

Although recent developments aimed to a greater integration with Simulink, the product has still in Matlab rather that Simulink its natural environment, therefore the resulting code for the neural network subsystem is sometimes redundant, slow, and very hard to integrate with Real Time Workshop. The latter feature would be extremely important for those who ultimately need their neural network to work in a real-time environment [14]. In addition, emphasis is given to the approximation result rather than to the approximation process, so that, using that toolbox, setting up (in

Simulink) a neural network for on-line learning is not as “natural” as letting a pre-trained neural network work as a simple static approximation function [14]. To overcome these situations, an "Artificial Neural Network Library is used [15]. The library provides flexibility to users to design a feed forward and radial basis networks for learning purposes. With the constructed models all simulations are done by using MATLAB- Simulink.

4. Simulation Results

2WIPV system was modeled with LQR and LQR- FEL type of controller in Simulink under MATLAB environment. Fig.7 shows the 2WIPV system with LQR type of controller. The numerical values of system parameters used in the simulations are listed in Table II

TABLE I: VALUES OF 2WIPV PARAMETERS.

Parameter	Values
Mass of body, (**M**)	55 *(Kg)*
Mass of wheel, ($\boldsymbol{m}$)	2.3 *(Kg)*
Wheel radius, ($\boldsymbol{r}$)	0.32 (*m*)
Friction factor, ($\boldsymbol{b}$)	2
Body moment of inertia, ($\boldsymbol{I_b}$)	8.0 *(Kg.m)*
Hanging distance in inertia test setup, ($\boldsymbol{R_i}$)	0.1 *(m)*
Terminal voltage, ($\boldsymbol{V_e}$)	24 *(volt)*
Length of rope in inertia test setup, ($\boldsymbol{L_i}$)	1.7 (*m*)
Wheel moment of inertia, ($\boldsymbol{I_w}$)	0.02 ($Kg.\ m^2$)
Back EMF constant, ($\boldsymbol{K_e}$)	0.05 (*V.s/rad*)
Motor terminal resistance, ($\boldsymbol{R}$)	1.4 (Ohm)
Torque constant, ($\boldsymbol{K_t}$)	0.05 (N/A)
Length of body to center of gravity, ($\boldsymbol{L}$)	0.25 (*m*)
Gravitational acceleration, ($\boldsymbol{g}$)	9.8 ($m/\ s^2$)
Period in inertia test setup, ($\boldsymbol{T_n}$)	3.13 *(s)*
Applied voltage, ($\boldsymbol{v}$)	19.8 *(volt)*
Motor inductance, ($\boldsymbol{l}$)	0.74 *(H)*
Gear ratio, ($\boldsymbol{n}$)	1:28.7
Motor armature current, ($\boldsymbol{i}$)	0.6865 (*Amp*)

Fig.7 shows the 2WIPV system with LQR type of controller.

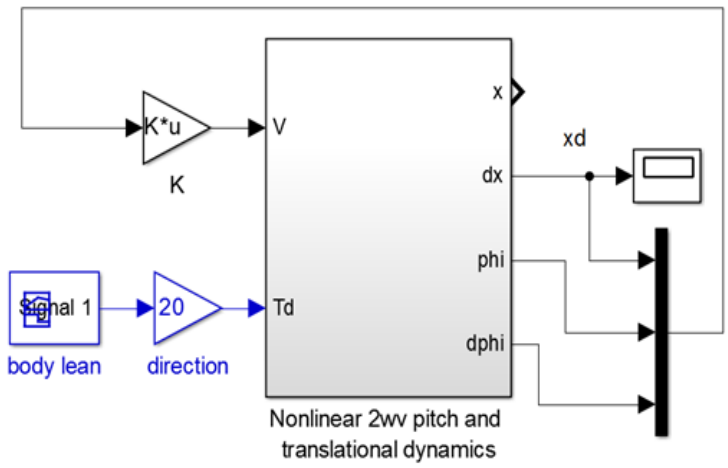

Fig 7: Nonlinear 2WIPV system with LQR controller

Similarly, Fig.8 shows 2WIPV system with LQR-FEL type of controller. ANN block was constructed in Simulink environment by using MLP-NN which is available under artificial neural network library.

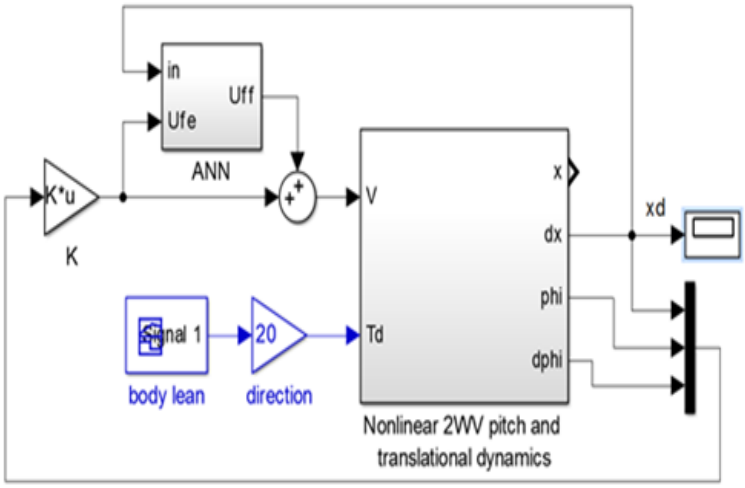

Fig 8: Nonlinear 2WIPV system with LQR-FEL controller

By using the interface provided by the artificial neural network library, neural network parameters such as number of inputs to the MLP-NN, number of hidden layers of MLP-NN, number of output of MLP-NN, weight limiters, learning rate, number of the neurons in each layer, etc can be initialized easily. The MLP-NN parameters are experimentally set as listed in Table III.

TABLE III: Values of MLP-NN parameters.

Parameter	Values
No. of input neurons	2.0
No. of output neurons	1.0
No. of hidden layers	1.0
No. of neurons in hidden layer	3.0
Learning rate	0,2
Stabilizing Factor	0,04
Weight Limiter	$5.0x10^{2}$
Sample Time	$1.0x10^{-4}$

The body lean signal that used in simulation is shown in Fig.9.

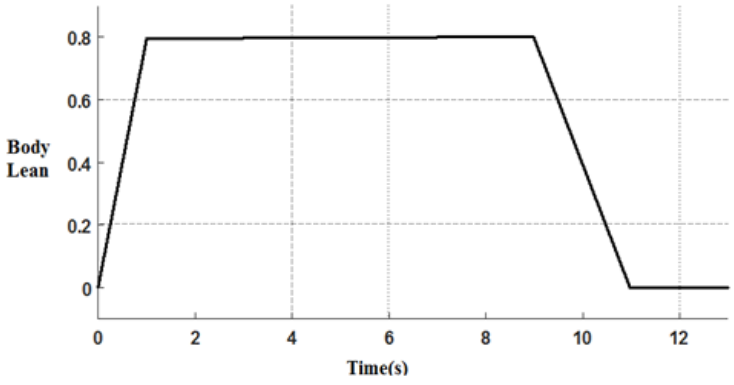

Fig 9: Body lean signal

Simulation results of 2WIPV systems with LQR and LQR-FEL type of controllers will be discussed by using graphs. To test the robustness of FEL architecture with LQR on the velocity of 2WIPV, some dynamical parameters such as length of driver, L, mass of driver, M and inertia of body, Ib, were changed at the beginning of each simulation. First of all, L, M and Ib were selected as 0.8 m, 90 kg and 14 kg.m respectively. These parameter's values are the average for the system.

In Fig.10, the velocity response of 2WIPV system with LQR and LQR-FEL type of controllers are shown. It can be easily seen that the system with the LQR-FEL type of controller has a smooth curve when compared to system with LQR type of controller. Moreover, according to the figure, 2WIPV system with LQR type of controller stops suddenly with damping nearly 10 seconds. This condition poses danger for users. Thus, the system with LQR-FEL type of controller is more comfortable. Also, there is an amplitude difference between the signals that are generated by both types of controllers. With reference to this amplitude difference, 2WIPV system with LQR-FEL type of controller works faster with the same body lean signal that is applied to both system.

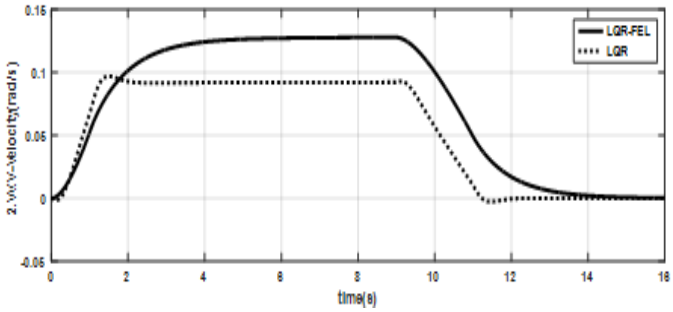

Fig 10: System response when L=0.8 *m*, M=90 *kg* and Ib=14 *kg.m*

After that, parameters of the system which are L, M and Ib were minimized to examine the velocity response of the system as shown in Fig.11.

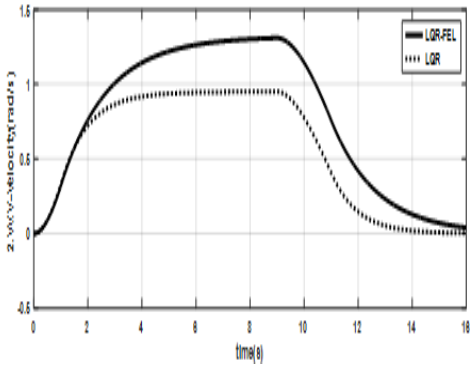

Fig 11: System response when L=0.15 m, M=35 kg and Ib=2 kg.m

In this case, the parameters L, M and Ib were changed to 0.15 m, 35 kg, 2 kg.m respectively. There is an amplitude difference between the velocity response of the 2WIPV system with LQR type of controller and that of the 2WIPV system with LQR-FEL type of controller. According to the figure, it can be seen that the system works well with both type of controller. But, 2WIPV system with LQR-FEL type of controller was faster with the same body lean signal.

It is wanted to force the system with high values of system parameters Hence, the parameter L, M and Ib were changed to 0.7 m, 125 kg, 16 kg.m respectively. Fig.12, shows that the 2WIPV system works well with LQR-FEL type of controller due to same reasons that is explained above.

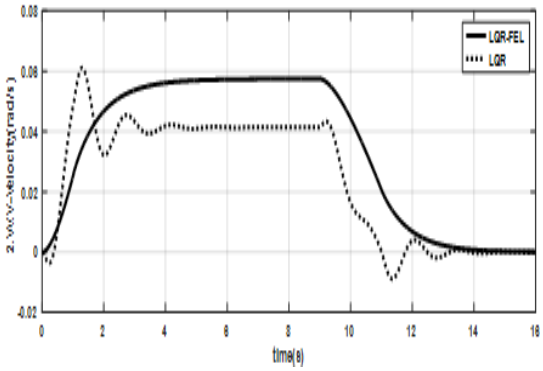

Fig 12: System response when L=0.7 *m*, M=125 *kg* and Ib=16 *kg.m*

Finally, to observe the adaptive and robust nature of proposed LQR-FEL controller, the parameters L and M were increased and keeping the value of inertia of the body same. The parameters L and M were set to 0.8 m and 150 kg respectively. Fig.13 shows the velocity responses of 2WIPV system with both type of controller.

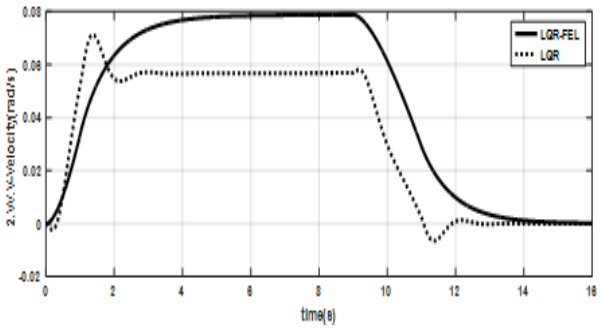

Fig 13: System response when L=0.8 m, M=150 kg and Ib=16 kg.m

According to Fig.13, it is clear that the 2WIPV system with LQR-FEL type of controller showed good performance and high amount of robustness even with hard operating conditions.

5. Conclusion

A feedback error learning FEL scheme is presented in this paper. The proposed controller combines LQR controller with adaptive neural network controller for two wheels vehicle system to insure system stability. The obtained simulation results show that the classical LQR state feedback control approach was not robust as well as not safe to deal with uncertainty and unknown dynamics of the system.

The simulation results show the superiority of proposed FEL control scheme which improved total system performance by means of making the system faster, more robust, and safer for human users.

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10

Specific Emitter Identification Based on Variational Mode Decomposition and Bluetooth Devices

Specific Emitter Identification Based on Variational Mode Decomposition and Bluetooth Devices

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Abstract

Specific emitter identification (SEI) designates the unique transmitter of a given signal, using only external feature measurements called the RF fingerprints of the signal. RF fingerprint extraction is a fundamental issue of specific emitter identification (SEI). SEI techniques are often used in civilian and military spectrum-management operations, and they are also applied to support the security and authentication of wireless communication, such as VHF radio networks, Wi-Fi networks, cognitive radios, and cellular networks and so on. Communication and radar signals turn out to be non-stationary and nonlinear time series, and estimating instantaneous parameters of such signals in time domain will benefit detecting and identifying specific emitters, such as civil or military radios. However, conventional methods such as Wavelet and Wigner-Ville distribution (WVD) methods are difficult to deal with these transient signals when

the signal is not stationary. The empirical mode decomposition EMD is a powerful substitution to the Fourier and wavelet transform, but it has several practical limitations that reduce its practical. To provide more efficient approach for estimating instantaneous parameters of non-stationary and identifying specific emitter with high accuracy, a method based on variational mode decomposition (VMD) for analyze RF transient signals emitted by Bluetooth (BT) devices is proposed in this paper. VMD is used to decompose (BT) transient signals into a series of band-limited modes, and then, the transient signal is reconstructed from the modes. Higher order statistical features are extracted from the reconstructed transients. Then, Linear Support Vector Machine (LVM) is finally used to realize the emitter classification. The method is tested on transient signals captured from six mobile phones of different brands and models. The simulation results highlight that the proposed method can achieve high accuracy of recognizing to Bluetooth (BT) devices.

Keyword: Variational mode decomposition, specific emitter identification, feature extraction, signal classification. RF fingerprint.

1. Introduction

Specific emitter identification (SEI) is a technique used to uniquely identify radio transmitters, even those of the same make and model, using only their transmitted radio signals [1]. This means of identification is possible due to hardware tolerances in the radio frequency (RF) circuitry created during manufacturing. SEI is also referred to as radio-frequency fingerprinting (RFF) or physical-layer identification. SEI aims to alleviate the mimicing or spoofing of the identities of radio devices as the identifying characteristics produced by SEI are inherently difficult to spoof. In this way, SEI is used to enhance the security of communication networks using wireless devices. Over the past decades, SEI techniques have been applied in different fields. SEI used to identify emitters of interest for intelligence gathering or countermeasure activities [2]. In civilian and military spectrum-management operations, SEI is often used in traffic analysis or in the determination of the source of interference [3]. Another important application of SEI is to enhance the security of

wireless communication networks, such as VHF radio networks and cellular networks. To improve the safety and security of wireless communication networks, specific emitter identification (SEI) techniques have been reported [4-7]. Generally, SEI techniques can be divided into two broad categories: radar signal-based SEI and communication signal-based SEI, according to different application scenarios and the characteristics of signals. However, some SEI methods can be used in both radar signals and communication signals. In the case of communication signals, SEI techniques can be divided into three categories: transient signal techniques, steady-state signal techniques, and nonlinear techniques. A transient signal is actually a brief radio emission produced while the output power of a transmitter goes from zero to the level required for data communication. A steady state signal is usually defined as the part between the end of the transient and the end of the whole signal. Transient signal of a transmission has useful RFFs, which have enjoyed much attention in the literature [8–10]. The RFF imbued in frequency and amplitude information have been exploited to identify WLAN transmitters and Bluetooth transmitters, and RFF imbued in amplitude and phase information have been utilized to identify VHF radios. The transient characters of transmitter signals are especially useful for detecting or identifying specific emitters. Fourier spectral analysis has provided a general method for examining the global energy-frequency distributions, but the system must be linear; and the data must be strictly periodic or stationary. The wavelet approach can be used to analysis the non-stationary time series, but the basic wavelet function has to be given before the analysis. Wigner-Ville distribution is able to describe emitter signals in time and frequency domains simultaneously, but the difficulty with this method is the severe cross terms as indicated by the existence of negative power for some frequency ranges. The empirical mode decomposition EMD of signal is an adaptive method and a powerful substitution to the Fourier and wavelet transform, but it has several practical limitations that reduce its practical utility and may cause inaccuracies in depicting signal dynamics [11-13]. Therefore the birth of variational mode decomposition VMD occurred as an alternative of EMD and can overcome the demerits of EMD [14-17]. In this paper we propose a

specific emitter identification (SEI) based on VMD. The rest of this article is organized as follows: Section 2 introduces the VMD (Variational Mode Decomposition). Section 3 the acquisition system acquires the RF signals produced by the access devices.
It then stores the data in a digital format for later processing. Section 4 signal processing is then performed on the stored digital RF signals to remove any arbitrary variances in the signals that may distort the signals and affect signal classification. The feature-extraction subsystem then extracts distinct features from the processed RF signals. Section 5 the classifier subsystem then takes the extracted features and builds an association between the device signals and the transmitters from which they were produced. Section 6 is the conclusion.

2. Variational Mode Decomposition

Variational Mode Decomposition decomposes the real valued input signal, into discrete numbers of sub-signals (modes), and it has certain sparsity property while producing the decomposed signal. The signal is decomposed into number of modes, $\mathbf{u_k}$ and is centered around$\boldsymbol{\omega_k}$. The input signal bandwidth is computed as follows: (1) the analytic signal for each mode $\mathbf{u_k}$ is constructed by means of the Hilbert transform to achieve a one side frequency spectrum; (2) by using demodulation method, the frequency spectrum of each mode is shifted to estimated baseband; (3) Finally, the squared L2 norm of the gradient of the demodulated signal is applied to estimate the bandwidth of each mode [14].

$$i.e.\Delta w_k = \int |\partial_t(u_k^D)|^2 \, dt = \|\partial_t(u_k^D)\|^2 \quad (1)$$

Therefore, the required minimization problem is

$$\min_{\{u_k\},\{\omega_k\}} \left\{ \sum_k \left\| \partial_t \left[\left(\delta(t) + \frac{j}{\pi t} \right) * u_k(t) \right] e^{-j\omega_k t} \right\|_2^2 \right\} \quad (2)$$

In order to render the problem unconstrained, both a quadratic penalty term and Lagrangian multipliers are used to construct the following augmented Lagrangian:

$$\mathrm{L}(\{u_k\},\{\omega_k\},\lambda) = \alpha \sum_k \left\| \partial_t \left[\left(\delta(t) + \frac{j}{\pi t}\right) * u_k(t) \right] e^{-j\omega_k t} \right\|_2^2$$

$$+ \left\| f(t) - \sum_i u_i(t) + \frac{\lambda(t)}{2} \right\|_2^2 - \left\| \frac{\lambda(t)^2}{4} \right\|_2^2 \quad (3)$$

Minimization with respect to $\mathbf{u_k}$ using Alternate Direction Method of Multipliers (ADMM) algorithm the sub-problem rewritten as the following:

$$u_k^{n+1} = \arg\min \{ \alpha \sum_k \left\| \partial_t \left[\left(\delta(t) + \frac{j}{\pi t}\right) * u_k(t) \right] e^{-j\omega_k t} \right\|_2^2$$

$$+ \left\| f(t) - \sum_i u_i(t) + \frac{\lambda(t)}{2} \right\|_2^2 \} \quad (4)$$

This problem can be solved in spectral domain and both terms written as half-space integrals over the non-negative frequencies:

$$\hat{u}_k^{n+1} = \arg\min \{ \int_0^\infty 4\alpha(\omega - \omega_k)^2 |\hat{u}_k(\omega)|^2 +$$

$$2 \left| \hat{f}(\omega) - \sum_i \hat{u}_i(\omega) + \frac{\hat{\lambda}(\omega)}{2} \right|^2 d\omega \} \quad (5)$$

The solution of this quadratic optimization problem is as following:

$$\hat{u}_k^{n+1}(\omega) = \frac{\hat{f}(\omega) - \sum_{i \neq k} \hat{u}_i(\omega) + \frac{\hat{\lambda}(\omega)}{2}}{1 + 2\alpha(\omega - \omega_k)^2} \quad , \quad (6)$$

The center frequencies $\boldsymbol{\omega_k}$ appear only in the first term. This quadratic problem is solved as:

$$\omega_k^{n+1} = \frac{\int_0^\infty \omega |\hat{u}_k(\omega)|^2 d\omega}{\int_0^\infty |\hat{u}_k(\omega)|^2 \, d\omega} \quad , \quad (7)$$

3. Data Acquisition and Transient Detection

The main purpose of our study is to test and examine the classification and identification steps correctly. This can be achieved using guaranteed real data and accurate procedures. Bluetooth signals were captured in the laboratory. The laboratory is located in an isolated location (underground) where no other equipment is operating, as any variation in temperature or humidity status may impact the accuracy of the identification. Temperature and humidity are kept constant in the laboratory. A signal acquisition system, shown in Fig. 1, is designed to collect Bluetooth (BT) signals from different mobile phones of different brands and models. Briefly, six different models of five popular brands (Huawei, IPhone, LG, Samsung, and Sony) were acquired for the experiments. The carrier frequency bandwidth of the Bluetooth signal ranges from 2400 MHz to 2483.5 MHz are received by a typical modem antenna and then delivered into an oscilloscope (4GHz). In order to keep the (Signal/Noise) Ratio (SNR) at a high level, the distance between the antenna and the mobile phone is maintained about 30 cm. The captured signals were digitized with ADC and a sampling frequency of at least 4.8 GHz. For a 2.4 GHz signal, the ADC should have a sampling frequency of at least 4.8 GHz, according to Nyquist theory. BT signals emitted by cell phones were captured in the laboratory by using high sampling rate oscilloscope (20 GSPS). One hundred BT signals were captured for each device. Therefore, we have a total of 600 records (BT signals), each of which consists of noisy part (channel noise), transient signal part and steady state part. Typical transmission data, such as that shown in Fig. 2, contain channel noise followed by the transient signal and the stable signal. Hence, the transmission data can be modeled as follows

$$d_i = \begin{cases} n(i) & if\ 1 \le i < m \\ s_t(i) + n(i) & if\ m \le i \le k \\ s_s(i) + n(i) & if\ \ k+1\ \le i \le N \end{cases} \quad (8)$$

Where di is the data sample at time instant i ; N is the number of samples ; m is the starting point of the transient signal ; k is the end point ; n(i) is the channel noise ; s(i) is the transient signal, when $\mathbf{i < m}$, $\mathbf{s_t(i) = 0}$; $\mathbf{s_s(i)}$ is the stable signal, when $\mathbf{i < k + 1}, \mathbf{s_s(i) = 0}$.

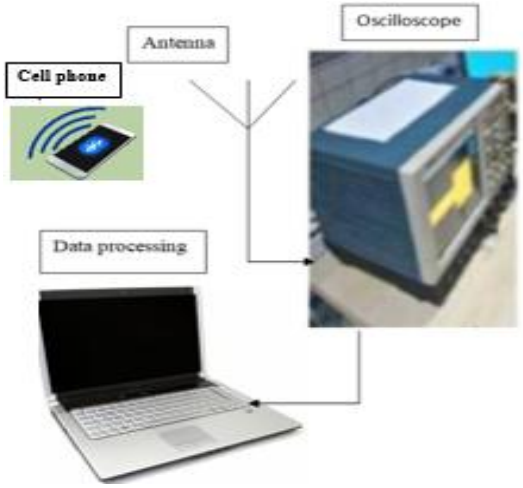

Fig 1: Signal acquisition system

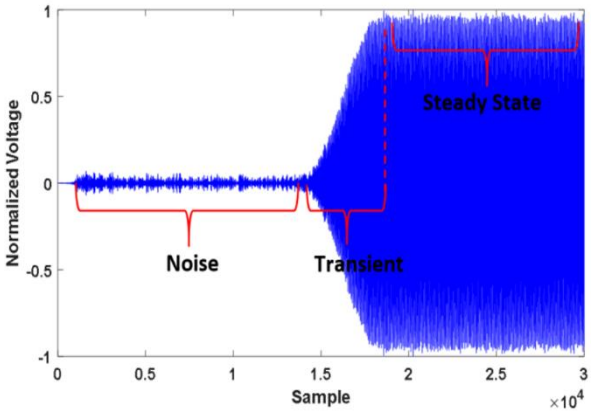

Fig. 2. A sample recording from BT signals captured in laboratory

The captured signals are transferred to a computer via local area network (LAN) and stored in digital format for further processing. Detection of transient signals' start and end points is critical for the performance of RFF system. For transient signal detection, performance of various techniques based on signal phase, amplitude and energy has been studied well in the literature. An improved technique proposed in [8] was employed for transient detection. Next, in order to evaluate the performance of the RFF method under realistic noise conditions, a captured channel noise were added randomly to the recorded transients that were captured initially at high Signal to Noise Ratio (SNR).

4. VMD Processing and Features Extraction

In RFF, it is possible to use HOS features directly extracted from recorded signals. This might give satisfactory results when the HOS features of both transient and steady state parts of the signal are used together, where the size of the feature set is increased greatly. However, it might not give satisfactory results when only a transient signal is used. Because these HOS features extracted from very short range, noisy transient signals (non-stationary) might not be discriminative enough. Therefore, the VMD technique is firstly used to decompose BT transient signals (□) into a series of band-limited [14]. Mainly, this technique decomposes the given input signal into various components known as modes, which have specific properties for reproducing the input signal. The BT transmitted signal contains a RF fingerprint. The signal RF fingerprint is associated with the cell phone brand and model. The RF fingerprint composed of bunch of unique features. The characteristics of signal such as instantaneous frequency $\mathbf{f(n)}$, instantaneous amplitude $\mathbf{a(n)}$ and phase $\emptyset\mathbf{(n)}$ can be used to obtain the RF fingerprint. To compute$\mathbf{a(n)}$, $\emptyset\mathbf{(n)}$,and $\mathbf{f(n)}$, the real transient signal x(n) is transformed into analytic signal (I and Q data) by a Hilbert transform. The complex form is useful in the calculating of instantaneous amplitude, frequency and phase. We can define the complex signal $\hat{\mathbf{x}}\mathbf{(n)}$ as

$$\hat{\mathbf{x}}\mathbf{(n)} = \mathbf{x(n)} + \mathbf{jH\{x(n)\}} = \mathbf{A(n)e^{j\theta(n)}} \quad (9)$$

$$\hat{\mathbf{x}}(\mathbf{n}) = \mathbf{x}(\mathbf{n}) + \mathbf{j}(\mathbf{h}(\mathbf{n}) * \mathbf{x}(\mathbf{n})) \quad (10)$$

Where the impulse response h(n) = $\frac{\mathbf{1}}{\boldsymbol{\pi}\mathbf{n}}$. The complex time domain signal $\hat{\mathbf{x}}(\mathbf{n})$ written in the expression:

$$\hat{\mathbf{x}}(\mathbf{n}) = \hat{\mathbf{x}}_{\mathbf{I}}(\mathbf{n}) + \hat{\mathbf{x}}_{\mathbf{Q}}(\mathbf{n}) \quad (11)$$

Instantaneous amplitude, $\mathbf{a}(\mathbf{n})$, phase, $\emptyset(\mathbf{n})$, and frequency, $\mathbf{f}(\mathbf{n})$, given by

$$\mathbf{a}(\mathbf{n}) = \sqrt{[\hat{\mathbf{x}}_{\mathbf{I}}(\mathbf{n})]^2 + [\,\hat{\mathbf{x}}_{\mathbf{Q}}(\mathbf{n})\,]^2} \quad (12)$$

$$\emptyset(\mathbf{n}) = \mathbf{tan}^{-1}\left[\frac{\hat{\mathbf{x}}_{\mathbf{Q}}(\mathbf{n})}{\hat{\mathbf{x}}_{\mathbf{I}}(\mathbf{n})}\right], \quad (13)$$

$$\mathbf{f}(\mathbf{n}) = \frac{\emptyset(\mathbf{n}) - \emptyset(\mathbf{n}-\mathbf{1})}{\mathbf{2}\boldsymbol{\pi}\Delta(\mathbf{n})} \quad (14)$$

The instantaneous amplitude, frequency response and phase are simply centered using

$$\mathbf{a}_{\mathbf{c}}(\mathbf{n}) = \mathbf{a}(\mathbf{n}) - \boldsymbol{\mu}_{\mathbf{a}} \quad (15)$$

$$\mathbf{f}_{\mathbf{c}}(\mathbf{n}) = \mathbf{f}(\mathbf{n}) - \boldsymbol{\mu}_{\mathbf{f}} \quad (16)$$

$$\emptyset_{\mathbf{cnl}}(\mathbf{n}) = \emptyset_{\mathbf{nl}}(\mathbf{n}) - \boldsymbol{\mu}_{\emptyset\mathbf{nl}} \quad (17)$$

Where N is the number of samples in the signal and $\boldsymbol{\mu}_{\mathbf{a}}$, $\boldsymbol{\mu}_{\mathbf{f}}$ are amplitude and frequency means, $\emptyset_{\mathbf{nl}}(\mathbf{n})$ is the resultant non-linear phase response given by

$$\emptyset_{\mathbf{nl}}(\mathbf{n}) = \emptyset(\mathbf{n}) - \mathbf{2}\boldsymbol{\pi}\boldsymbol{\mu}_{\mathbf{f}}(\mathbf{n})\Delta\mathbf{t} \quad (18)$$

Then the sequences$\mathbf{a}_{\mathbf{c}}(\mathbf{n})$, $\mathbf{f}_{\mathbf{c}}(\mathbf{n})$ and $\emptyset_{\mathbf{cnl}}(\mathbf{n})$ are normalized by dividing by the maximum value. Statistics are calculated after the sequences are centered and normalized [18-19]. The statistics for a

randomly centered and normalized sequence $\mathbf{v(k)}$ with $\mathbf{N_v}$ samples are:

$$\boldsymbol{\sigma_v^2 = \frac{1}{N_v}\sum_{k=1}^{N_v}[v(k) - \bar{v}]^2} \quad (19)$$

$$\boldsymbol{\gamma_v = \frac{1}{\sigma_v^3 N_v}\sum_{k=1}^{N_v}[v(k) - \bar{v}]^3} \quad (20)$$

$$\boldsymbol{k_v = \frac{1}{\sigma_v^4 N_v}\sum_{k=1}^{N_v}[v(k) - \bar{v}]^4} \quad (21)$$

Where $\mathbf{v(k)}$ represents any of the sequences given in equations (19), (20), and (21) after they normalized. The number of features can be created by using these sequences with these three high order statistics. The purpose of RF fingerprinting process is to get sufficient properties to classify the BT transceiver from other transceivers. The features that are used in this study are extracted from the original transients and VMD- reconstructed transients. Nine features are generated from each transient signal. To show the robustness of extracted features before applying the classifier, a conventional two dimensional Matlab plot is used. Features of the descriptive statistics can be visualized by means of conventional Matlab plot Fig.3 and Fig. 4. Because of the separation property, the variance (VAR) of transient signal instantaneous phase is one of the most robust features. This feature is extracted from instantaneous characteristics of the original transient signal as shown in Fig.3 The conventional two dimensional Matlab plot of the (VAR) of VMD-reconstructed transient signals' instantaneous phases is shown in Fig. 4.

It's clear from Fig. 4, that some classes are completely separated compared with Fig.3. For instant, class_1 (Huawei_G5) is completely separated from class_1 through class_6, however class_3 is partially separated (nearly separable) from class_4 (SamSung_S4). However, there are some classes are barely separated such as class_5 (LG_G4) and class_6 (SamSung_Note3). The advantage of the conventional two dimensional Matlab plot is that by which we can know the number of interfered records and interfered records' numbers for each class.

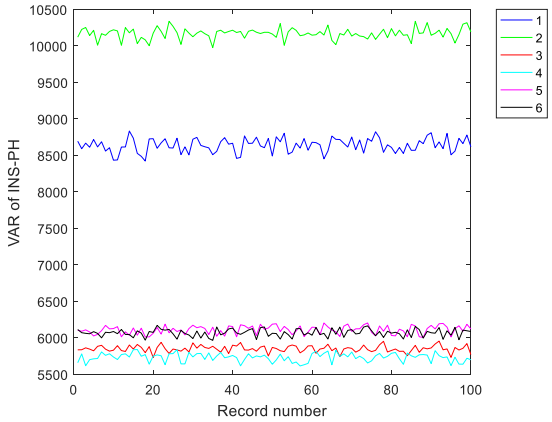

Fig 3: Conventional plot of VAR of trans. ins. Phases based on original transients

On the other hand from features representation in Fig. 3 we can note that features of device 5 and device 6 are completely overlapping while features created by VMD- reconstructed transient Fig. 4 are nearly separated which is increased the performance classification about 2% by VMD- reconstructed method.

5. Classification and Results

When a series of characteristic vectors are created, classification can be made. To be able to classify, characteristic vectors must be divided by training data and testing data for each Bluetooth device. Training process presented to establish a relationship between characteristic vectors and the BT device in which they are formed. The process is accomplished by providing the classifier with a characteristic vector and a corresponding BT device tag for all characteristic vectors in the training set. Next, a test set of characteristic vectors is applied to predict the success of the classifier. At this step, the classifier is fed with each unlabeled characteristic vector in the testing data, and the classifier bring back the tag of the BT device that most correspond to the characteristic vectors. In this work, the nine features that have been created used to perform the RF fingerprinting of 6 devices each containing 100 records (transients). The created characteristics are segmented into training data and test data, so that each feature created

by each device is segmented into the training data group by 40% and the test data group by 60% of the overall data. For each set of data, a linear support vector machine (LSVM) is applied. LSVM is an intelligence technique depended on theoretical basis of powerful statistical learning that is effectively implemented in many real data tests, like pattern estimation and devices identification [20].

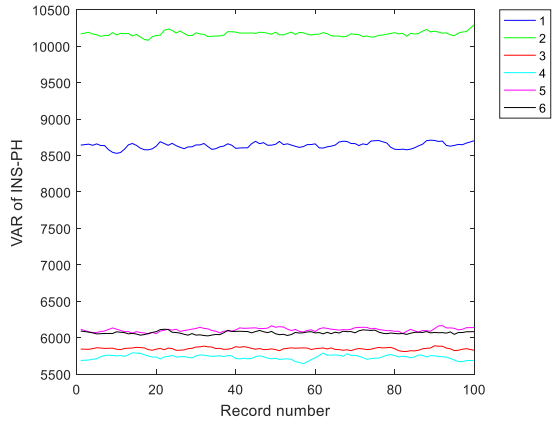

Fig 4: Conventional plot of VAR of trans. ins. Phases based on VMD-reconstructed transient

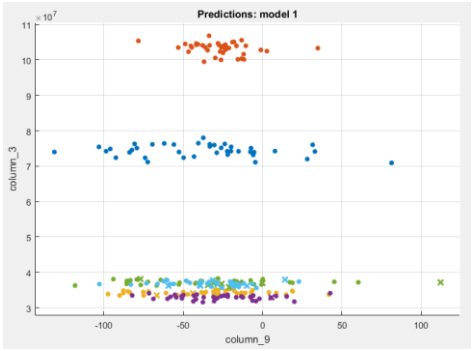

Fig 5: Scatter plot of data features based on original transients

LSVM applied in two stages for identification objective. In the 1st stage, LSVM is trained with the data group that is selected as training set. As soon as the LSVM is trained, the decision equation of LSVM is estimated:

$$\mathbf{f(x) = sign(\omega . \emptyset(x) + b)}, \quad (22)$$

In the 2nd stage, an LSVM is applied to the test data for classification according to the decision equation specified in the training stage. The classification function is defined as:

$$\mathbf{f(x) = sign\left[\left(\sum_{i=1}^{L} \propto_i y_i K(x_i, x_j)\right) + b\right]} \quad (23)$$

Where $\mathbf{K(x_i, x_j)}$ is kernel function, $\propto_\mathbf{i}$ is i-th mode embedded dimension. Further description of LSVM in [21].

A. Training Data

In this study we considered the classification accuracy in two cases. The first case, we measure the classification performance of the original transients using nine features under SNR range (0: 5dB). In the second case, we determine the classification performance of VMD-reconstructed transients using nine features for the same SNR levels, then the results of both cases are compared. The LSVM classifier is applied to train data to generate a classifier model. The generated model is utilized to classify the test data based on the classifier training (learning). The training confusion matrix based on 40% (40 elements) of datasets. The training confusion matrices demonstrate 91.8% as correct classification for the features that extracted from the original transients and 100% correct classification for VMD- reconstructed transients. The features F1 (VAR of ins. phase) against F6 (SKEW of ins. amplitude) of original transient are plotted as scatter plot of the train data for 6 classes (Fig. 5).

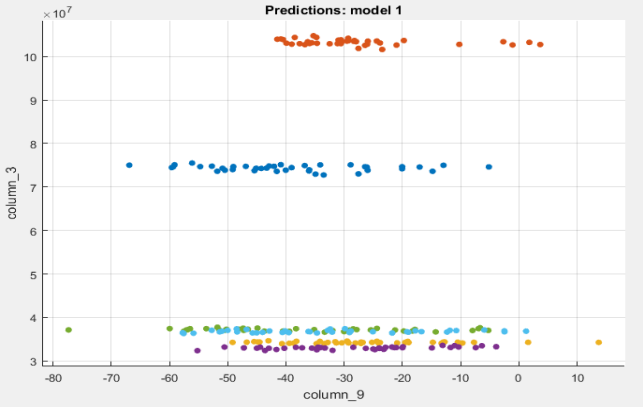

Fig 6: Scatter plot of features based on VMD-reconstructed transient

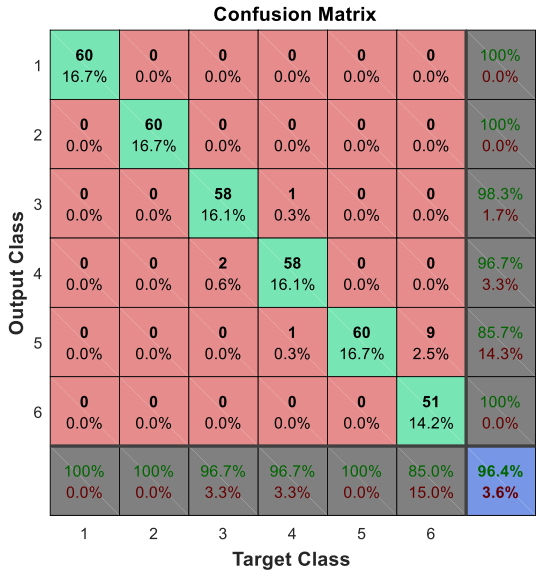

Fig 7: Confusion matrix based on original transients

The scatter plot of the same features for VMD-reconstructed transients is shown Fig. 6. It's deduced from the features scatter plots that the features' plots of each class records are close to each other for VMD-reconstructed transients method compared with original transient method.

B. Testing Data

The LSVM classifier is used to test a set of data representing 60% (60 elements) of the overall data to estimate the performance of the classifier after the training procedure. Fig. 7 shows the test data confusion matrix for six Bluetooth devices (cell phones) based on original transients. Fig. 8 illustrates the test data confusion matrix for six Bluetooth devices (cell phones) based on VMD-reconstructed transients. The first column of each confusion matrix represents the output class, the remaining columns show the target class and the diagonal elements of the matrix (green cells) represent the percentage of correct classification. In addition, the percentage of the misclassified transients of the devices are represented in red.

For example, when class 6 (SamSung_Note3) is tested for classification using VMD-reconstructed transients, 56 classes (devices) are identified correctly as class 6 and 4 classes are miss-classified as class 5 (LG_G4). Otherwise when using original transients method only 51 classes are identified correctly and 9 classes are miss-classified as class 5 .The classification results for both cases is shown in Table 1. As presented in the table the correct classification average is 98.3%, based on VMD-reconstructed transients and 96.4% based on the original transients. Classification performance of VMD-reconstructed transient's method is better than original transient's method.

Table 1 Classification accuracy

Method / SNR Level	Low SNR (0 : 5 dB)
Method based on original transient	96.4%
VMD-reconstructed transient method	98.3%

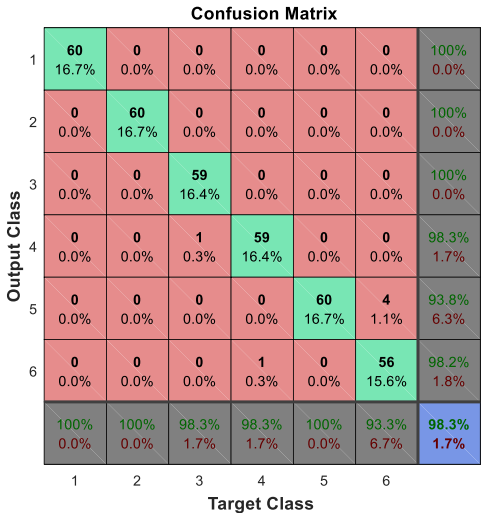

Fig 8: Confusion matrix based on VMD-reconstructed transient

6. Conclusion

In this paper we proposed and investigated a specific emitter identification technique based on variational mode decomposition. Therefore, a data set of six mobile phones is presented and one hundred Bluetooth (BT) transient signals are formed for each mobile phone. The formed transient signals are detected based on the energy envelope. Each BT transient signal is decomposed into a several band limited modes which are added to generate the reconstructed transient signal. Nine HOS features (variance, skewness and kurtosis of instantaneous amplitude, frequency and phase) are extracted from the reconstructed transient signals. The LSVM classifier is used to identify the six BT classes (mobile phones). The classification accuracy based on VMD- reconstructed transient is compared with the classification accuracy based on original transient. Simulation results demonstrate that the proposed method is effective and the classification performance of VMD-reconstructed transient is better than the classification performance based on original transient (2% higher accuracy).

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