Plate Number Recognition based on Hybrid Techniques

Hemin Omer Latif[1], Hawar Hussein Yaba[2]

[1]Department of IT/SE, American University of Iraq, Sulaimani, Sulaymaniyah, Iraq, [2]Computer Institute in Sulaymaniyah, Sulaymaniyah, Iraq

ABSTRACT

Globally and locally, the number of vehicles is on the rise. It is becoming more and more challenging for authorities to track down specific vehicles. Automatic License Plate Recognition becomes an addition to transportation systems automation. Where the extraction of the vehicle license plate is done without human intervention. Identifying the precise place of a vehicle through its license plate number from moving images of the vehicle image is among the crucial activities for vehicle plate discovery systems. Artificial intelligence systems are connecting the gap between the physical world and digital world of automatic license plate detection. The proposed research uses machine learning to recognizing Arabic license plate numbers. An image of the vehicle number plate is captured and the detection is done by image processing, character segmentation which locates Arabic numeric characters on a number plate. The system recognizes the license plate number area and extracts the plate area from the vehicle image. The background color of the number plate identifies the vehicle types: (1) White color for private vehicle; (2) red color for bus and taxi; (3) blue color for governmental vehicle; (4) yellow color for trucks, tractors, and cranes; (5) black color for temporary license; and (6) green color for army. The recognition of Arabic numbers from license plates is achieved by two methods as (1) Google Tesseract OCR based recognition and (2) Machine Learning-based training and testing Arabic number character as K-nearest neighbors (kNN). The system has been tested on 90 images downloaded from the internet and captured from CCTV. Empirical outcomes show that the proposed system finds plate numbers as well as recognizes background color and Arabic number characters successfully. The overall success rates of plate localization and background color detection have been done. The overall success rate of plate localization and background color detection is 97.78%, and Arabic number detection in OCR is 45.56 % as well as in KNN is 92.22%.

Index Terms: Image, Automatic Number Plate Recognition, Background-Color detection, Arabic Number Recognition, K-Nearest Neighbors, Tesseract-OCR

1. INTRODUCTION

1.1. Overview

The large challenge in several nations where road traffic and additionally traffic-related crime is increasing day by day such as swiping hit and also run kidnapping murder despoilment as well as additionally trafficking. With the improvement of people's living standards, every household now has a vehicle [1]. In contemporary life, we have to encounter numerous problems, one of which is traffic congestion ending up being severe extra day after day. It is necessary to adopt the relevant, intelligent traffic management system to strengthen the city security prevention and control and the effective management of motor vehicles in the city management. Nowadays, in the automobile era, the license plate recognition system has become the inevitable product of intelligent human life. Its application scope is vast: The management of vehicle access in residential areas, the detection of speeding vehicles on highways, parking lot

Corresponding author's e-mail: Hawar Hussein Yaba, Computer Institute in Sulaymaniyah, Sulaymaniyah, Iraq.
E-mail: hawar.yaba@spu.edu.iq

management, and so on need the assistance of the license plate recognition system. It is a crucial place of a research study because of its applications like car parking, availability control, roadway tolling, and also authorities. The research and development of the Intelligent Transportation System (ITS) [2] supply information about vehicle identification using plate numbers, which can be utilized in evaluations and control.

Automatic License Plate Recognition [3] is a real-time machine-intelligent as well as the ingrained system which recognizes the vehicles straight from the photo of the number plate. Because of modern technology and additionally the raise in the use of vehicles, the requirement for a machine-oriented acknowledgment along with checking system is of immense significance. Each vehicle on the planet should have its really own number plate that installed on its body (a minimum of on the back). Each vehicle has serial number perception on a plate; therefore, there is no need for external cards, tags, or transmitters. The vehicle identifying permit plate system replaces the manual permit plate number composing process in the computer system. ANPR system has been extensively taken on for number plate discovery for the English Language in industrialized nations. In this paper, a method exists for an automatic license plate recognition system that deals with the difficulties of Arabic permit plate system faced presently. The number plate of vehicle detection is executed for Iraq locations using the Arabic Language. The project fundamentals representation in number 1 revealed over.

The license plate identification technique consists of three main topics. (1) Find number plate area from vehicle images. (2) Identify the background color of the license plate. (3) Arabic numeric character segmentation and (4) Arabic numeric character recognition. The number plate background color [4] identifies the vehicle types: (1) White color for private vehicle; (2) red color for bus and taxi; (3) blue color for governmental; (4) yellow color for trucks, tractors, and cranes; (5) black color for temporary license; and (6) green color for army vehicles. Arabic Number Recognition is carried out using two methods. (1) KNN Machine Learning Algorithm and (2) Tesseract OCR.

1.2. Problem Background and Research Objective and Scope

To identify the automated license plate from the image captured, we need to get the precise location of the plate. Image segmentation plays a fundamental duty, so regarding finding a plate from the image. Different background color

plates show different categories of vehicle types. Accurate color detection is a challenging task due to different variable appearance and ranges. There are many methods for character recognition of license plate images [5], such as template matching method, pattern recognition algorithm, artificial neural network recognition algorithm, structural feature recognition algorithm, and statistical feature recognition algorithm. Finding the best practices for plate extraction, background-color detection, and number recognition are a challenging task.

License plate discovery, as well as recognition, is among the significant facets of using the image processing techniques toward smart transportation systems. It is critical to deal with the difficulties of impeding traffic as well as public safety and security renovation in the Kurdistan Regional of Iraq (KRI). In Iraq, the licensed vehicle has six types of plates with different backgrounds and Arabic font color. The background color of the number plate identifies the vehicle types. We first need to set up a number template. The 0–9 in Arabic numbers representing ٠٩٨٧٦٥٤٣٢١ license numbers. Arabic numbers get recognized through artificial intelligence through various algorithms of Machine Learning and Optical Character Recognition (OCR). The challenging task is to find the best algorithm with the highest accuracy that recognizes background color and Arabic numbers from the extracted vehicle plate.

License plate detection locates the accurate area in the image as an essential step of the license plate recognition system. First, the research goal aims at plate extraction from a licensed vehicle image correctly. The plate's background colors are different for identifying different vehicles. Second, it aims at detecting background color efficiently for vehicle type recognition. The project implements two main techniques for Arabic Number Recognition as follow: (1) Training Testing based K-mean Nearest Neighborhood Supervised Machine Learning (KNN) and (2) Tesseract Optical Character Recognition (OCR) that aims to find the best technique among them to yield an overall accuracy.

2. LITERATURE REVIEW AND BACKGROUND STUDY

2.1. Vehicle License Plate Number and Color Recognition (VLPNCR)

VLPNC refers to the automatic extraction from the image data of license plate and information identification. The report includes Arabic numerals and license plate colors.

The license plate acknowledgment system primarily includes four essential aspects: License plate location extraction, background color acknowledgment, number segmentation, and license plate Arabic number acknowledgment. The latest market survey regarding these steps is critical to building up an efficient working system to fulfill the criteria, it is required to study the newest literature of paper and technologies.

Research study on vehicle number plate suggestion or Automatic Number Plate Recognition (ANPR) is mostly done to produce an intro that has high accuracy. Several techniques of picture managing implemented as side detection as well as morphology, link analysis in between things, artificial intelligence, and additionally deep discovering. The system established likewise included professional system to be able to discover the blunder of the number plate acknowledgment in addition to repair it based on the positioning of the personality group in the number plate. In this research study, a K-NN gadget finding out ANPR system established in character acknowledgment.

Research of license plate recognition based on HSV space suggests an approach based on HSV color acknowledgment of license plate and fixes the fundamental issue of license plate acknowledgement. The license plate detection method constructed on color, because the color of the type of car license is limited, and the characters and the cards have apparent color difference. The primary method advantage of these features for license plate recognition is the color edge algorithm, the color distance and similarity algorithm, and so on the distance similarity algorithm. Accordingly, this paper puts forward the different from most other recognition methods of a vehicle authorization plate. The system on the HSV color space is a unique advantage and the color characteristics of the license plate and integration of the binary image mathematical morphology processing method.

Language recognition and translation from document [6] are a crucial action of a document analysis system, considering that recognition engines call for the combination of a language version to boost the transcription performance. The application can scan input message from a file, segment the text, and compute the self-confidence value, after that detect the types of input language and convert the text into the target language. The project is working for four languages, which are Bangla, English, Spanish, and Arabic, that are done by the Tesseract OCR.

2.2. Image Pre-processing

Pre-processing is the initial phase in the electronic image processing, which improves the high quality of the image information for both proper esthetic perception as well as computational handling. Pre-processing improves the image information by getting rid of both background noise, undesirable information, and image reflections as well as normalizing the intensities of the individual image fragments. A significant reason for the failing of vehicle license plate discovery is the poor quality of the vehicle image information. The aim is to remove noise with out losing quality of data needed. Here are some image processing [7] steps, including: The conversion into grayscale, Grayscale to binary image conversion, Resizing the image, and Gaussian Blur Image.

2.3. Plate Area Extraction

Plate area extraction is the second phase of the projects that is process splits in four steps as (1) Morphological operation, (2) extract all contours and matched as characters, (3) group of contour and possible plate detection, and (4) character segmentation.

2.4. Plate Background Color Recognition with HSV Color Space and Threshold Range

HSL and also HSV are alternative depictions of the RGB shade model. HSV color has three components of hue (H), saturation (S), and brightness (V) from that only H associated with color. Hence, when the value of H does not change, and S and V components have little change, they represent the color range fix. H value, when the value of V is not changed, changes in the brightness of V, and the saturation of S, the saturation, and brightness of color gets change. When the equations of $V = 1$ and $S = 1$ have established, the color has the highest purity. Reduce the value of S; color tends to become white. When the value of V is close to zero, the color becomes dark. Therefore, the saturation of S and the brightness of V affect the final color yet. Here, if the equation of $V > T$ and $S > T$ has established, the color is expressed by the H that is the color so the calculation of hue (H), saturation (S), and brightness (V) threshold in the given range of the final output of recognition of color.

2.5. Optical Character Recognition (OCR)

Optical character recognition alters characters included in the image into characters' format [8] commonly, the text of the checked image consists of published letters, transcribed letters, and so forth. The character is checked to evaluate the image, and afterward, the character is gotten. Digitally refining published and transcribed characters, then storing them on a computer system, browsing them, and also

introducing them is an area of computer system vision and also pattern acknowledgment study. OCR is a complex process that involves many steps. The steps involved in OCR are pre-processing feature selection and classification. First, capture the image of the digit categorized in a standard image format such as JPEG, PNG, or bitmap.

2.6. Machine Learning (KNN Algorithm)
Machine learning guided to examine datasets to generalize as well as likewise observe the patterns of that information or details. To anticipate the future worth or behavior from those checking or designs, it will absolutely after that iteratively gains from information, unlike normal computer system programs. The purpose of machine learning is to program computer systems to make use of instance information as an experience or variant as well as additionally use the patterns of these details to anticipate the future based on that information. Machine learning does not just deal with details resource issues, in addition to it is in addition an application of professional system (AI) also. It aids to resolve various troubles in face recommendation, biometrics verification, clinical diagnoses, farming, economics, and robotics [9], [10]. Machine learning involves training a computer version with data or historical info [11], to potentially forecast behavior of the system in the future. Machine learning split right into three primary parts: (1) Supervised learning, (2) unsupervised learning, and (3) reinforcement learning. [Figure 1]

2.6.1. Supervised learning
Supervised learning consists of historic forecasters usage as well as end results with the intent that the model offers valuable predictions of brand-new combinations of forecasters [12] Supervised finding out formulas come in lots of kinds with details toughness, weak points, as well as objectives [11]. Details versions that are suitable for the research study in this paper include linear regression and random forests [13].

2.6.2. Define train-test data
Training machine learning model, the dataset must be separated into two datasets: (1) Training dataset and (2) testing dataset. The separation into two sets is significant since the training process forms the basis of the ability of the procedure to generalize, which is measured by performance on the testing dataset. Models developed to manipulate the training dataset. After that, it makes predictions on the testing dataset. The fundamental design shows in Fig. 2a.

2.6.3. k-Nearest neighbor (kNN) algorithm
The k-nearest neighbor method (kNN) describes a strategy to classify objects in the functions space based on the nearby training samples. KNN is sample-based discovering. Features
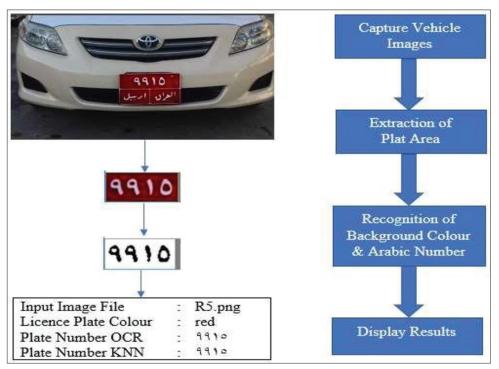

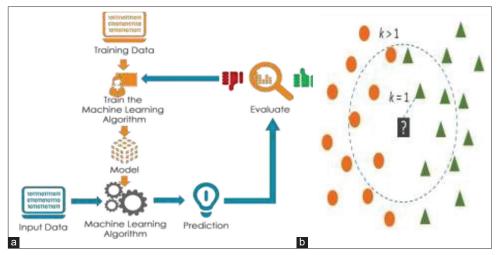**Fig. 1.** Fundamental diagram of the research work.

Fig. 2. (a) Training – testing based classifier and (b) kNN Algorithm of distance.

are exclusively approximated in your area in addition to every computation postponed till classifications. KNN procedure thought about the most convenient contrasted to various other machine learning algorithms. KNN as character classifier is a reputable as well as thoroughly used classifier on the market as a result of its simple [5], [14] considering that it does not believe any sort of styles for the circulation of characteristic vectors in space, it additionally has high error resistance over non-linear multi-class issues. KNN computes the range from an unknown to all samples in the design room and also keeps in mind the marginal variety [15]. The class that has the very little array from the unknown is the closest next-door neighbor k= 1, where the value k refers to the neighborhood dimension (Fig. 2b). When it pertains to k > 1, voting of the bulk decision is made to establish the class of the unknown example. It can be seen from [1 that k = 1 continuously creates the highest possible accuracy in addition to is verified by trial and error through the advancement procedure.

3. METHODS AND MATERIALS

This project is a technological remedy for vehicle photos making use of various techniques of image processing. The main target of the system is to give a computerized service utilizing artificial intelligence, image processing, and machine learning for achieving sustainability in the area of transportation or even more generally called as intelligent transportation systems (ITS). However, the system greatly relies on catching these pictures in a top-quality way. The project implemented in Python uses various software and libraries such as OpenCv, Google Tesseract, pytesseract, imutils, Numpy, Scipy, Sk-image, and Sklearn. The project implementation flow chart is shown in Fig. 3.

3.1. Dataset Collection
Project experiment required input vehicle images that contain visible license number plate with proper minimum resolutions. Furthermore, it should contain all type of background color, and Arabic number plates to fulfill the requirements its total of 90 images from those 46 images captured by CCTV and 46 images downloaded through internet. The images contain all types of background color available number of plates. The list of images with background color is given in Table 1.

3.2. Plate Area Extraction
The morphology method is the method most often used to extract a character from the image. The area containing the license plate part stood for as a region of passion (ROP). With the assistance of morphological procedure, finding all possible contours as characters using pre- processing steps. Morphology applied to a binary and grayscale representation. The purpose of the removal is to obtain the characters on the vehicle plate. Each contour location indeed is scanned to get prospects of personality. Each candidate of the personality undoubtedly inspects whether this is a personality or not.

The number plate extracted for further processes such as character segmentation group of similar characters. The algorithm carried out on all contours, which is used to detect the boundaries and edges of the character relevant code. The license plate area number of the edge formed by group of all matched contours edge detection methods. Crop the
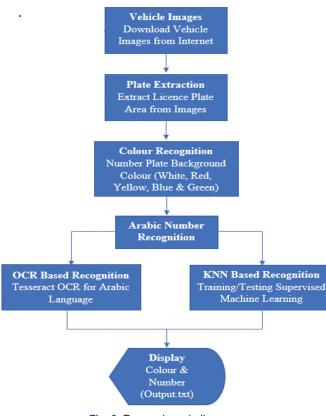
Fig. 3. Research work diagram.

TABLE 1: License plate background color list

Background color	Vehicle type	No. of Images
White	Private vehicle	36
Yellow	Trucks, tractors, and cranes	18
Red	Vehicle for hire, bus, and taxi	13
Blue	Governmental	09
Green	Army	08
Black	Temporary plates	06
Total images of vehicle plates		90

TABLE 2: Color recognition for all six types of vehicle

Plate						
Color	Black	Blue	Green	Red	Yellow	White

3.4. Implementation of OCR using Pytessrect

Tesseract OCR is precise open-source optical character recognition engines for the Arabic language. Pytesseract is the Python library for Tesseract OCR that can use Python script on Tesseract OCR. The Tesseract OCR library is used to analyses the extracted plate area, and character string is retrieved from characters. Pytesseract image to string function and image to data with specific configuration output is OCR text and confidence level. The Tesseract OCR algorithm implements in "Recognition.py".

3.5. Implementation of KNN Algorithm

The purpose of segmentation is used to extract the target of interest from an image character identity. It is creating the character database taking place on a pre-prepared set of characters containing all necessary for correct identification Arabic numbers; the reference image should be prepared in a format and with parameters such as a scanning system. A set of characters for learning appears on the screen. Here, the table shows the different font size sets of Arabic numbers. The created database of the letter inside the "letter" directory inside the project directory. That contains all ten directories of Arabic numbers (0–9) and samples of images. The image size of each letter is 30 x 45 as dimension where 30 widths and 45 heights of each number image. The number-letter directories and images inside each letter, as shown in Fig. 5.

K-Training samples, whose qualities are reasonably comparable (closest) to the test samples acquire. The examination examples are categorized based on the course labels of the most intimate training samples. These training samples are known as the nearest neighbors. The nearest neighbor (NN) formula called an instance-based approach as
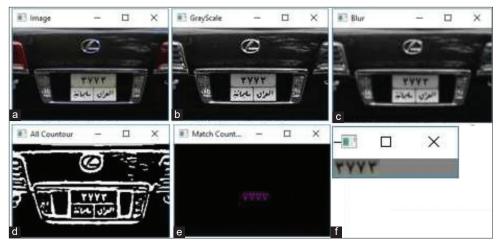
particulate contours group edge from the original image, so its RGB extracted a license plate which contains only Arabic number. Find all possible plates by minimum group and matching contours and make a list of all plates.

The whole steps of implemented as code in a project for Arabic number parts are shown in Fig. 4.

3.3. Implementation of Color Recognition

Once the license plate has been extracted, each plate background color can be recognized. Plate color is characterized by an initial RGB color. The first step is to convert the RGB image into HSV space because the affected light conditions need image histogram equalization. Next step is to calculate the hue (H), saturation (S), and brightness (V) threshold range between lower and upper limit to find the plate color. The resulting range with fuzzy logic is the output of the plate color. The color recognition algorithm implements in "Recognition.py" as shown in Fig. 4 and the color recognition sample, as shown in Table 2.

Fig. 4. Whole steps of plate area extraction of the vehicle image. (a) Vehicle image in RGB, (b) Gray-scale, (c) Gaussian blur by 3 × 3, (d) All contours edge by morphology, (e) All matched contours and group of contours, and (f) Extract plate area. More detail explanation in the other answer file.
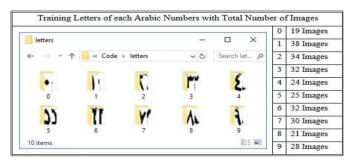

Fig. 5. Arabic number images as a training database.

the examination instances compared to training instances that have actually stored in memory. Here, the training model is created from the 0–9 Arabic numbers, which shows in figure, and the model saved as "knn_model.pkl".

3.6. Writing the Results as Files
The project has successfully extracted plate area and recognizes plate color and Arabic number with confidence by OCR and KNN techniques. The result of recognition displays, as shown in Fig. 6, as the text file (A) "NumberPlate. txt" and (B) on command prompt. Furthermore, written results in the form of the database as "NumberPlate.data."

4. RESULTS AND DISCUSSION

The outcomes of methods that are widely used by researchers to detect the location of the vehicle plate are discussed in this section. Starting with taking vehicle objects and plate locations and recognizing the system. The system checks the area where it undoubtedly the license plate number characters.

Each image has tested whether it is a vehicle number plate or not. Furthermore, recognizing plate background color and Arabic number on the plate by KNN and OCR methods.

4.1. Plate Area Extraction
In the beginning, our objective discovers a depictive Arabic number set from number plates, which are identifiable by human beings. The system has tested on all 90 images to extract the plate area. The sample of plate area extraction results as shown in Fig. 7.

4.2. Background Color Recognition
The second goal of the project is to find the background color of the plate to identify vehicle types. Once the vehicle plate area is detected, we can classify it based on its plate colors and detect vehicle type. Intensity correlates with visual image quality, contrast, brightness, etc. Furthermore, taking image time as day time and night time affects the results. The vehicle license plate is mostly a combination of light background and darker characters, otherwise dark background and bright characters. The system implements an HSV mode color image for the detection of plate color instead of RBG.

Conduct the testing of the experimental project on the whole 90 images for plate background color, the results of the recognized color are shown in Table 3. Explained in more detail in the other answer file.

4.3. Arabic Number Recognition
The third goal of the project is to understand the Arabic number in the vehicle plate. Each extracted plate has an

Fig. 6. (a and b) Results as output in text file and command prompt.

Fig. 7. Sample of plate extraction.

Arabic number that is identified using both the technique as KNN and OCR. The results of OCR and KNN for 90 images are shown in Table 3.

4.4. Preliminary Prediction
The project tested on 90 images which have different sizes, dimensions image types, and resolutions. The smallest image size is 7.35 kb, and the highest image size is 804 kb. The minimum pixel dimension of the image as 194 W × 178 H and 219 W × 57 H. Minimum width is 194-pixel and the minimum height is 57 pixels. The maximum pixel dimension of image is 1920 W × 1080 H and 960 W × 1280 H. Maximum width is 1920 pixels and the maximum height is 1280 pixels. Among all these types of images, plate area extraction by removing Arabic characters and other noise is done successfully by retrieving only Arabic numbers. All those extracted plates have different background colors those areas: (1) Black color (six image), (2) blue color (nine images), (3) green color (eight images), (4) red color (13 images), (5) white color (36 images), and (6) yellow color (18 images). The project has identified all the background colors of the extracted plate efficiently with 97.78% accuracy. Table 4 shows the sample result of all images for OCR and kNN.

4.5. The best technique for Arabic Number Recognition
The obtained all plates tested for Arabic number recognition with OCR and KNN techniques shown in Table 4. OCR identified 41 number plates, and KNN identified 83 number plates correctly. The confidence of identification OCR versus KNN for all images is shown in Fig. 8.

Here, the graph X-axis shows image count and the Y-axis demonstrated the confidence of recognition (OCR: Blue line KNN: Red line). The graph clearly shows that the overall confidence level of attention of KNN is higher than OCR among all images. OCR does not identify two images whose confidence level is −1, whereas KNN identified that also. The performance of Arabic number recognition using the KNN technique is better than the OCR technique.

4.6. Research Performance achieved benchmark
The research aimed to achieve license plate recognition for Iraq vehicles containing number plates of different background color types. An efficient methodology for automatic number plate extraction results in extracting the license plate information from 90 images of an Iraqi vehicle successfully that can be used in a real-time environment. This project discusses the five license plate recognition steps, including (1) image pre-processing, (2) license plate location, (3) Background-color recognition, (4) Arabic number segmentation, and (5) Arabic number recognition.

4.6.1. Plate extraction and background color recognition (97.78 % accuracy)
In the image pre-processing stage, the unwanted character gets removed, gray, and binary processing added, which significantly improves the image accuracy of plate extraction. Second, the background color of the number plate is recognized using the HSV color model instead of using the RGB color model. The detection of background color plate area of extracted plate worked with high accuracy of 97.78 % resulted in recognizing Iraqi vehicle type (Army, Government, Police, etc.) successfully.

4.6.2. Arabic number recognition
Arabic is among one of the most renowned languages in the world. The following task to section the number characters of the License Plate is done after getting drawn
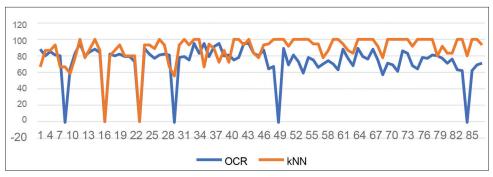
Fig. 8. OCR versus KNN confidence for all the images.

TABLE 3: Plate background color, OCR, and KNN results for all images

Extract plate	Color	OCR	KNN	Extract plate	Color	OCR	KNN
٢٨٢٣٠	black	٠٢٨٢٣	٠٣٢٨٢	٢١٥٧٠	Red	٠٧٥١٢	٠٧٥١٢
٣٥٦٨٤	Black	٤٨٦٥٣	٤٨٦٥٣	١٥٦٠٣١	Red	١٣٠٦١٥	١٣٠٦٥١
٩١٧٦٦	Black	٦٦٧١٩	٦٦٧١٩	١٧٤٠٨	Red	٨٠٤١٧	٨٠٤٧١
٦٥٠٧٣	Black	٣٧٠٥٦	٣٧٠٥٦	٢٧٨١٣	Red	٢٧٨١٣	٣١٨٧٢
١٠٢٤٨	Black	٨٤٢٠١	٨٤٢٠١	١١٣٢٧٨	Red	٨٧١١٣٢	٨٧٢٣١١
٦٨	Blue	NA	٣٥٥٦		Yellow	NA	١٧٠٤٨
٢١٠	Blue	٢١٠	٠١٢	٩٥٨٢٤	White	٤٢٨٥٩	٤٢٨٥٩
١٢٦	Blue	٦١٢	٦٢١	١٧٤٠٨٥	White	٥٠٨٤٧١	٥٨٠٤٧١
١٤٣	Blue	٣٤١	٣٤١	٢٧٥٣٦	White	٦٣٥٧٢	٦٣٥٧٢
١٩٧	Blue	٧٩١	٧٩١	١٤٨٠٠٣	White	٣٠٨٠٤١	٣٠٠٨٤١
١٧٠	Blue	٠٧١	٠٧١	٦٩٠٧٣	White	٧٣٠٩٦	٣٧٠٩٦

TABLE 4: Sample of OCR and kNN results for all images

No.	Extracted plate	OCR		kNN	
01.	٢٨٢٣٠	٠٢٨٢٣	✓	٠٣٢٨٢	✓
02.	٣٥٦٨٤	٤٨٦٥٣	✓	٤٨٦٥٣	✓
03.	٩١٧٦٦	٦٦٧١٩	✓	٦٦٧١٩	✓
04.	٦٥٠٧٣	٣٧٠٥٦	✓	٣٧٠٥٦	✓
05.	١٠٢٤٨	٨٤٢٠١	✓	٨٤٢٠١	✓
06.	٦٨	NA	✗	٣٥٥٦	✗
07.	٢١٠	٢١٠	✗	٠١٢	✓
08.	١٢٦	٦١٢	✗	٦٢١	✓
09.	١٤٣	٣٤١	✓	٣٤١	✓
10.	١٩٧	٧٩١	✓	٧٩١	✓

out Arabic License Plate. The method tested on about 90 vehicles obtained plate images of different background colors for Arabic number recognition by OCR and KNN technique. In our experiments, it has observed that among all 90 plate images, OCR technology recognized the Arabic number accurately for 65 images but some images show sequence irregular so finally 41 images identified perfectly with 45.56% accuracy while KNN technology recognized Arabic name for 83 images with 92.22% accuracy. The performance of KNN technology is better than OCR.

4.7. Discussion
By comparison the proposed system with [22] that used machine learning technique to detect and recognize Iraqi plate number, as a result, determined that the accuracy and confidentiality is less than proposed system. Table 5 showing the comparison result details.

TABLE 5: Comparison results

K Parameter	No. of Image	No. of Successful Result	Accuracy
The Proposed System	90	83	92.2%
D. AbdAlhamza, A. Alaythawy [16]	50	45	90%

5. CONCLUSION

This project implements the five steps of license plate extraction, including image pre- processing; license plate location; background color recognition; character segmentation; and character recognition. In the pre-processing stage, GRAY and BINARY processing is added, which significantly improves the image accuracy. Then, the spatial domain filtering is used to get an accurate location for the license plate area. In the license plate positioning stage, the position is determined by edge detection. The license plate is accurately positioned and cropped. The project implements a complete developed system to recognize the background color of the plate using the HSV color model and color histogram depending on finding a matching range of color in between the lower and upper fields. It successfully identifies each six types of background color as white, red, green, yellow, blue, and black. The project proposes an approach for the recognition of Arabic numbers in various scenarios and complex scenes Google Tesseract is specified for character recognition in an OCR technology, generating automated number plate acknowledgment. Supervised machine learning and template matching technique as KNN is one of the most advantageous methods carried out in the proposed project. It helps in recognizing the Arabic number with high accuracy and makes the identification closer.

These proposed project experimental results show that accuracy for each module is achieved up to the greatest extent on the dataset of the total 90 images. The project has achieved a plate extraction and background color accuracy as 97.78%, Arabic number recognition with OCR as 45.56%, and with KNN as 92.22%. On comparison of various Arabic number recognition algorithms, it inferred that the KNN technique is the most efficient one. Thus, the proposed system achieves the extraction of number plates and the recognition of Arabic numbers in vehicles. It works out better using a low-cost embedded board and software such as python. The project demonstrates that image processing is a far more efficient method of license plate recognition as compared to traditional techniques.

REFERENCES

[1] I. N. Mahmood, H. T. S. AlRikabi, A. H. M. Alaidi and F. T. Abed. "*Design and Implementation of a Smart Traffic Light Management System Controlled*" Wirelessly By Arduino, 2019.

[2] Y. Kessentini, M. D. Besbes, S. Ammar and A. Chabbouh. "A two-stage deep neural network for multi-norm license plate detection and recognition". *Expert Systems with Applications*, vol. 136, pp. 159-170, 2019.

[3] S. Sugeng and E. Y. Syamsuddin. "Designing automatic number plate recognition (ANPR) systems based on K-NN machine learning on the raspberry pi Embedded system". *JTEV Journal Teknik Elektro dan Vokasional*. vol. 5, pp. 19-26, 2019.

[4] Q. Ying and J. G. Sheng. "Research of License Plate Recognition Based on HSV Space". *3rd International Conference on Materials Engineering, Manufacturing Technology and Control*. Atlantis Press, 2016.

[5] A. R. Quiros, R. A. Bedruz, A. C. Uy, A. Abad, A. Bandala, E. Dadios and A. Fernando. "A kNN-based Approach for the Machine Vision of Character Recognition of License Plate Numbers". *TENCON-IEEE Region 10 Conference*, pp. 1081-1089, 2017.

[6] M. Khan, M. Hassan, A. B. M. Noman and S. Rajbangshi. "*Language Recognition and Translation from Document*", 2018.

[7] A. Al-Zawqari, O. Hommos, A. Al-Qahtani, A. A. Farhat, F. Bensaali, X. Zhai and A. Amira. "HD number plate localization and character segmentation on the Zynq heterogeneous SoC". *Journal of Real-Time Image Processing*, vol. 16, pp. 1-15, 2018.

[8] E. Alpaydin. "*Introduction to Machine Learning*". MIT Press, Cambridge, 2014.

[9] M. Mohri, A. Rostamizadehand and A. Talwalkar. "*Foundations of Machine Learning*". MIT Press, Cambridge, 2018.

[10] P. Lison. "*An Introduction to Machine Learning*". Springer, Cham, Denmark, 2015.

[11] M. Kuhn and K Johnson. *Applied Predictive Modelling*". Vol. 26, Springer, New York, 2013.

[12] T. Hastie, R. Tibshiraniand and J. Friedman. "*The Elements of Statistical Learning*". Springer Series in Statistics, Springer, New York, 2001.

[13] J. O. Rawlings, S. G. Pantula and D. A. Dickey. *Applied Regression Analysis: A Research Tool*. Springer Science and Business Media, Germany, 2001.

[14] T. K. Hazra, D. P. Singh, and N. Daga. Optical Character Recognition using KNN on Custom Image Dataset. In: *8th Annual Industrial Automation and Electromechanical Engineering Conference*, pp. 110-114, 2017

[15] N. B. A. Hamid and N. N. B. Sjarif. "Handwritten Recognition Using SVM, KNN and Neural Network". *arXiv*, vol. 2017, p. 00723.

[16] D. AbdAlhamza and A. Alyathawy. "Iraqi license plate number recognition based on machine learning". *Iraqi Journal of Information and Communications Technology*, vol. 3, pp. 2222-758x, 2020.