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Journal of Computer Graphics and Multimedia Applications

Aims and Scope

Global Journal of Computer Graphics & Techniques provides a medium to communicate information concerning interactive CG and CG applications. The journal focuses on interactive computer graphics, visualization and novel input modalities including virtual environments, and, within this scope, on graphical models, data structures, languages, picture manipulation algorithms and related software.

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Contents

Credit Card Fraud Detection using Machine Learning

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ABSTRACT:

These days online transactions are the most Preferred mode of transactions. It's basically a constant payment method which has become a key part of our lives. But there are some problems associated with this mode of transaction which are fraud transactions that are associated with it and as the count of the online transactions increase, the count of the fraudulent transactions increases along with it. If not being completely put to an end, these. Fraud transactions can definitely be reduced to some extent. There are various methods for that, out of which data analytics and machine learning are one of the methods First a data set is provided from which the maximum, minimum and standard deviation is found. Using this a histogram is plotted which provides a visualisation of the data. Once this is done, 2 groups of graphs are created using the data which are the amount vs class graph and type of transactions vs time graph. Then later 3 machine learning algorithms are used that is light GBM , Adaboost and random forrest classifier to provide the recall , precision and accuracy of the model. A function to find the time taken to run these algorithms is also used. In the end, the value provided by these 3 algorithms are compared to find the one which provides the best result.

I.INTRODUCTION

Ever since the rapid growth of E-commerce, theusage of credit cards for online purchases has dramatically increased and has caused an explosion in the credit card fraud.Many modern technologies based on artificial lintelligence, datamining, fuzzylogic, machine learning Sequence alignment, genetic programming etc. has alsoevolved in detecting various credit card frauds. The traditional detectionmethod mainly depends on database system and the education of customers, whichare usually delayed inaccurate and not in time. After that methods based on discriminate analysis and regression analysis are widely used which can detect fraud by credit rate for cardholders and credit card transaction. For a large amount of data, it is not efficient.

II.SYSTEM ARCHITECTURE

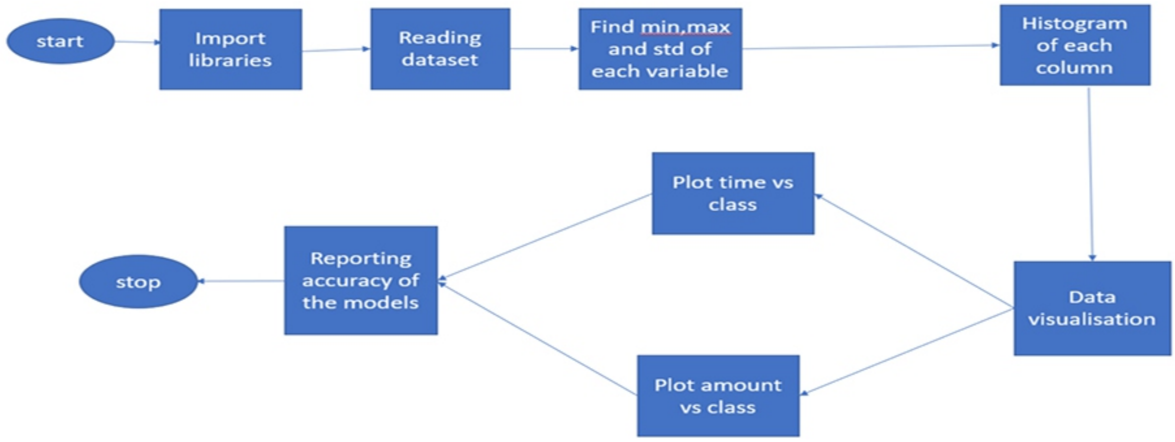

Figure-1

Figure-1 represents the system architecture of the systemwhich begins by importing the libraries are imported such as numpy, pandas, matlab which are an essential part for visualising the data.

After this, the sample dataset contains transactions made by credit cards in September 2013 by European card holders and then the max, min and std of each variable is found after which histogram of each of the predictor columns is produced. The next step is to visualise the data by producing graphs which are the time of transaction vs amount by class graph and amount per transaction by class along with this the total number of fraud cases in test dataset is also produced thus providing a clear picture of the data and number of fraudulent transactions. Once this is done the accuracy , precision and recall of the project is produced using 3 machine learning algorithms which are Light GBM , Adaboost and random forest classifier along with this a time function is added to produce the time taken for these algorithms to run and so a comparison can be done using the 4 outputs.

Credit Card Fraud Detection using Machine Learning

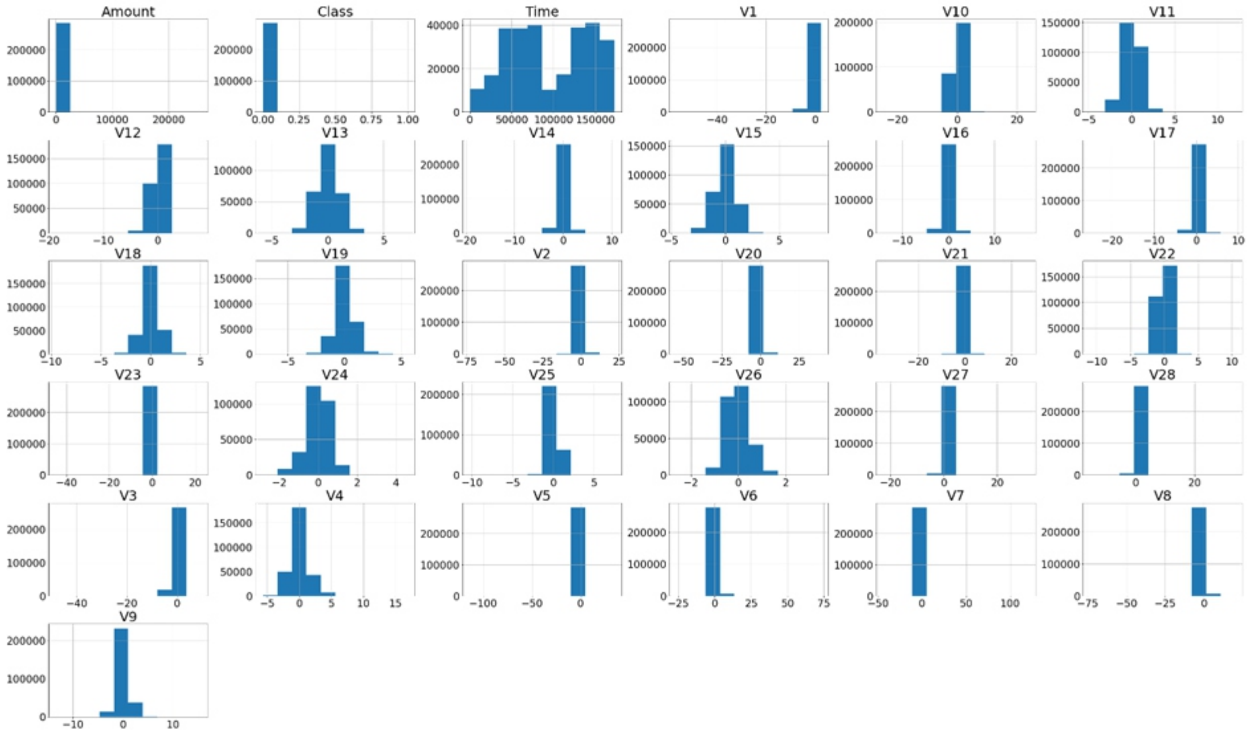

Figure-2

Figure-2 represents the histogram of each column in the dataset. This is obtained by first reading the provided dataset , then the maximum , minimum and std of each variable is found using describe() function .Once this is done, a histogram of each of the predictor columns is generated . This allows for a better visualization of our dataset once the max , min and std has been found.

IV.DATA VISUALIZATION

Data visualization is done using various python libraries which are made available such as Matplotlib , Seaborn etc. Using the various data visualization libraries made available , the data will be visualized into a couple of graphs illustrating the number of fraud cases in the dataset along with a time of transaction vs amount by class graph and a amount vs class graph.

4.1.NUMBER OF FRAUD CASES

By incorporating sampling and normalization using standard scaler , the number of fraud cases present in test dataset can be generated .In the case of this test dataset, the total fraud cases in test data set is 156.

4.2.TIME VS CLASS

The Figure-3 graph is generated to illustrate the time of transaction vs amount by class graph. The Figure-3of the time vs class graph helps acquire a better understanding of the type of transaction that occurs, that is the number of transactions that are fraudulent and normal. This is visibly apparent from figure-3.

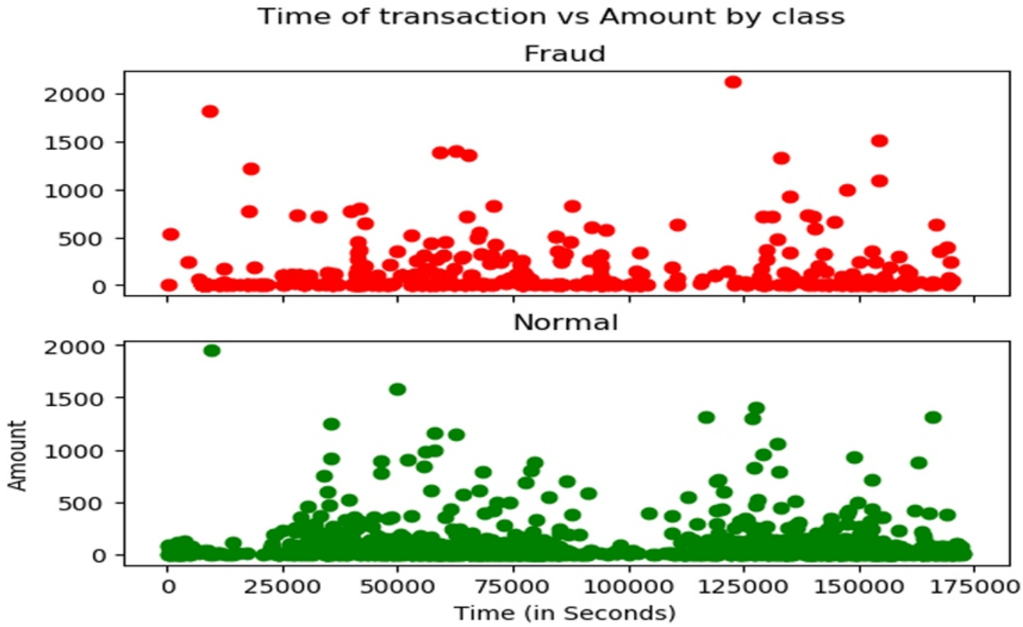

Figure-3

4.3.AMOUNT VS CLASS

The other aspect of data visualization is the amount vs class graph. Figure-4 produces a clear graphical representation of the amount per transaction by class graph. It consists of 2 types of graphs, one which covers amount of transactions vs fraud ,
and ,another which covers amount of transactions vs normal .This presents a clearer picture of the number of transactions that occur in both cases. Figure-4 paints a clear picture of the dataset thus providing the required data regarding fraudulent transactions.

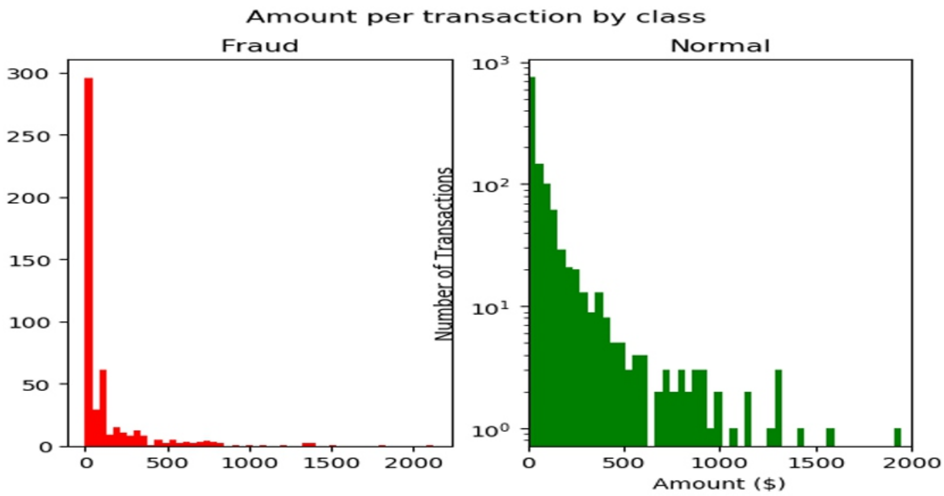

Figure-4

V.SELECTION OF ML MODEL AND REPORTING ITS ACCURACY

5.1.LIGHTGBM

LightGBM is a gradient boosting framework that uses tree based learning algorithm. LightGBM is implemented tree leaf-wise while other algorithms are implemented levelwise. The accuracy , precision and recall of the model is generated using light GBM that is Confusion Matrix: [[395 2] [22 150]]

5.2. ADABOOST CLASSIFIER

Adaboost stands for "Adaptive Boosting". It aims to convert a set of weaker classifier into a strong one. This is a useful algorithm for fraud detection systems. The accuracy , precision and recall of this model is implemented as well thus giving us the following result

5.3. RANDOM FOREST CLASSIFIER

It is probably the most popular classification algorithm. This algorithm is used for both classification and regression problems. As the name suggests it creates a forest with trees, the more trees in the forest the more accurate the model is. The accuracy, precision and recall of the model is produced using random forest classifier which is

VI.CONCLUSION

In conclusion, the number of fraudulent transactions has been identified. In the beginning, the minimum, max and standard deviation of the sample dataset is found. Using this, histogram (Figure-2) and 2 graphs (Figure-3 and Figure-4) have been generated , one is the time vs class graph and the other being the amount vs class graph. As well as calculating the accuracy of the model using 3 algorithms, which are Light GBM, Adaboost and Random forest classifier. Comparison made of the 3 algorithms reveals which of produces the best result. In terms of accuracy, Ada Boost provides the highest result with 0.9613. In terms of precision, Light BGM produces the highest result with 0.986. In terms of recall , Adaboost provides the highest recall with 0.889. In terms of execution time, Random Forest Classifier executes the fastest among the 3 present algorithms.

FUTURE WORKS

With regards to the project, there is still a lot of room for improvement in terms of efficiency. After recognising the impediments in methodology of the program it can concluded that this program can benefit from improvements from other fields as well as adding even more parameters when it comes to detecting credit card transaction fraud. Some of the parameters for detecting credit card fraud transactions that can be included are location , real time credit card information as well improved efficiency to support the stated parameters. Future works will include adding the above stated features into a successful working model which can efficiently detect fraudulent credit card transactions with a real time dataset rather than a sample one.

REFERENCES

1. Andrea Dal Pozzolo, Olivier Caelen, Reid A. Johnson and Gianluca Bontempi. Calibrating Probability with Undersampling for Unbalanced Classification. In Symposium on Computational Intelligence and Data Mining (CIDM), IEEE, 2015 [CrossRef]

2. Dal Pozzolo, Andrea; Caelen, Olivier; Le Borgne, Yann-Ael; Waterschoot, Serge; Bontempi, Gianluca. Learned lessons in credit card fraud detection from a practitioner perspective, Expert systems with applications,41,10,4915-4928,2014, Pergamon [CrossRef]

3. Dal Pozzolo, Andrea; Boracchi, Giacomo; Caelen, Olivier; Alippi, Cesare; Bontempi, Gianluca. Credit card fraud detection: a realistic modeling and a novel learning strategy, IEEE transactions on neural networks and learning systems,29,8,3784-3797,2018,IEEE [CrossRef]

4. Dal Pozzolo, Andrea Adaptive Machine learning for credit card fraud detection ULB MLG PhD thesis (supervised by G. Bontempi) Carcillo, Fabrizio; Dal Pozzolo, Andrea; Le Borgne, Yann-Aël;

5. Caelen, Olivier; Mazzer, Yannis; Bontempi, Gianluca. Scarff: a scalable framework for streaming credit card fraud detection with Spark, Information fusion,41, 182-194,2018,Elsevier [CrossRef]

6. Bertrand Lebichot, Yann-Aël Le Borgne, Liyun He, Frederic Oblé, Gianluca Bontempi Deep-Learning Domain Adaptation Techniques for Credit Cards Fraud Detection, INNSBDDL 2019: Recent Advances in Big Data and Deep Learning, pp 78-88, 2019 [CrossRef]

7. Fabrizio Carcillo, Yann-Aël Le Borgne, Olivier Caelen, Frederic Oblé, Gianluca Bontempi Combining Unsupervised and Supervised Learning in Credit Card Fraud DetectionInformation Sciences, 2019

Design a Robotic Upper-limb Exoskeleton using CT Images and CAD Software

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Abstract:

Many people suffer from weakness in the upper or lower extremities, and there were no techniques to compensate for this weakness until not long ago, but with the progress and development of modern technologies, it became possible to provide these people with artificial external structures to help them recover even a small part of the energy of the weak limb called a robotic exoskeleton. In this paper, we studied the manufacturing of an upper exoskeleton which designed to help people with weak upper extremity muscles to rehabilitate and exercise these muscles and help them to carry out activities that they were not able to do, such as lifting weights and using the hand in simple daily activities. The final 3d model of the upper robotic exoskeleton shows a comfortable shape for the patient and static analysis of it illustrates his ability to handle high torque loads.

Keywords: Upper Robotic Exoskeleton – Upper extremities – CAD – Static analysis.

I. INTRODUCTION

As a result of the rapid progress that humanity is experiencing in the past few decades and the rapid change in lifestyle, many health problems have come to the surface and the number of people with them has increased significantly. One of these problems was muscle problems, the most important of which is muscle weakness, which has increased significantly during the last century in general and the past few decades in particular, like the abnormalities in the skeletal muscles resulting from the increase in problems related to stress and psychological causes which varied between muscle, nervous, metabolic, and other causes, the most important of which are strokes [1]. Hence the need for advanced techniques that contribute to restoring hope to those who have suffered muscle weakness and help them overcome their ordeal as much as possible by using means to help them improve their ability to rehabilitate and use their muscles as naturally as possible and increase their ability to integrate into society and serve it and improve their quality of life and life The community in which they live [2].Based on the foregoing, many forms of assistive devices and exoskeletons have emerged for the purposes of treating,rehabilitating, and even exercising the muscles of people with muscular weakness. These devices went through many stages of development, with improved degrees of freedom, flexibility, and ability to move smoothly and comfortably, without neglecting the increased reliability of these devices and their ability to meet patients' demands with the passage of time. The types and shapes of these devices differed, including robotic devices, the most important of which is the HAL series, the last of which is the 5-HAL series, produced in 2008. Among these devices, we also mention contact interfaces, which include an increase in reproducibility, scalability, safety, and control of the conditions of the environment, and finally, we mention the external structures with feedback as Handyman, Hardiman, ARTS or PERCRO are unmatched devices that allow greater movement during contact reactions [3-5]. Upper Exoskeletons (UEs) is one of the most famous and easy to implement among robotics exoskeletons. The research deals with designing a new prototype of (UEs) using 3d reconstruction of CT images so we can use the accurate shape of the upper limbs and uses it inside the fixed parts of (UEs) and makes the patients feel more comfortable.

II. LITERATURE REVIEW

Ekso Vest is a passive upper exoskeleton was presented by Ekso-BIONICS, the results the tests showed that this device reduce the fatigue on the patients and decrease the load on the shoulders by 10%, also reduce the spine loading [6]. Five-DOF wearable upper exoskeleton, the design shoed a good performance especially using a novel cable-driven mechanism with total weight 4.2 kg [7]. H-PULSE was introduced as a new semi-passive UE, the prototype makes patients feel less strain and more able to do activities also reduce the heart rate that cause of device weight [8]. Recent research work on designing adjustable UE which can be fit on any patient or user using simple design with few actuators [9].

III. METHODOLOGY

The aim of this paper is to propose a novel robotic upper-limb exoskeleton. This design takes into account the accurate dimensions of fixed parts of the device using 3d reconstruction of CT images of an upper limb, modified it, and embedded the actuators with the links and parts. Finally, we will make a static study on this device. The numerical static study will show the efficiency of our robotic exoskeleton.

A. 3D-model of the upper limb This stage was achieved by, (1) taking CT images for a patient who suffers from muscle weakness (2) pre-processing these images (slices) so we can detect efficiently the skin and bone positions. (3) 3D-reconstruction of those slices using special software like DeVIDE or 3D-Doctor and export them into .STL file.

B. Design UE using CAD software

After we obtained a three-dimensional model of the upper limb that will be installed to the supporting device, we divided it to three parts as shown if Fig.1.

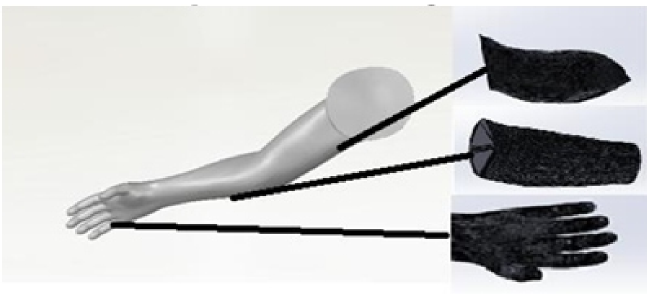

Fig. 1 3D-model of a real arm and its divided parts.

In our project, we will design an external support device (Upper Exoskeleton) with servo motors for the elbow, forearm and palm region. It mainly consists of: 1- Socket items or fixing items (printed with 3D printer). 2- Bearing arms (made of aluminum and chrome). 3- Servo motors, where two MG996R motors were used, because they provided high torque to carry the rest of the parts, and two SG90 motors responsible for lifting the hand area (palm). Initially the parts was shelled using shell instructions and then the outer surfaces were flattened to ensure good contact with the carrying arms. And also the allocation of holes for placing a fixation tape with the patient's arm Fig. 2.

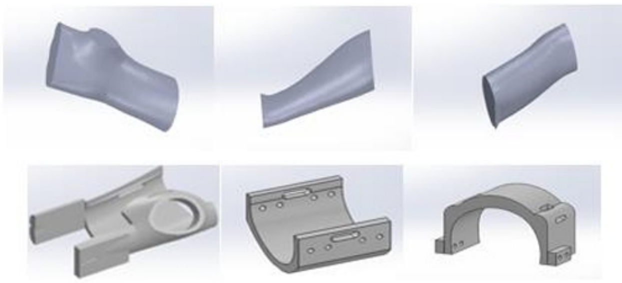

Fig. 2 the real limb parts and modified designs for the Exoskeleton device.

Here, we left an opening for the thumb in order to fix it well in the patient's hand, in addition to the holes for placing a fixation strap with the patient's hand. Bearing links are chrome-aluminum bars and actuaters are MG996R Servo motors. Final design of the proposed (UE) after assembly shown in Fig. 3.

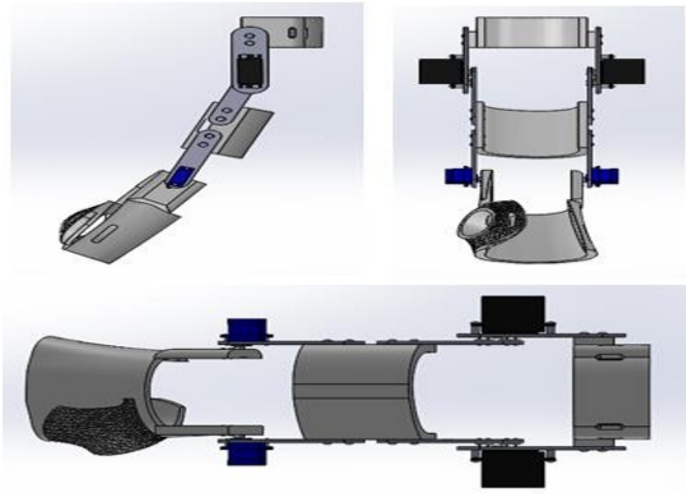

Fig. 3 CAD model of proposed robotic upper exoskeleton.

C. Static simulation parameters

In the beginning, we must first determine the static loads applied to the device, which are:

• The weight of the device, which is related to the type of material it is made of.

• The weight of the hand and forearm that is moved with the device.

• The weight of the hand represents 0.58% of the weight of the full body, and let's assume that the body weight is 75kg, then the weight of the hand equals 0.435kg.

• The weight of the forearm represents 1.65% of the total body weight, and let's assume that the body weight is 75kg, then the weight of the hand equals 1.2375kg.

First case:

Use of ABS PC material for printed fastening elements. Using Chrome stainless steel for carrying arms. Consideration of motors are made of ABS PC material. The rivets are made of Plain carbon steel. In the case that we have a moving mechanism and want to study the effect of forces on it, we must do one of two steps: Install the device at its beginning and apply static forces to the final section so that the applied forces do not cause mechanical transmission on the device, otherwise the simulation will fail. We studied each area separately, taking into account the strength of the deleted areas, and we used this method to achieve simulation.

Second case:

Use of PC High Viscosity for printed fixing elements. Using Chrome stainless steel for carrying arms. Consideration of motors are made of ABS PC material. The rivets are made of Plain carbon steel.

Table. 1. Mechanical properties of ABS and PC.

Property	**ABS PC**	**PC High Viscosity**	**Unit**
Elastic Modulus	24575.011	23657.27	kgf/cm^2
Poisson's Ratio	0.3897	0.3912	N/A
Shear Modulus	8791.93962	8454.415	kgf/cm^2
Mass Density	0.00107	0.00119	kg/cm^3
Tensile Strength	407.884	639.358	kgf/cm^2
Thermal Conductivity	0.000625717	0.000451721	cal/(cm·sec·°C)
Specific Heat	454.111	366.874	cal/(kg·°C)

IV. RESULTS AND DISCUSSION

The simulation was done using each case alone, after selecting the fixing joints, we select the static loads, where we applied force 0.55kg (hand weight with machine weight) on hand + 1.3kg (forearm weight with machine weight).

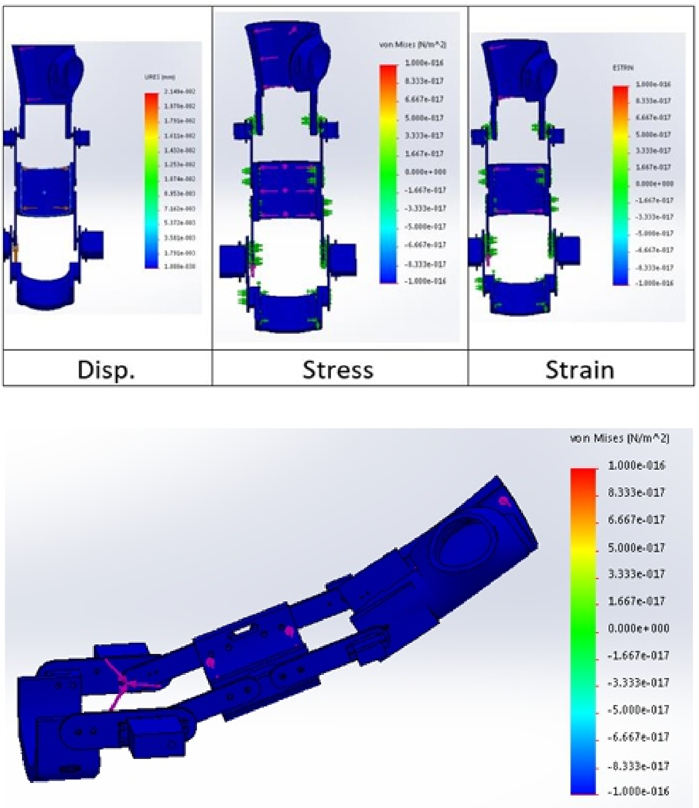

Fig. 4. First case static study results.

First case results in Fig. 4 illustrate that the device can handle the maximum loads without any distortion or future failure. Second case also did the same response and efficiency as shown in Fig. 5.

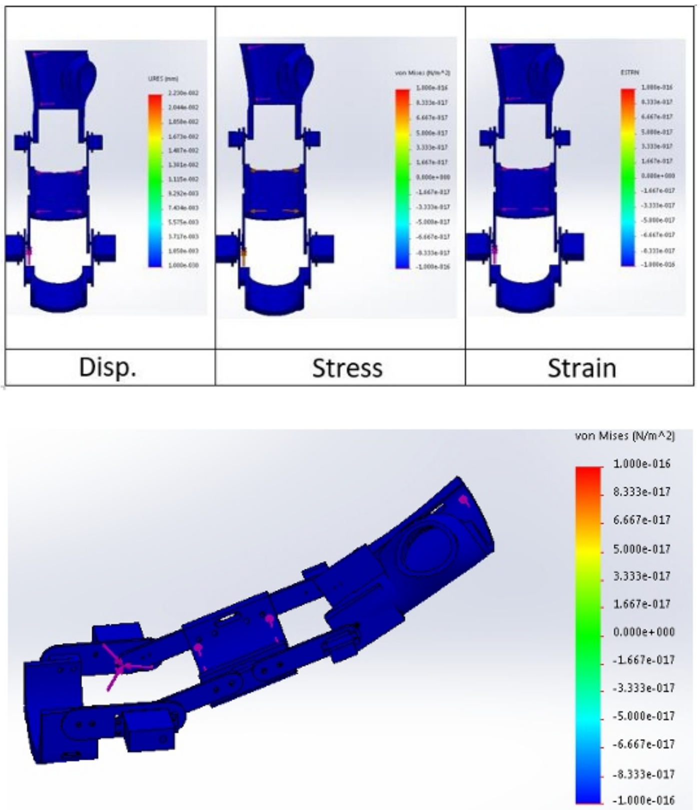

Fig. 5. Second case static study results.

We can use ABS PC and PC materials in these kinds of Exoskeletons because they offer good performance,

long-term execution time, and rapid manufacturing using 3D-printing. The benefits of using CT images were clear in the accurate shape of the positioning of the fixing parts. We can just scale the parts a little bit and add some of the canvas layers on the internal face of the printed parts so we can ensure that patients will like it more.

V. CONCLUSION

After all that has been dealt with in this research, including a quick summary of the topic of external support devices, and a presentation of the most famous types of external support devices that are internationally recognized. In the end, in the practical section, we were able to collect the important points and benefit from them in studying the mechanism and requirements of building an external support device for the facility in proportion to what is available in the local market in terms of mechanical and electronic parts in order for the cost to be acceptable in terms of circuits, motors and mechanical designs.

ACKNOWLEDGMENT

This research belongs fully self-made and represent a novel design methodology of the robotic upper-limb exoskeleton. This research doesn’t relate to any labs or research team or company. Solidworks was used for designing and simulation without any commercial usage of the results.

REFERENCES

1. Stefanaki, C., Pervanidou, P., Boschiero, D., & Chrousos, G. P. Chronic stress and body composition disorders: implications for health and disease. Hormones, 2018, 17(1), 33-43. [CrossRef]

2. Kizilbash, S. J., Ahrens, S. P., Bruce, B. K., Chelimsky, G., Driscoll, S. W., Harbeck-Weber, C., ... & Fischer, P. R. Adolescent fatigue, POTS, and recovery: a guide for clinicians. Current problems in pediatric and adolescent health care, 2014, 44(5), 108-133. [CrossRef]

3. Pacchierotti, C., Sinclair, S., Solazzi, M., Frisoli, A., Hayward, V., & Prattichizzo, D. Wearable haptic systems for the fingertip and the hand: taxonomy, review, and perspectives. IEEE transactions on haptics, 2017, 10(4), 580-600. [CrossRef]

4. Ajayi, M. O. Modelling and control of actuated lower limb exoskeletons: a mathematical application using central pattern generators and nonlinear feedback control techniques (Doctoral dissertation, Université Paris-Est), 2016.

5. Islam, M. R., Assad-Uz-Zaman, M., & Rahman, M. H. Design and control of an ergonomic robotic shoulder for wearable exoskeleton robot for rehabilitation. International Journal of Dynamics and Control, 2020, 8(1), 312-325. [CrossRef]

6. Kim, S.; Nussbaum, M.A.; Esfahani, M.I.M.; Alemi, M.M.; Jia, B.; Rashedi, E. Assessing the influence of a passive, upper extremity exoskeletal vest for tasks requiring arm elevation: Part II–"Unexpected" effects on shoulder motion, balance, and spine loading. Appl. Ergon. 2018, 70, 323–330. [CrossRef]

7. Gunasekara, M.; Gopura, R.; Jayawardena, S. 6-REXOS: Upper limb exoskeleton robot with improved pHRI. Int. J. Adv. Robot. Syst. 2015, 12, 47. [CrossRef]

8. Grazi L, Trigili E, Proface G, Giovacchini F, Crea S, Vitiello N. Design and experimental evaluation of a semi-passive upper-limb exoskeleton for workers with motorized tuning of assistance. IEEE Transactions on Neural Systems and Rehabilitation Engineering. 2020 Aug 5;28(10):2276-85. [CrossRef]

9. ERSİN Ç, Mustafa YA, GÖKÇE H. Upper Limb Robot Arm System Design and Kinematic Analysis. El-Cezeri Journal of Science and Engineering.;7(3):1320-31.

Soleprint Image Gabor Filtering, Extraction of Local Ridge Orientation, and Binarisation

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Abstract:

Soleprint is an impression of the friction ridge of a part of the human plantar, a point on the sole of the foot adjacent to the big toe, at the flat space behind the toes, Lepers do have soleprint but mostly do not have fingerprint. The three (3) soleprint samples, a whorl, a loop and an arch were picked out of the 240 soleprint images collected from 120 lepers of 9 colonies in Nigeria, and compare withthree (3) fingerprint images, a loop, a whorl and an arch, drawn from a database created in 2010 during my PhD research. The fingerprint recognition algorithm was applied to the images for comparison, with interest in finding local ridges orientation, Gabor filtering and binarization. The orientation patterns revealed that fingerprint and soleprint images belonging to same class do have their line of orientation similar. The Binarized images were discovered to contain lots of false minutiae points because of dirt and little mutilation on the foot. The fact remains that 1/10 of a portion of the entire surface is sufficient enough to conduct a match. The image can also be enhancedusinga good technique for better results. The soleprint has identical features to that of the fingerprint that can produce minutiae points.

Keywords: Soleprint, Binarisation, Double Loop, Whorl, Arch, Fingerprint, Voting.

I.INTRODUCTION

A soleprint is an impression of the friction ridge of a part of the human plantar. This is a point on the sole of the foot adjacent to the big toe, at the flat space behind the toes, as depicted by Fig. 1. [1][2]. In accordance to the Henry's method, there are three (3) patterns in fingerprint, namely, arches, loops and whorls. There can be subdivided into six; arch, tented arch, left loop, right loop, double loop or twin loop and whorl [3]. The fingerprint pattern also contains other features that can be useful in classification of the patterns. These features, known as minutiae points or Galton point [3] are those small unique patterns on the fingerprint such as ridge endings and ridge bifurcations Studies has revealed in Obaje, (2010) [2] that the Soleprint also has patterns that are similar to those found on the fingerprint that can be studied. On the soleprint are loops and whorls, but the kind of arches found on the Soleprint are inverted [2]. Initially arch is an alphabet best described as inverted "U", that goes to say that the kind of arches found on the Soleprint are "U" in appearance. Should this impression henceforth be called "inverted arches", that is "inverted arch" and"inverted tented arch" respectively. The Soleprint is to be studied to see if it can replace the absence of fingerprint for some special set of people all over the world. The leprosy victims all over the world according to WHO (2017) stands at 1 out of

10,000 world population of 7.7 Billion as revealed by United Nations in Worldometer (2019). These huge populations of a group of stigmatized people known as lepers are not enjoying democracy at all [4][5]. These set of people are denied of their fundamental human right of voting and it is because of their inability to partake in voting. The basic mode for voting all over the world is through the use of fingerprint. And they lack the fingerprint and toeprint all together, they cannot vote for candidate of their choice. The lepers do have soleprint that can be used for voting if their finger or toe print is conspicuously absent.

Soleprint Image Gabor Filtering, Extraction of Local Ridge Orientation, and Binarisation

Fig.1: Complete Palmar showing regions of Soleprint

The fingerprint image recognition system can also work for the Soleprint images. The main components of the image recognition system are sensing, feature extraction and matching. Matching, the end point and the most crucial aspect of the recognition system, is to compare previously stored template of images against a candidates query image for authentication purposes.

The recognition system can be further summarised into stages like, image capturing, image enhancement, feature extraction, storage of extracted feature and matching. After collection of image, the clarity of the image will suggest a choice of suitable algorithm to be employed, as a well enhanced image will produce high-quality feature extraction. Also, the result of matching with such good quality image is overwhelming. We can conclude to say that, a good image will yield fast and accurate matching result even with high threshold. In this experiment, special cognisance is given to three very crucial stages of the recognition system, these are; local ridge orientation, binarisation and thinning.

II.EXPERIMENTS

A comparable image recognition algorithm has been developed for both sun-print and finger-print tests (Jain et al., 1997; Chandan et al., 2005; Zhang, 1984; Hong, Wan and Jain, 1998; Maltoni et al., 2003)[6][8]. The images were selected such that, the three major classes, Loop (Double loop), Whorl and Arch are represented respectfully.

3.1 Local ridge orientation

The equation for calculating gradient is,

$$Vx(i,j) = \sum_{u=i-8}^{i+8} \sum_{v=j-8}^{j+8} 2gx(u,v)gy(u,v),$$

$$Vy(i,j) = \sum_{u=i-8}^{i+8} \sum_{v=j-8}^{j+8} gx^2(u,v) - gy^2(u,v),$$

$$\theta(i,j) = \frac{1}{2} archtan\left(\frac{Vy(i,j)}{Vx(i,j)}\right) \quad (1)$$

Where w is the size of the local window, 16 are the gradients in the x and y directions of gx, and gy. The level of consistency of the orientation field in the local block (i, j) was calculated with the formulae..

$$C(i,j) = \frac{1}{N}\sqrt{\sum_{(i',j')\epsilon D} |\theta(i',j') - \theta(i,j)|^2}, \quad (2)$$

$$|\theta' - \theta| =$$

$$\begin{cases} d & if\ (d = (\theta^1 - \theta + 360)\ mod\ 360) < 180 \\ d - 180, & otherwise \end{cases} \quad (3)$$

3.2 Gabor Filtering

The Gabor filter design was based on the uniform real component of the original 2D Gabor filter that was also adopted in (Hong, 1998) [10] and (Jain andFarrokhnia1991) [11].

Thus,

$$g(x,y,T,\varphi) = exp\left(-\frac{1}{2}\left[\frac{x_\varphi^2}{\sigma_x^2} + \frac{y_\varphi^2}{\sigma_y^2}\right]\right) cos\left(\frac{2\pi x_\varphi}{T}\right) \quad (4)$$

$$x_\varphi = x\cos\varphi + y\sin\varphi \quad (5)$$

$$y_\varphi = -x\sin\varphi + y\cos\varphi \quad (6)$$

φ is the orientation of the derived Gabor filter; and T is the period of the sinusoidal plane wave. Decomposing the equation into two orthogonal parts, one parallel and the other perpendicular to the orientation φ, the following formula can be deduced.

$$g(x,y,T,\varphi) = h_x(x;T,\varphi)\ X\ h_y(y;\ \varphi)$$
$$= \left\{exp\left(-\frac{x_\varphi^2}{2\sigma_x^2}\right) cos\left(\frac{2\pi x_\varphi}{T}\right)\right\}.\left\{exp\left(-\frac{y_\varphi^2}{2\sigma_y^2}\right)\right\} \quad (7)$$

3.3 Binarization

Binarisation is to convert the gray scale image into binary image by fixing the threshold value. The algorithm made use of by, Jain, Hong, Pakanti and Bolle in [12] reported a ridge extraction or Binarisation algorithm whereby an image whose orientation is already known in a non-overlapping 16 x 16 neighbourhood is convolved with two masks. The two masks, ht(i,j;u,v) and hb(i,j;u,v), of size L x H (on average 11 x 7).

$$h_t(i,j;u,v) = \begin{cases} -\frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{u}{\sigma^2}}, if\ u = \left(v\cot(\theta(i,j)) - -\frac{H}{2\cos\theta(i,j)}\right),\ v \in \Omega \\ \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{u}{\sigma^2}}, if\ u = (v\cot(\theta(i,j))),\ v \in \Omega \\ 0, \quad otherwise \end{cases} \quad (8)$$

$$h_b(i,j;u,v) = \begin{cases} -\frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{u}{\sigma^2}}, if\ u = \left(v\cot(\theta(i,j)) + -\frac{H}{2\cos\theta(i,j)}\right),\ v \in \Omega \\ \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{u}{\sigma^2}}, if\ u = (v\cot(\theta(i,j))),\ v \in \Omega \\ 0, \quad otherwise \end{cases} \quad (9)$$

$$\Omega = \left[-\left|\frac{Lsin(\theta(i,j))}{2}\right|, \left|\frac{Lsin(\theta(i,j))}{2}\right|\right], \quad (10)$$

$\theta\ (i,j)=$ pixel direction ; and σ = large constant.

III.RESULT AND DISCUSSION

The implementation environment used for the work is as follows: MATLAB R2015b on a Window 7 Operating System. The Sample set used for the experiment is three Soleprint images (a loop, a whorl and an arch) collected from 140 individual lepers of the 9 leprosarium in Nigeria. The opportunity for the data collection was given to me by the TETFund research grant offered me recently (2014). The Fingerprint image were also (a loop, a whorl and an arch), obtained from a previous work I did during my PhD work at University of Ilorin in 2010. All the images were collected through ink dab method. Even though the image resolution was not exactly 256 × 256, the program demands to be adjusted to this.The experiment is aimed at subjecting the Soleprint to the same treatment with the fingerprint recognition algorithm and to see if a similar result will be obtained. Image quality and the algorithm and to see if a similar result will be obtained. Image quality and the algorithm performance evaluation is not the goal here, so the execution timeand effectiveness of algorithm was not taken into consideration. First of all, the RGB images were converted into gray scale images as found in the first table, Fig. 2(a) is the Grayscale Fingerprint and a double loop, Fig. 3(a) is the Grayscale Soleprint and is as well a double loop. Other Gray scale images are Fig. 4(a) Gray scale fingerprint – Whorl, Fig. 5(a) Gray scale soleprint – Whorl. Fig. 6(a) and Fig. 7(a) are the Gray scale images for finger and soleprint – Arch, respectively. Before the orientation,preprocessing was purely done through normalization approach(results not shown). Fig. 2(b) and Fig 3(b),shows the result of orientation for Double loop fingerprint and soleprint respectfully. Fig. 4(b) is the orientation result for Whorl fingerprint and Fig. 5(b) is

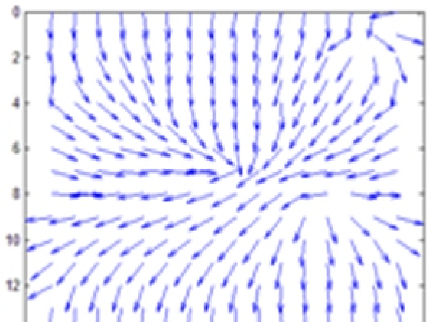
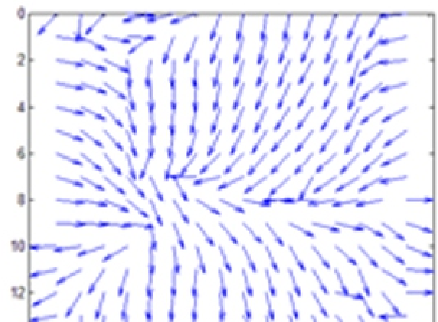
that for Soleprint whorl. Orientation result for Arch fingerprint is as shown in Fig. 6(b) and that for soleprint is as shown in Fig 7(b). It was observed that the orientation pattern formation is identical for images belonging to same class irrespective of whether it is a fingerprint or soleprint image. The double loop patterns are concentric at halfway on the plot. The whorls are concentrated at the centre, while the arches line of flow is from top to bottom of the plot. It was observed that the images used for the experiment were of poor quality, especially on the soleprint and that could be due to dirtiness of the foot, which should be cleaned more properly if a better result is aimed at. Due to the poor quality of the images, the Binarisation results revealed for both the fingerprint and the soleprint are not so good at all. As can be seen, this imageneeds to be properly enhanced before thinning, if not many false minutiae points would be created. The reason for the experiment is not to test the viability of any image recognition system but to show that a soleprint image is like the fingerprint image.

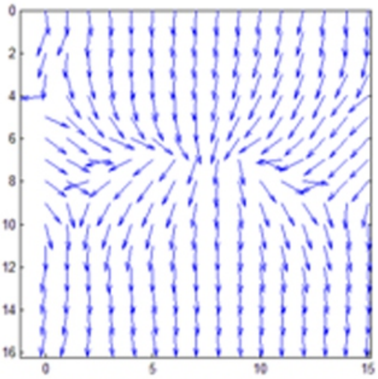
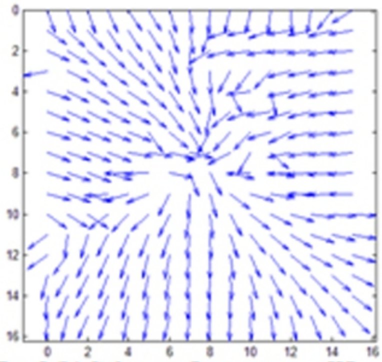
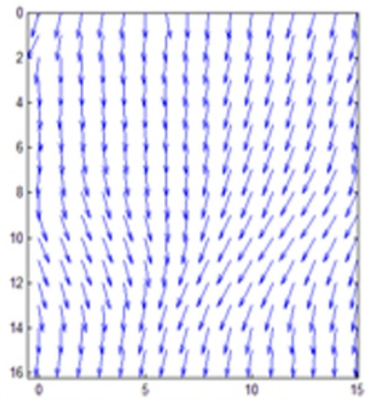
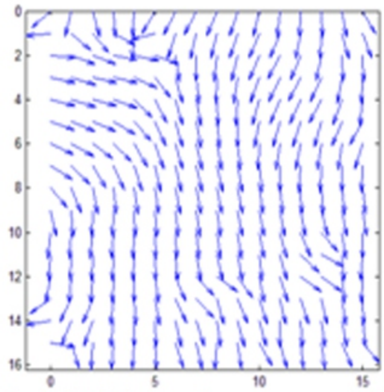
1. Result for Grayscale

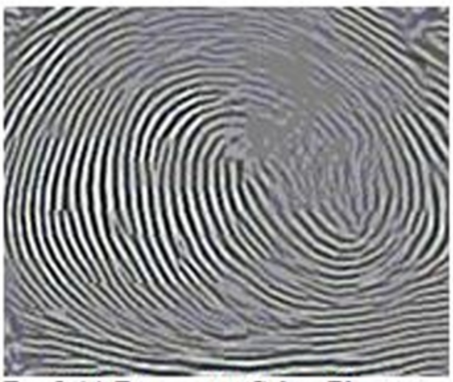
Class	Fingerprint	Soleprint
Loop	 Fig. 2 (a) Grayscale Fingerprint – Double loop	 Fig. 3 (a) Grayscale Soleprint - Double loop

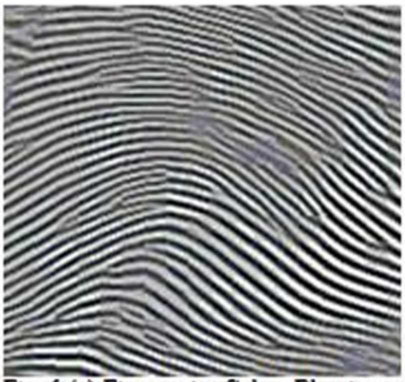
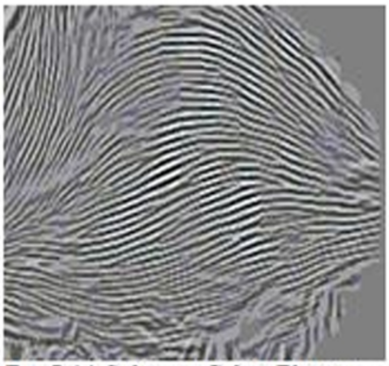
Whorl	 Fig. 4 (a) Grayscale Fingerprint – Whorl	 Fig. 5 (a) Grayscale Soleprint – Whorl
Arch	 Fig. 6 (a) Grayscale Fingerprint – Arch	 Fig. 7 (a) Grayscale Soleprint – Arch (Inverted)

2. Orientation Result

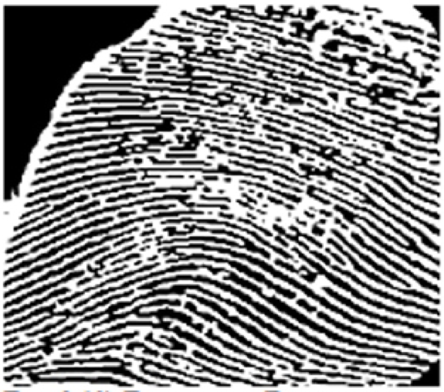
Class	Fingerprint	Soleprint
Loop	 Fig. 2 (b) Fingerprint Orientation – Double loop	 Fig. 3 (b) Soleprint Orientation – Double loop

Whorl	 Fig. 4 (b) Fingerprint Orientation – Whorl	 Fig. 5 (b) Soleprint Orientation – Whorl
Arch	 Fig. 6 (b) Fingerprint Orientation – Arch	 Fig. 7 (b) Soleprint Orientation – Arch

3. Gabor Filter Result		
Class	**Fingerprint**	**Soleprint**
Loop	 Fig. 2 (c) Fingerprint Gabor Blurring – Double loop	 Fig. 3 (c) Soleprint Gabor Blurring – Double loop

Whorl	 Fig. 4 (c) Fingerprint Gabor Blurring – Whorl	 Fig. 5 (c) Soleprint Gabor Blurring – Whorl
Arch	 Fig. 6 (c) Fingerprint Gabor Blurring – Arch	 Fig. 7 (c) Soleprint Gabor Blurring – Arch

4. Binarisation Result		
Class	**Fingerprint**	**Soleprint**
Loop	 Fig. 2 (d) Fingerprint Binarisation – Double loop	 Fig. 3 (d) Soleprint Binarisation – Double loop

Whorl	 Fig. 4 (d) Fingerprint Binarisation – Whorl	 Fig. 5 (d) Soleprint Binarisation – Whorl
Arch	 Fig. 6 (d) Fingerprint Binarisation – Arch	 Fig. 7 (d) Soleprint Binarisation – Arch

IV.CONCLUSION

The poor nature of the images as conspicuously visible on the results will introduce false minutiae points, loss of real minutiae points and also introduce large errors in minutiae direction or position. Image enhancement algorithm with more efficient performance and image handling capability should be employed if the image quality is a factor. The fact remains that 1/10 of a portion of the entire surface is sufficient enough to conduct a match. The experiment revealed that, the soleprint possess the basic characteristics of being unique to individuals, have features that can be extracted, and is characterized by presence of minutiae points. Hence, it can be used in place of fingerprint.. A leper or victim of accident that has no fingerprint can now make use of their soleprint. A new mode for personal identification known as the Soleprint capable of being used for voting by lepers and accident victims who have no fingerprint is hereby proposed.

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REFERENCES

1. S. E. Obaje, Lepers Personal Identification Using the Soleprint in Place of Fingerprint: Proceedings of the 3rd International Conference on Electronics and Computer Technology, Kanyakumari, India, 2011, pp. V3-471-V3-474 [CrossRef]

2. S. E. Obaje, Automatic Fingerprint and Toeprint Recognition for Personal Identification and Forensic Application, Masters diss. Department of Electrical & Electronics Engineering, University of Ilorin. 2010.

3. R. E Gaensslen., Peter R. Deforest and Henry C. Lee., "Forensic Science, An Introduction to Criminalistics", McGrawHill, New York, 1983.

4. Worldometer,. World Population Clocks 7.7 Billion People, 2019www.worldometer.info.

5. WHO (2017),. "Fact Sheet On Leprosy, Disabled People International". United Nation Enable. www.un.org

6. K. Jain, L. Hong, S. Pankanti, and R. Bolle, Online Fingerprint Verification, IEEE transaction Pattern Analysis & Machine Intelligence, 1997, vol.19, no.4, pp302-313 [CrossRef]

7. D. Maltoni, D. Maio, A. K. Jain, and S. Prabhakar, handbook of fingerprint recognition, Springer, New York, 2003.

8. L. Hong, Y. Wan, and A.K. Jain, Fingerprint Enhancement Algorithms and Performance Evaluation, IEEE Trans. On pattern, Analysis and Machine Intelligence, 1998, vol. 20, no. 8, pp. 777-789. [CrossRef]

9. A. R. Rao., "A Taxonomy for Texture Description and Identification", Springer, New York, NY, 1990.

10. Hong, L., "Automatic Personal Identification Using Fingerprints", Ph.D Thesis, Michigan State University, USA. 1998.

11. A.K.Jain,. and F.Farrokhnia, "Unsupervised Texture Segmentation Using Gabor Filters", Pattern Recognition, vol. 24, no. 12, pp. 11671186. 1991. [CrossRef]

12. A. Jain, , l.Hong, , S. Pankanti, and R.Bolle, , "An IdentityAuthentication System Using Fingerprints", Proceeding of IEEE (special issue on automated biometrics) 85(9); 1365-1388. 1997. [CrossRef]

Method of Group Decision Making for Production Planning of the Oil Refinery Plant

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Abstract :

This article is devoted to the problem of decision making under uncertainty. An aggregated approach is used that combines optimization and choice of a solution, which makes it possible to obtain a more realistic solution. The criteria in the vector optimization problem are: profit, product quality, employee satisfaction. To solve the optimization problem, 3 methods were used: "Goal programming", "Interactive", "FMOLP". The task of group decision making is implemented on the basis of the package FGDSS-CD (Fuzzy group Decision Support System).

Keywords: Uncertainty, group decision making, planning, oil refinery plant, fuzzy , goal programming, interactive, FMOLP

I. INTRODUCTION

The group decision making methods have been developed for solving semi structured and unstructured problems [1-6], so for problems with high level of uncertainty of information. Uncertainty can be related with imprecise of given data and with uncertainty of goals so when we have several contradictory objectives. These methods usually are used for problems where alternatives are presented in non numerical values. As rule the preferences of experts are expressed by linguistics terms. In systems are based on group decision making technology , the experts make decisions by evaluation of proposed alternatives. The evaluation process is based on the intuition, experience and special algorithm of achieving consensus.[7-9]. General structure of group decision making is presented on Fig. 1.

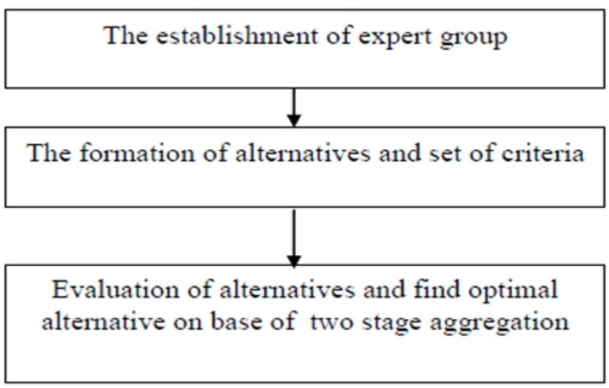

Fig. 1. General structure of group decision making

If necessary, in general structure can be included the blocks for conversation pair wise values into absolute ones and normalization procedures. The most known methods are following:. - ELECTRE method (Elimination and Choice Expressing Reality);[10-12]/ - AHP method (Analytic hierarchy process); - TOPSIS method (Technique for order Preference by similarity to ideal solution) and others; The ELECTRE method was first method of classification alternatives. It was proposed by French scientist B.Rua. AHP method was proposed by American scientist T.Saati for analysis situation where application of mathematical methods is impossible. TOPSIS method use the approach where decision based on compromise of maximum distance from negative ideal and minimum distance from positive ideal decisions. Consider the general scheme of group decision making. The group of experts E_k (к=1,..L) are given. For any expert is assigned the weight coefficient $w_k\,(k=1,...,L)$. This coefficient is reflects the trust level of expert. The set of criteria for evaluation of alternatives are given F_j $(j=1,...,m)$ For any criteria the weight is assigned Also the set of alternatives is determined v_j $(j=1,...,m)$ A_i, $i=1,...,n$ The process of determination of optimal alternative can be describe by two stage procedure . This process can be presented in pay off table form .

	v_1	v_2		v_m	
	F_1	F_2	....	F_m	
A_1	C_{11}	C_{12}		C_{1m}	$\overline{C}_1^{(k)}$
		C_{ij}			$\overline{C}_2^{(k)}$
...	...	...	...	...	
A_n	C_{n1}	C_{n2}	...	C_{nm}	$\overline{C}_n^{(k)}$

Here) (k i C-is aggregative value of i-th alternative by k-th expert, ij C-value of i-th alternative by j-th criteria ij C are determine by expert by estimation . For any expert k E the payoff matrix is built. For any к alternative aggregative values) (k I C

$$\sum_{j=1}^{m} c_{ij} v_j = \overline{C}_I^{(k)} \qquad k=\overline{1,l}, \quad i=\overline{1,n}$$

In second stage the matrix of values by all experts is established. All operations are performed on base of fuzzy approach.

	w_1	w_2		w_l	
	E_1	E_2	E_k	E_l	C_1^*
A_1	$C_1^{(1)}$	$C_1^{(2)}$	$C_1^{(k)}$	$C_1^{(l)}$	C_2^*
A_2					
....	...	...	...	...	...
A_n	$C_n^{(1)}$	$C_n^{(2)}$	$C_n^{(k)}$	$C_n^{(l)}$	C_n^*

On base of weight coefficients of expert w_k $\mathrm{k} = \overline{1, \ell}$ the aggregative value for any alternative are determined.

$$\sum_{k=1}^{\ell} w_k C_k^* = C_i^*$$

The process is finished by determination of optimal alternative so aggregative solution by all experts *
I C

$$i^* = \max_i C_i^*$$

All group decision making methods are based on this general scheme , Fuzzy versions of this approach differs on usage of linguistic variables. Consider the planning of oil refinery plant. The problem is present in multicriteria variant. Refinery process consists of two units: production and compound. (Fig.2) .

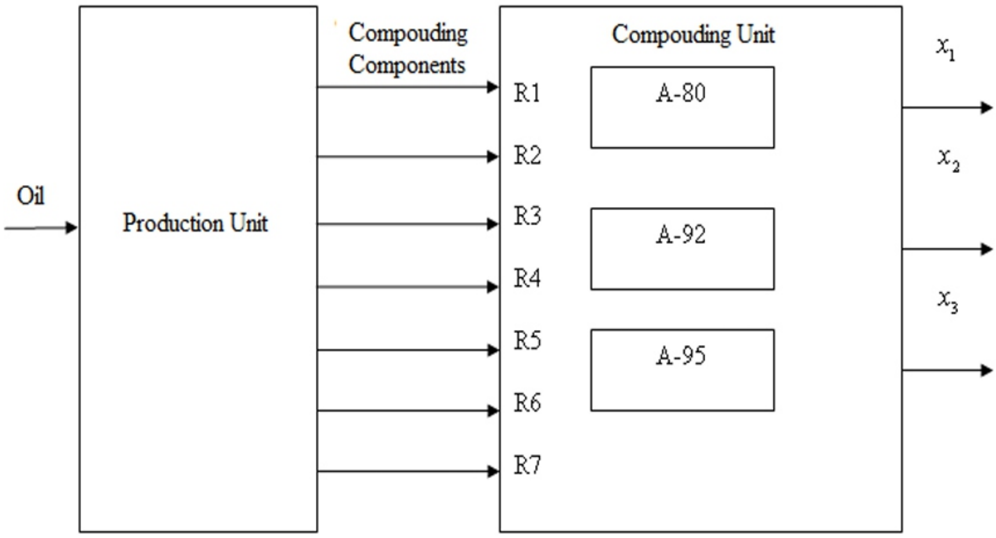

Fig. 2. The major units of oil refinery process

Production unit realize two stages oil refinery process. In the first stage is conducting of primary oil processing, in the next stage the catalytic cracking and coke processes are performing. In production unit are produced the fraction which are used needed for manufacturing car petrol.

II. METHOD

The fuzzy planning problem statement In last years many scientists for planning problem use multicriteria problem where are used economical, social and ecology criteria. In this connects the fuzzy problem statement can be presented as following: Fuzzy Goal function includes three functions : profit, product quality, worker satisfaction

$$max\ \tilde{f}(x) = max\begin{pmatrix}\tilde{f}_1(x)\\ \tilde{f}_2(x)\\ \tilde{f}_3(x)\end{pmatrix} = max\begin{pmatrix}\tilde{c}_{11}x_1 + \tilde{c}_{12}x_2 + \tilde{c}_{13}x_3\\ \tilde{c}_{21}x_1 + \tilde{c}_{22}x_2 + \tilde{c}_{23}x_3\\ \tilde{c}_{31}x_1 + \tilde{c}_{32}x_2 + \tilde{c}_{33}x_3\end{pmatrix} = max\begin{pmatrix}28\tilde{8}x_1 + 2\tilde{9}0x_2 + 3\tilde{0}0x_3\\ \tilde{8}x_1 + \tilde{5}x_2 + \tilde{3}x_3\\ \tilde{4}x_1 + \tilde{8}x_2 + \tilde{6}x_3\end{pmatrix}$$

fuzzy constraints: Resource constraints :

HK-85 fraction: $\tilde{a}_{11}x_1 + \tilde{a}_{12}x_2 + \tilde{a}_{13}x_3 = 0.2\tilde{2}89x_1 + 0.0\tilde{1}028x_2 \leq b_1 = 27611.9$

Stabile platformate

$$\tilde{a}_{21}x_1 + \tilde{a}_{22}x_2 + \tilde{a}_{23}x_3 = 0.0\tilde{6}91x_1 + 0.3\tilde{4}94x_2 + 0.7\tilde{8}57x_3 \leq b_2 = 38\tilde{6}214$$

Coker gasoline: $\tilde{a}_{31}x_1 + \tilde{a}_{32}x_2 + \tilde{a}_{33}x_3 = 0.08\tilde{4}6591x_1 \leq \tilde{b}_3 = 69\tilde{2}5.4$

high-octane component:

$$\tilde{a}_{41}x_1 + \tilde{a}_{42}x_2 + \tilde{a}_{43}x_3 = 0.4\tilde{9}01x_1 + 0.\tilde{6}402x_2 + 0.2\tilde{1}42x_3 \leq \tilde{b}_4 = 61\tilde{4}955$$

Virgin gasoline: $\tilde{a}_{51}x_1 + \tilde{a}_{52}x_2 + \tilde{a}_{53}x_3 = 0.\tilde{0}4718x_1 \leq \tilde{b}_5 = 38\tilde{5}8$

HK-85-180 fraction: $\tilde{a}_{61}x_1 + \tilde{a}_{62}x_2 + \tilde{a}_{63}x_3 = 0.0\tilde{1}289x_1 \leq \tilde{b}_6 = 10\tilde{5}4.40$

Hydro treated gasoline: $\tilde{a}_{71}x_1 + \tilde{a}_{72}x_2 + \tilde{a}_{73}x_3 = 0.\tilde{0}671x_1 \leq \tilde{b}_7 = 54\tilde{8}7.8$

Plan constraints:

Production of gasoline A-80: $\tilde{a}_{81}x_1 + \tilde{a}_{82}x_2 + \tilde{a}_{83}x_3 = \tilde{1}x_1 \geq \tilde{b}_8 = 20\tilde{0}0$

Production of gasoline A-92: $\tilde{a}_{91}x_1 + \tilde{a}_{92}x_2 + \tilde{a}_{93}x_3 = \tilde{1}x_2 \geq \tilde{b}_9 = 20\tilde{0}0$

Production of gasoline A-95: $\tilde{a}_{101}x_1 + \tilde{a}_{102}x_2 + \tilde{a}_{103}x_3 = \tilde{1}x_3 \geq \tilde{b}_{10} = 20\tilde{0}0$

Products quality constraints :

$$\tilde{a}_{111}x_1 + \tilde{a}_{112}x_2 + \tilde{a}_{113}x_3 = 0.27\tilde{7}569x_1 \geq \tilde{b}_{11} = 0$$

$$\tilde{a}_{121}x_1 + \tilde{a}_{122}x_2 + \tilde{a}_{123}x_3 = 0.07\tilde{3}72x_2 \geq \tilde{b}_{12} = 0$$

$$\tilde{a}_{131}x_1 + \tilde{a}_{132}x_2 + \tilde{a}_{133}x_3 = 0.0\tilde{0}62x_3 \geq \tilde{b}_{13} = 0$$

Balance constraints : $\tilde{a}_{141}x_1 + \tilde{a}_{142}x_2 + \tilde{a}_{143}x_3 = \tilde{1}x_1 + \tilde{1}x_2 + 1\tilde{x}_3 \leq \tilde{b}_{14} = 104\tilde{6}107.1$

Where 1 x-amount of gasoline A-80, 2 x- amount of gasoline A-92, 3 x- amount of gasoline A-96.Coefficiets of objective functions and constraints are presented by fuzzy triangle numbers (LR) type.

$$\mu_{\tilde{a}}(x) = \begin{cases} 0, & x < a \text{ или } c < x \\ (x\text{-}a)/(b\text{-}a), & a \le x < b \\ 1, & x = b \\ (c\text{-}x)/(c\text{-}b), & b < x \le c \end{cases}$$

III. RESULTS

This problem have been solved by three methods of multicriteria optimization : FMOLP, GOAL programming, Interactive method. Consider the one scheme of group decision making to problem to find consensus of decision which have been achieved by three different methods. As results of solving oil refinery planning problem on base of multicriteria model with 3 criteria-profit, quality and worker satisfaction by three different methods, ("Goal programming ","Interactive", "FMOLP") are presented in

Table 1.

"Goal programming" method	"Interactive" method	"FMOLP" method
X[1] = 42079,3098 X[2] = 897406,6352 X[3] = 88777.4486 $\tilde{f}_1(x) = 290\tilde{0}00000$ $\tilde{f}_2(x) = 509\tilde{0}000$ $\tilde{f}_3(x) = 788\tilde{0}235$	X[1] = 48013.8179 X[2] = 901917.0926 X[3] = 65434.6646 $\tilde{f}_1(x) = 29501\tilde{4}335.7861$ $\tilde{f}_2(x) = 509\tilde{0}000$ $\tilde{f}_3(x) = 780\tilde{0}0000$	X[1] = 42117.8841 X[2] = 898834.0329 X[3] = 88139.2835 $\tilde{f}_1(x) = 29923\tilde{3}3636.19$ $\tilde{f}_2(x) = 509\tilde{5}531.98$ $\tilde{f}_3(x) = 788\tilde{7}979.81$

These solutions are considered as alternatives and also group of experts 1 2 3 E ,E ,E A,A ,A 1 2 3 are presented for find final decision of problem. For solving this problem is used software package FGDSS-CD(Fuzzy group Decision Support System). In first stage are determined weight coefficients of any expert and list of criteria (Fig. 3.)

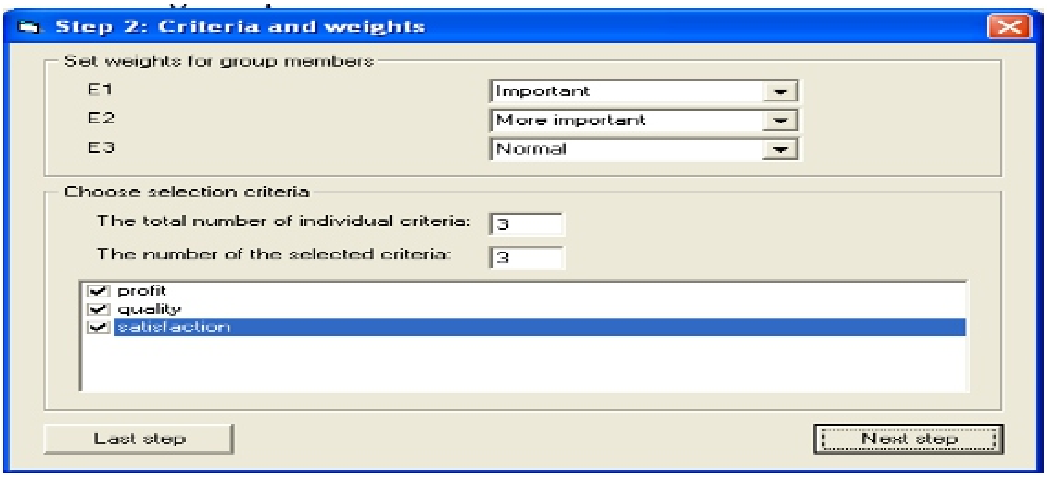

Fig.3. The determination weight coefficients of experts and forming of criteria set.

In next step any expert enter the pairwise matrix of own preferences to the criteria and evaluate all alternatives . All operations are realized in the fuzzy formalism (Fig. 4).

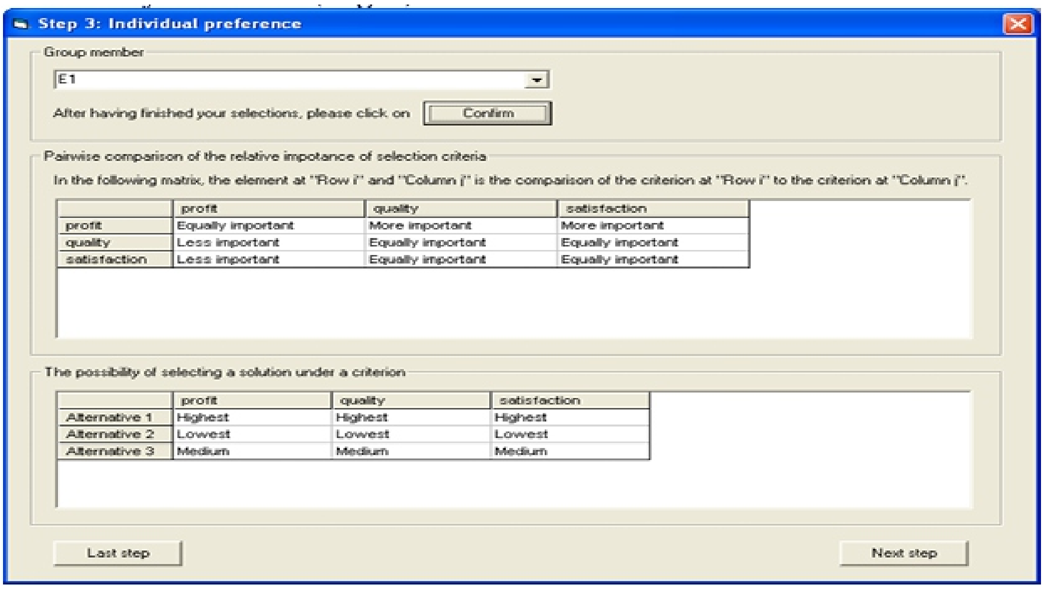

Fig. 4. Entering the pairwise preferences matrix and alternative's evaluation for expert

In next step was performed aggregation procedure by experts.(Fig.5.)

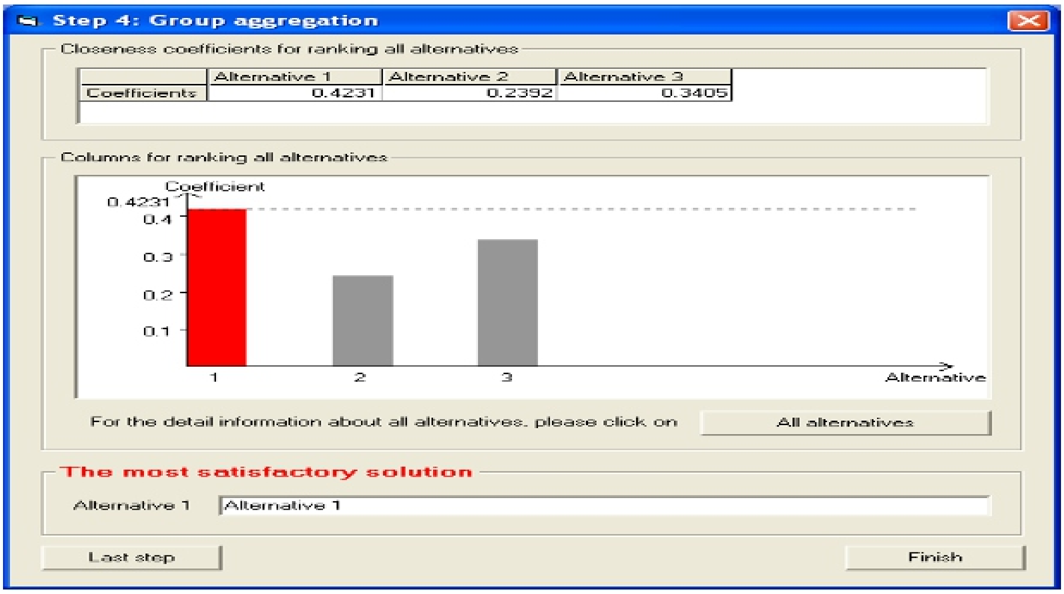

Fig. 5. The achievement of the final decision

As result of twice aggregation we have final decision (first alternative was selected). IV. CONCLUSION İn this paper the method of group decision-making is developed for a solving problem of planning of process of oil refinery under uncertainty. From three results obtained by three decision groups wich applied various approaches , the problem of choosing an optimal solution was solved.

REFERENCES

1. Leyva-Lopez, J.C., and E. Fernandez-González, (2003), "A new method for group decision support based on ELECTRE III methodology," European Journal of Operational Research, Vol. 148, pp. 14-27. [CrossRef]

2. Saaty T.L., Fundamentals of Decision Making and Priority Theory with the AHP, RWS Publications, Pittsburgh, PA, U.S.A., (1994).

3. Jie Lu, Guangquan Zhang Da Ruan, Fendjie Wu.Multi-objective group decision Making. Imperial College Press, London, 2007, 390.

4. Filip Andonov. An Interactive method for Group Decision Making. Problems of Engineering Cybernetics and Robotics, Academy of Sciences, Sofia, 2006. 57, pp. 3-7, Bulgarian

5. Chung-Hsing Yeh, Yu-Hern Chang. Modeling subjective evaluation for fuzzy group multicriteria decision making. European Journal of Operational Research, Volume 194, Issue 2, 16 April 2009, Pages 464-473 [CrossRef].

6. C.T.Chen. "Extensions of the TOPSIS for group decision-making under fuzzy environment," Fuzzy set anf Syatems., vol. 114. no. I. pp. 1-9, Aug. 2000. [CrossRef]

7. Base of technology processing of plastic mass. Text-book for high schools/S.V.Vlasov, M. "Chemistry", 2004, 600p.

8. Amirov Fariz.Shixaliyev Kerem. Properties of Linear Low Density Polyethylene. International Journal of Innovative Technology and Exploring Engineering (IJITEE). Volume-9 Issue-9, July 2020.pp. 348-352 ISSN: 2278-3075. //www.ijitee.org/download/volume-9-issue-3/ SCOPUShttps:

9. Kerem Shixaliyev. Paint and Varnish Materials Based on Epoxy Novolac oliqomers Jour of Adv Research in Dynamical & Control Systems. Vol. 12, Special Issue-02, 2020.pp351-358

10. Kerem ShixaliyexSefi..DETERMINATION OF COMPATIBILITY OF POLYMER SYSTEMS, SKEP, PU, KhKPE and CH EMICAL FEATURES OF THEIR MIXTURES. Jour of Adv Research in Dynamical & Control Systems. Vol. 12, Special Issue-02, 2020.pp359-370

11. Ermilova EA, Sizova AA, Ilyicheva NN, Pleshakov DV // Study of thermodynamic compatibility of a three-component mixture of nitramines with a copolymer of methyl methacrylate and methacrylic acid technology / Chemical successes. .-2014 - №2.-p.65-67.

Marine Robotics: An Improved Algorithm for Object Detection Underwater

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Abstract:

The visibility of items in water is lower than that of those on land. Light waves from a source don't have enough time to reach an item before it vanishes beneath the surface because light waves in water travel more quickly than they do in air. As a result, it can be challenging for people to deal with water properly due to certain of its physical characteristics. In light of this, object detection underwater has a wide range of uses, including environmental monitoring, surveillance, search and rescue, and navigation. This might enhance the precision, efficiency, and safety of undersea activities. In light of the aforementioned, this paper presents an algorithm for detecting objects underwater using YOLOv5. The algorithm has been improved by changing the way YOLOv5 works, which makes it better at detecting small objects. We tested our algorithm and found that it is more accurate than the original YOLOv5 algorithm.

Keywords: Underwater Object Detection, Marine Robotics, Deep Learning, YOLOv5.

I. INTRODUCTION

In recent years, marine robots have gained attention for their applications in ocean exploration, marine research, underwater engineering, and environmental monitoring [1][2]. Underwater object detection has far-reaching significance for the development of marine industry [2]. The development of underwater robots is necessary to achieve the goal of detecting and catching marine small objects [3]. These robots are at the intersection of the field of robotics and oceanic engineering [1]. Underwater robots are useful instruments for identifying items underwater, and their applications include deep sea infrastructure inspections, environmental monitoring, and oceanographic mapping [1]. Marine robot performance needs difficult underwater navigation techniques such as localization, path planning, and following [4]. Autonomous navigation is critical for success in executing these activities, especially in underwater situations where communications are limited [1]. Vision-based object recognition and tracking systems for underwater robots have been thoroughly investigated. Visual data from cameras remains a compelling tool for underwater sensing, particularly for close-range detections [1]. The sensors used by marine robots have different characteristics due to the medium they operate in [4]. Detection and tracking experiments have been conducted using marine robots to detect artificial targets, and proposed algorithms for color restoration and detection/tracking of underwater target objects have been demonstrated in experiments with underwater robot platforms [1]. Recently, a method for detecting seafood items in real-time was suggested that incorporates the use of Faster R-CNN and the kernelized correlation filter (KCF) tracking algorithm. An underwater picture library was used to train a faster R-CNN detector using a VGG model [3]. Small object detection and counting is an essential need that must be met before underwater robots may be utilised to capture seafood. Marine robots are essential for completing tasks such as docking station, cable tracking, and underwater area coverage for monitoring purposes [4]. In addition, marine robots are considered an efficient solution to replace divers in capturing seafood in marine aquaculture [3]. In research studies using data from the 2019 China Underwater Robot Competition, the upgraded YOLOv5s network demonstrated better mean Average Precision (mAP) [5]. Due to diverse underwater surroundings and inadequate training data, existing underwater target identification algorithms exhibit unacceptable accuracy. To increase detection accuracy, a redesigned YOLOv5s network with incorporated CA and SE modules was presented [5].

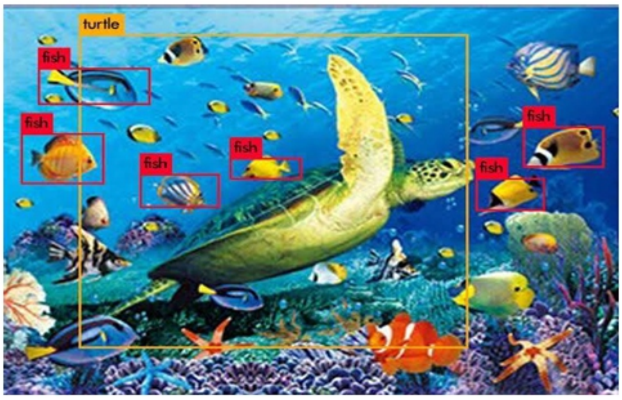

Fig. 1 Sample image of how the detection is taking place

The **fig.1** shows a sample image of how the detection is taking place, where the red boxes indicate objects that have been detected by the algorithm.

Underwater robots are used for various marine pursuits, including object detection. One popular technology for underwater sensing is vision-based object detection, which works effectively for close range detections [1]. Another research approach involves the application of learning-based visual object detection algorithms to detect debris in the water, such as plastic debris [6]. Convolutional neural networks (CNN) have been successfully used to detect submerged marine debris with high accuracy, with the inclusion of different kinds of objects in each class, potentially improving the variability of object detection [7]. To identify and detect underwater objects, researchers have investigated various object detection algorithms and state-of-the-art technologies equipped with underwater robots. For example, a novel object detection algorithm has been proposed for underwater detection, which uses a combination of deep learning and support vector machine (SVM) techniques to improve its accuracy [2]. Additionally, researchers have studied the effects of underwater electro communication and attenuation on the performance of different popular object detection algorithms to improve their effectiveness in underwater environments [8]. Furthermore, an underwater robot with a length of about 1 m and a width of about 0.8 m has been developed for marine pursuits, including object detection [9]. Research in this field brings the marine robotics community closer to finding viable methods for detecting and identifying objects underwater.

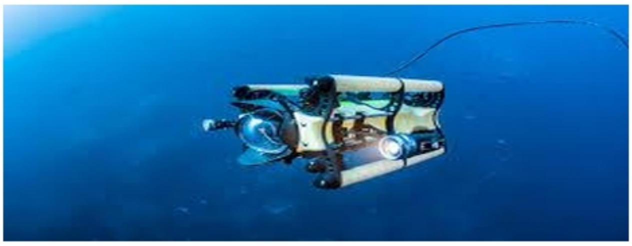

Fig. 2 Object Detection Robot

Object detection is a computer vision technology used to locate items in images or videos. It entails detecting and recognising things of interest within a given picture or video, such as people, automobiles, buildings, and other objects. To recognise things in an image or video, object detection algorithms often employ a mix of feature extraction, classification, and localisation approaches. The use of marine robots equipped with underwater object detection provides many advantages over traditional methods for exploring the ocean. These robots play an important part in the operation of self-driving marine robots, assisting with operations including course planning, collision avoidance, and control [10]. Furthermore, marine robots can collect information about marine animals that is useful for decision-making [10]. For example, in commercial fisheries management, marine robots may collect critical information for cultivation, status tracking, and disease detection [10]. Furthermore, as compared to traditional approaches, the utilisation of marine robots with underwater object identification gives a significant advantage in ocean exploration [10]. By combining marine robots with advanced machine vision techniques, exploring the underwater environment becomes much more efficient and effective [10]. Marine robots also have advantages in object detection compared to traditional methods for exploring the underwater environment [10].Using marine robots, object detection can locate occurrences of visual items in digital photos, providing critical information for numerous downstream operations [10]. For example, sea urchins are the primary study focus of aquatic product detection, and the suggested feature-enhanced sea urchin detection method outperforms the traditional Single-Shot Multi Box Detector (SSD) approach [11]. Moreover, marine robots equipped with underwater object detection can improve the accuracy and sensitivity to small targets, making them an essential tool for many underwater tasks such as robot grabbing tasks of marine products [10][11]. So, the advancement of marine robotics has opened up new avenues for ocean research, and autonomous detection and fishing by underwater robots will be the primary method of obtaining aquatic items in the future.

A. Impact of Computer Vision and Deep Learning in Underwater

Underwater object detection is a challenging task that has attracted little attention in the realm of lightweight object detection, despite its importance in marine science and repair and maintenance of underwater structures. The complex underwater environment poses a significant challenge for detecting underwater targets, as it has low visibility, low contrast, and color distortion due to illumination [19]. Additionally, small underwater objects make detection challenging. Traditional object detection algorithms perform badly in underwater object detection tasks in terms of accuracy and generalisation [20]. Additionally, underwater pictures include significant noise, limited visibility, fuzzy edges, low contrast, colour variation, and crowded backgrounds, making it a difficult study issue in computer vision technology [20]. Deep learning has been used to address a wide range of issues in underwater object detection, but the benefits and drawbacks of these systems remain unknown [21]. Light absorption and scattering induced by the medium and suspended particles result in low-contrast and haze-like phenomena in underwater photography, resulting in low-quality movies and photos that make underwater object recognition difficult [22][19]. Additionally, the movement of image collecting equipment can result in blurring [22]. Aquatic organisms often have camouflaged appearances, which increase the difficulty of detecting them. The challenges in underwater object detection mainly include light scattering and absorption, low-quality images and videos, multi-scale detection, image enhancement, feature enhancement algorithms, and accurate detection models that are stable, generalizable, lightweight, and real-time [20][23][19][20]. An optimal solution for underwater object detection and species classification does not exist due to these challenges [23]. The complex and unique nature of underwater environments presents numerous challenges in object detection, including low visibility, low image quality, and high variability in appearance. However, computer vision and deep learning methods have been shown to address these issues effectively [24].

Deep learning approaches, such as Convolutional Neural Networks (CNNs), can achieve illumination invariance in underwater object recognition, overcoming the limitations of low-quality movies [25]. Because the interest points discovered by previous approaches are tiresome and lack powerful discriminative information, identifying objects based on their forms has been proven to be more successful than employing local characteristics [25]. To overcome the challenge of finding interesting locations, a deep CNN model is trained to create abstract discriminative features from low-contrast and low-resolution underwater films [25]. Transfer learning was used to construct a customised CNN model for underwater object identification, which overcomes the restriction of CNNs with limited underwater training data. However, due to poor speed and high model size, using DCNNs directly to underwater settings is inefficient [19]. As a result, for underwater object identification, a lightweight detector with high detection accuracy and a small model size is required. Furthermore, the colour conversion module intends to convert colour photos to grayscale images in order to tackle the problem of underwater colour absorption, hence improving object recognition performance while reducing computing complexity [26]. Finally, a lightweight deep underwater object identification network has been developed to address these issues, with promising results in conventional object detection [26][24]. These new approaches have brought solutions to the issues of underwater object identification, allowing for enhanced underwater structural maintenance and repair. Underwater item detection is a difficult task due to interference from the underwater environment, such as complex backdrop structures, marine object characteristics, and exploration equipment restrictions [27]. Recent advances in computer vision and deep learning have showed promise in tackling these issues. Deep learning approaches have sparked a lot of interest in underwater object recognition because of their ability to directly learn feature representations from data. Underwater object identification based on deep learning provides better performance and enormous potential to enhance maritime operations. The review focuses on vision-based underwater marine item detection, with a particular emphasis on the detection of marine animals due to their economic value. The work provides a comprehensive assessment of deep learning-based underwater object identification approaches and outlines four underwater research challenges: picture quality deterioration, tiny item detection, inadequate generalisation, and real-time detection [26]. In light of the stated issues, a full analysis is offered to provide a clear grasp of the topic [27]. Because of wavelength-dependent absorption and scattering, underwater photographs frequently contain significant noise, resulting in significant visibility loss, contrast reduction, and colour distortion. This noise can mislead detectors and make identifying tiny objects harder [28]. Deep learning-based detectors are currently unsuccessful in detecting small items seen in underwater datasets [28]. Recent research, however, have offered novel strategies, such as SWIPENET, a Sample-Weighted hyPEr Network that generates high-resolution and semantic-rich Hyper Feature Maps, which improves tiny object recognition [28]. When compared to many state-of-the-art techniques for underwater

object recognition, the SWIPENET+CMA framework provides superior or comparable accuracy in object detection. Although attentional mechanisms have received less attention, properly using their potential is likely to effectively improve the development of underwater object detection. In conclusion, while advances in computer vision and deep learning for underwater object recognition have been made recently, there are still numerous obstacles to solve, notably in recognising minute items in noisy, low-resolution pictures. Future study should concentrate on overcoming these obstacles, including additional examination attention-based multi-scale feature fusion [27][28].

II. REVIEW CRITERIA

Due to the intricacy of the underwater environment, detecting underwater objects is a difficult task. The primary obstacles of underwater object identification include poor contrast, limited visibility, and the presence of noise. A variety of approaches have been offered to solve these difficulties. The identification of underwater objects is a vital component of underwater robots and surveillance. For underwater object identification, several sensors, such as acoustic sonar or optical cameras, can be utilised [12]. However, due to strong competitive advantages, vision-based object identification is favoured [12][13]. Image quality deterioration, tiny item detection, inadequate generalisation, and real-time detection are some of the current issues of vision-based underwater object detection [13]. Techniques for detecting underwater objects are mostly developed from general object detection and underwater picture enhancement technologies [14]. Deep learning-based object detection algorithms with two and one stages have been employed for underwater item detection. Underwater photos have noise, colour variation, low contrast, blur, and other flaws that make it difficult to distinguish objects underwater. However, researchers have developed different deep learning-based underwater object identification systems that have yielded excellent results [14]. Real-time detection in underwater object detectors necessitates detection models that are accurate, reliable, generalizable, real-time, and lightweight. Two major strategies for achieving this objective are lightweight network architecture and model compression. It is advised to iteratively use lightweight network design and model compression to develop a more elegant model that can be implemented on autonomous underwater vehicles [18]. While numerous researchers have suggested different deep learning-based underwater object recognition approaches, attentional processes for object detection in underwater settings have received little attention. The pipeline that improves photos before object recognition is a popular strategy in the underwater object detection community, and it has been demonstrated to help robots perform underwater missions more effectively [12]. Detecting objects in underwater environments is a difficult problem that differs greatly from object detection in air.

Unbalanced light conditions, poor contrast, occlusion, and imitation of aquatic animals, which can generate unclear objects in photos and videos acquired by underwater cameras, bring additional hurdles to object detection [13]. Furthermore, generic detectors frequently fail on these ambiguous items, reducing the accuracy of object detection algorithms. Object identification tasks in aquatic environments are more difficult than those in terrestrial and static contexts. As a result, deep learning models for training in maritime settings require a huge number of high-quality photos or videos. The quality of datasets is also critical for detecting objects in aquatic environments [16]. The water media makes it challenging to get good photos or movies when detecting objects underwater [15]. The viewing distances of any locations match with haze concentration, which is a unique constructive cue for salient object recognition retrieved from underwater photos. The seeing distance of underwater pictures may be adjusted by the haze concentration to provide a unique depth saliency for underwater landscapes [16]. Despite recent advances in deep learning, underwater object identification remains a difficulty. In underwater object recognition, noisy and inaccurate photos are used as sources of supervision, and there are relatively few salient object detection algorithms developed for underwater applications [15][17]. Object identification technologies for underwater applications are less effective than those used on land. Furthermore, underwater object identification algorithms have difficulties that are not evident in air situations [15]. Due to a variety of circumstances, underwater object recognition is a substantial difficulty. One of the key obstacles is a lack of data, as there is no access to huge datasets that cover a wide range of adverse underwater circumstances, making it difficult for models to handle the complicated nature of underwater settings [17]. Furthermore, background fluctuation is a significant difficulty in underwater object identification since waves, optical diffraction, and different illumination conditions may all have an influence on detection accuracy [17]. Most research investigations are limited by the technology employed in underwater object detection, which might result in low-quality photos and movies taken by AUV-mounted cameras [18]. When it comes to AUV-based detection, the hostile circumstances in undersea/subsea waters complicate object identification, making it a difficult operation. Furthermore, underwater jobs can be costly and risky for human divers, making high-quality data from these conditions impossible [18]. Deep learning-based algorithms have challenges due to the low quality of underwater images and the complexity of underwater settings. Traditional hand-designed feature extraction algorithms are likewise unsuitable for genuine underwater scenes, as they are incapable of meeting the requirements for object recognition in such settings [19]. Furthermore, variances in size or shape, as well as overlapping or occlusion of marine animals, make object detection even more difficult. Furthermore, most research have an emphasis on low-level feature extraction, which results in poor recognition, low accuracy, and sluggish recognition [18]. These difficulties make finding an appropriate solution for underwater item recognition and species categorization challenging [20]. Other obstacles for tiny object identification include light scattering and absorption, domain changes, and an imbalance between positive and negative samples. Overall, underwater object identification is a difficult process that necessitates the use of specialised equipment and algorithms in order to overcome the numerous hurdles offered by the hostile underwater environment.

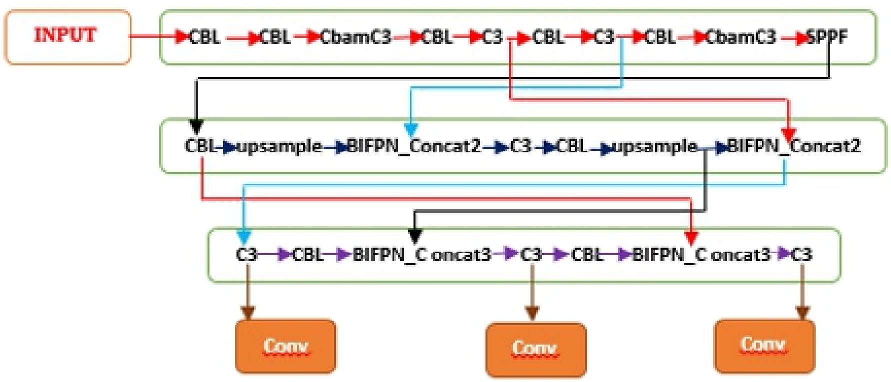

Fig. 3 Network structure of the improved algorithm

The network architecture of the enhanced technique is illustrated in Figure 1, which comprises four crucial components: input, backbone, neck, and detection. This network retrieves local features from input images through various modules such as CBL, CBAMC3, C3, and SPPF. The BiFPN neck structure is equipped with innovative fusion modules that blend features of different scales and output the results via the detecting head. One of the significant components of the network is the convolutional block attention module (CBAM) of [17]. It is a flexible and lightweight focus module that can be entirely integrated into any CNN network. By using CBAM, the model can improve its performance and interpretability by paying more attention to the original image. Moreover, CbamC3 is an extension of CBAM to C3, as shown in Figure 2. The CBAM module multiplies the attention map with the input feature map after receiving an intermediary feature map, which sequentially infers the closely monitoring along two autonomous dimensions, i.e., channel and space. The enhanced technique network comprises four components that work together to retrieve local features from input images and fuse them to detect objects accurately.

The network architecture includes various modules such as CBAM and CbamC3 that help the model pay more attention to the original image and improve its performance.

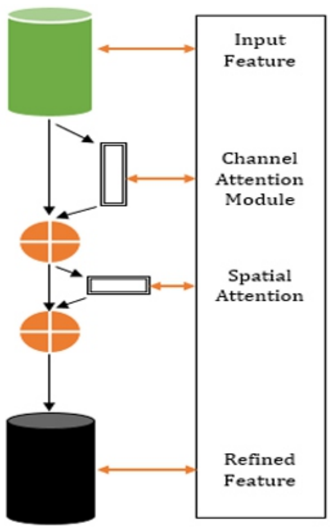

Fig. 4 Network structure of CBAM

The multichannel attention module is shown in the above illustration. The input map is processed using two Max Pool and Avg Pool layers simultaneously, and then it is resized to 11. Next, the map goes through an MLP module, which reduces the number of channels and then increases it back to its original number. The Re LU activation function is applied to produce the intermediate output results, which are then combined element by element. A non-linear function is used to generate the final output result of the channel attention, which is multiplied by the original image to produce the final result. The multichannel attention module is a technique used to enhance the image's features by processing it through various layers and modules. The input map goes through Max Pool and Avg Pool layers and is then resized before passing through an MLP module. The output is then combined and used to generate the final output result of the channel attention, which is multiplied with the original image to get the finished product.

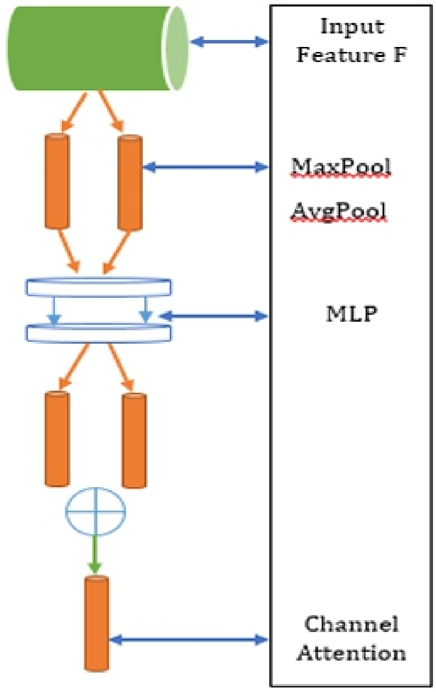

Fig. 5 The channel attention module

The visual attention module is a component of an artificial intelligence system that helps it focus on specific parts of an image. This module uses a combination of MaxPool and AvgPool layers to extract important features from the image. These layers take the output of the previous layer and combine it to create two feature maps with a single channel each. These feature maps are then merged together to create a single feature map with one channel. Next, the spatial attention feature map is generated. This map helps the system focus on specific regions of the image that are most relevant to the task at hand. The spatial attention feature map is created by passing the merged feature map through a nonlinear activation function. This function helps highlight important parts of the image while suppressing irrelevant details. Once the spatial attention feature map is generated, it is multiplied by the original image to bring it back to its original size.

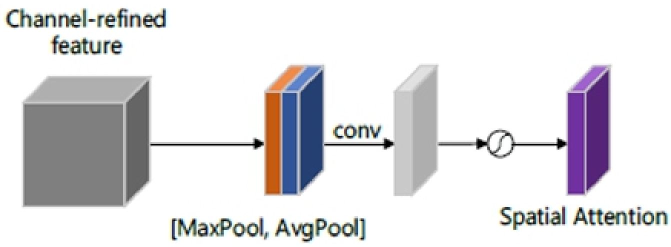

Fig. 6 The spatial attention module

To create the CbamC3 module, we combine the CBAM module with the C3 module. The final output of the convolutional layer will, as shown in Fig. 5, first pass through the channel attention module in the cbam, then it will pass through with a high dimensional data module, and lastly it will be balanced to achieve the result. To improve extraction of features, the generated findings are then combined with the original input utilising the residual structure. To improve the backbone network's capacity for extracting features, we substituted the first and final C3 modules with the CbamC3 module after performing preliminary verification.

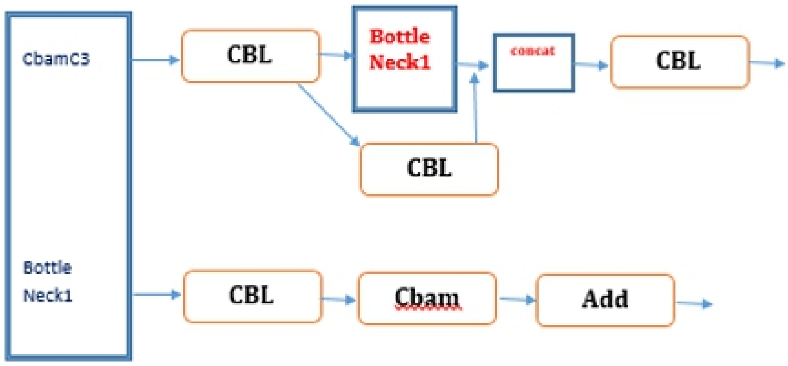

Fig. 7 Network structure of CBAMC3

B. Feature Fusion Network: The weighted bidirectional feature pyramid network (BiFPN) of [18], a novel feature matching network that can simply and rapidly execute inter convolution layer, is used to replace the FPN of YOLOv5. In order to extract richer feature data from pictures, the BiFPN structure primarily combines feature maps from the backbone. The BiFPN structure, as matched to other feature fusion structures, includes a skip connection that may be used to access feature data from earlier layers and boost model effectiveness.

In order to fuse the findings of the same layer through a cross-scale link, we altered the FPN structure to a BiFPN structure, created a connection here between the communications system and the fusion module, and illustrated in Fig. 1. This feature fusion will not raise computing cost because it is inside the same layer, but it may boost detection accuracy. C. Fusion Module : Features are frequently scaled to the same resolution before being fused when fusing features with various resolutions. The resolutions of various input characteristics vary, and they make varying contributions to the features of the output. Therefore, the weighted fusion approach involves giving each input weight and allowing the network to determine the significance of each input characteristic. This procedure, known as Fast normalized fusion, is controlled by; When O denotes the weight, I is the network's learnable weight, ii denotes the input feature map, and denotes a tiny integer. As a result, we use this novel fusion module, BiFPN Concat, in the neck of YOLOv5, where BiFPN Concat2 and BiFPN Concat3 are fusion modules with two and three inputs, respectively. The fusion module learns a varied weight for the final fusion based on various inputs, enhancing the network's capacity to fuse features and increasing efficiency. The final graph is displayed in Fig. 1.

IV. RESULTS

To assess the viability and effectiveness of our suggested approach, we performed tests on the Water Surface Object Detection Dataset (WSODD). The primary purpose of this dataset is to solve the issue of limited data on water-based targets in various settings. The WSODD includes photos from three different types of water bodies (ocean, lake, and river) and three weather conditions (sunny, overcast, and foggy), with a total of 14 different categories of aquatic objects such as boats and ships. For our experiment, we chose the WSODD dataset and randomly divided it into training and validation sets at a ratio of 8:2. The training set contained 5909 photos, while the validation set contained 1558 images. This allowed us to test our approach on a large dataset with a variety of aquatic objects and settings. During our implementation, we used specific hardware and software indicators, which are listed in Table I. These indicators played an important role in our experiment, helping us to ensure that our approach was effective and reliable. By carefully selecting our hardware and software, we were able to optimize our approach for the WSODD dataset and achieve accurate results.

Table I.

OS	CPU	GPU	RAM	FRAMEWORK	VERSION
Ubuntu	Intel Xeon Silver 4210	NVIDIA TESLA T4	32G	Pytorch	YOLOv5. 6.0

C. Measures of Evaluation: We use mean average precision (mAP) and recall as the assessment measures to gauge how well the suggested method works. They come from;

RECALL = TP/TP +FN

Map = AP/N = o1 P(r)dr/N

False negatives (FN) are objects that are present in the picture but are not picked up by the network, whereas true positives (TP) signify an object that has been correctly spotted in the image. Precision stands for p, recall for r, and category number for N. D. Discussions and Results In this experiment, we contrast the original Yolov5s approach with our enhanced version. We decided on a training batch size of 16 and 150 experimental epochs. Table II displays the final findings.

Table II. Comparative Results.

	mAP0.95	Recall
YOLOv5	0.5988	0.8753
Ours	0.6062	0.8984

Studies reveal that compared to the original method, our revised approach has a higher mAP and Recall rate. It shows that our model works better than the YOLOv5. The MAP is raised by roughly 1%, while the Recall is raised by about 2% when compared to the original method. Fig. 6 displays a visualization of the detection outcomes from the WSODD dataset. The detection result of YOLOv5 is on the left, while the detection result of our enhanced method is on the right. As can be observed, the updated algorithm recognizes the target's position with greater accuracy, and the incidences of missed and false detection have greatly decreased. In summary, our new algorithm performs better and the identification of tiny targets is enhanced.

Fig 8. Visualization of the detection

V. CONCLUSION

The proposed algorithm was tested on a variety of underwater environments and the results were promising. The system uses a combination of image processing algorithms, deep learning, and computer vision techniques to accurately detect objects with high accuracy.

The results of this research suggest that object detection in an underwater environment is feasible and can be used in various applications. Despite the advancements in object detection algorithms for underwater environments, there are still some research gaps that need to be addressed. These include the lack of real-world testing and validation, limited research on the generalization of algorithms, inadequate exploration of environmental factors, insufficient analysis of computational complexity, and limited research on low-cost implementations. Addressing these gaps will improve the practicality and effectiveness of object detection algorithms for underwater environments.

DECLARATION

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Conflicts of Interest/ Competing Interests	No conflict of Interest to the best of my knowledge.
Ethical Approval and Consent to Participate	No, the Article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material/ Data Access Statement	Not Relevant, because it is original research based on model development.
Authors Contribution	Usman Ibrahim Musa contributed in80% of the work where he worked on the algorithms and the coding part, while Apash Roy contributed in reviewing the article and suggestions for further improvement.

REFERENCES

1. Donghwa Lee, Gonyop Kim, Donghoon Kim, Hyun Myung, Hyun-Taek Choi, Vision-based object detection and tracking for autonomous navigation of underwater robots, Ocean Engineering, Volume 48, 2012, Pages 59-68, ISSN 0029-8018,. [CrossRef]

2. Sixian Cai, Guocheng Li, Yuan Shan, Underwater object detection using collaborative weakly supervision, Computers and Electrical Engineering, Volume 102, 2022, 108159, ISSN 0045-7906,. [CrossRef]

3. F. Xu et al., "Real-Time Detecting Method of Marine Small Object with Underwater Robot Vision," 2018 OCEANS - MTS/IEEE Kobe Techno-Oceans (OTO), Kobe, Japan, 2018, pp. 1-4, doi: 10.1109/OCEANSKOBE.2018.8558804.

4. D. Kim, D. Lee, H. Myung and H. -T. Choi, "Object detection and tracking for autonomous underwater robots using weighted template matching," 2012 Oceans - Yeosu, Yeosu, Korea (South), 2012, pp. 1-5, doi: 10.1109/OCEANS-Yeosu.2012.6263501.

5. Wen, G.; Li, S.; Liu, F.; Luo, X.; Er, M.-J.; Mahmud, M.; Wu, T. YOLOv5s-CA: A Modified YOLOv5s Network with Coordinate Attention for Underwater Target Detection. Sensors 2023, 23, 3367. [CrossRef]

6. M. Fulton, J. Hong, M. J. Islam and J. Sattar, "Robotic Detection of Marine Litter Using Deep Visual Detection Models," 2019 International Conference on Robotics and Automation (ICRA), Montreal, QC, Canada, 2019, pp. 5752-5758, doi: 10.1109/ICRA.2019.8793975.

7. M. Valdenegro-Toro, "Submerged marine debris detection with autonomous underwater vehicles," 2016 International Conference on Robotics and Automation for Humanitarian Applications (RAHA), Amritapuri, India, 2016, pp. 1-7, doi: 10.1109/RAHA.2016.7931907.

8. Yu, H., Li, X., Feng, Y. et al. Multiple attentional path aggregation network for marine object detection. Appl Intell 53, 2434–2451 (2023). [CrossRef]

9. Fayaz, S., Parah, S.A. & Qureshi, G.J. Underwater object detection: architectures and

algorithms – a comprehensive review. Multimed Tools Appl 81, 20871–20916 (2022). [CrossRef]
10. Er, M.J.; Chen, J.; Zhang, Y.; Gao, W. Research Challenges, Recent Advances, and Popular Datasets in Deep Learning-Based UnderwaterMarine Object Detection: A Review. Sensors 2023, 23, 1990. [CrossRef]
11. Kai Hu, Feiyu Lu, Meixia Lu, Zhiliang Deng, Yunping Liu, "A Marine Object Detection Algorithm Based on SSD and Feature Enhancement", Complexity, vol. 2020, Article ID 5476142, 14 pages, 2020. [CrossRef]
12. Er, M.J.; Chen, J.; Zhang, Y.; Gao, W. Research Challenges, Recent Advances, and Popular Datasets in Deep Learning-Based Underwater Marine Object Detection: A Review. Sensors 2023, 23, 1990. [CrossRef]
13. Er, Meng Joo; Jie, Chen; Zhang, Yani; Gao, Wenxiao (2022): Research Challenges, Recent Advances and Benchmark Datasets in Deep-Learning-Based Underwater Marine Object Detection: A Review. TechRxiv. Preprint. [CrossRef]
14. Shubo Xu, Minghua Zhang, Wei Song, Haibin Mei, Qi He, Antonio Liotta, A systematic review and analysis of deep learning-based underwater object detection, Neurocomputing, Volume 527, 2023, Pages 204-232, ISSN 0925-2312,https://doi.org/10.1016/j.neucom.2023.01.056.
15. Zhe Chen, Hongmin Gao, Zhen Zhang, Helen Zhou, Xun Wang, Yan Tian, Underwater salient object detection by combining 2D and 3D visual features, Neurocomputing, Volume 391, 2020, Pages 249-259, ISSN 0925-2312,. [CrossRef]
16. Ning Wang, Yuanyuan Wang, Meng Joo Er, Review on deep learning techniques for marine object recognition: Architectures and algorithms, Control Engineering Practice, Volume 118, 2022, 104458, ISSN 0967-0661,. [CrossRef]
17. Donghwa Lee, Gonyop Kim, Donghoon Kim, Hyun Myung, Hyun-Taek Choi, Vision-based object detection and tracking for autonomous navigation of underwater robots, Ocean Engineering, Volume 48, 2012, Pages 59-68, ISSN 0029-8018,. [CrossRef]
18. Dinakaran, R.; Zhang, L.; Li, C.-T.; Bouridane, A.; Jiang, R. Robust and Fair Undersea Target Detection with Automated Underwater Vehicles for Biodiversity Data Collection. Remote Sens. 2022, 14, 3680. [CrossRef]
19. Zhang, M.; Xu, S.; Song, W.; He, Q.; Wei, Q. Lightweight Underwater Object Detection Based on YOLO v4 and Multi-Scale Attentional Feature Fusion. Remote Sens. 2021, 13, 4706. [CrossRef]
20. Sixian Cai, Guocheng Li, Yuan Shan, Underwater object detection using collaborative weakly supervision, Computers and Electrical Engineering, Volume 102, 2022, 108159, ISSN 0045-7906,. [CrossRef]
21. Computer Science > Computer Vision and Pattern Recognition.https://arxiv.org/abs/2209.10151 Accessed 2023-04-17
22. Chenping Fu, Risheng Liu, Xin Fan, Puyang Chen, Hao Fu, Wanqi Yuan, Ming Zhu, Zhongxuan Luo, Rethinking general underwater object dete tion: Datasets, challenges, and solutions, Neurocomputing, Volume 517, 2023, Pages 243-256, ISSN 0925-2312,. [CrossRef]
23. Fayaz, S., Parah, S.A. & Qureshi, G.J. Underwater object detection: architectures and algorithms – a comprehensive review. Multimed Tools Appl 81, 20871–20916 (2022). [CrossRef]
24. L. Chen et al., "Underwater object detection using Invert Multi-Class Adaboost with deep learning," 2020 International Joint Conference on Neural Networks (IJCNN), Glasgow, UK, 2020, pp. 1-8, doi: 10.1109/IJCNN48605.2020.9207506.
25. Xin Sun, Junyu Shi, Lipeng Liu, Junyu Dong, Claudia Plant, Xinhua Wang, Huiyu Zhou, Transferring deep knowledge for object recognition in Low-quality underwater videos, Neurocomputing, Volume 275, 2018, Pages 897-908, ISSN 0925-2312,. [CrossRef]
26. C. -H. Yeh et al., "Lightweight Deep Neural Network for Joint Learning of Underwater Object Detection and Color Conversion," in IEEE Transactions on Neural Networks and Learning Systems, vol. 33, no. 11, pp. 6129-6143, Nov. 2022, doi: 10.1109/TNNLS.2021.3072414.
27. Er, Meng Joo, Jie Chen, Yani Zhang, and Wenxiao Gao. 2023. "Research Challenges, Recent Advances, and Popular Datasets in Deep Learning-Based Underwater Marine Object Detection: A Review" Sensors 23, no. 4: 1990. [CrossRef]
28. Long Chen, Feixiang Zhou, Shengke Wang, Junyu Dong, Ning Li, Haiping Ma, Xin Wang,

Huiyu Zhou, SWIPENET: Object detection in noisy underwater scenes, Pattern Recognition, Volume 132, 2022, 108926, ISSN 0031-3203,. [CrossRef]

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