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Libyan Vehicle Number Plate Recognition System using (WHT)

Anisa F. Elbokhare **EmadEddin Gamati** **Amani M. Soliman**

Computer Science Department, Faculty of Education Tripoli University of Tripoli

A.elbokhare@uot.edu.ly *E.gamati@uot.edu.ly* *a.soliman@uot.edu.ly*

الملخص:

تحظى أنظمة التعرف على لوحات الترخيص (LPR) بالكثير من الاهتمام من قبل الباحثين مدفوعة بالطلب التجاري على تطبيقاتها. في الآونة الأخيرة، شكلت LPR الجزء الأساسي من أنظمة النقل الذكية بسبب تطبيقاتها المحتملة في مجالات مثل جمع الرسوم الإلكترونية للطرق السريعة، وأنظمة إدارة / مراقبة حركة المرور، والأغراض الأمنية، وما إلى ذلك. يمكن أن يكون تشغيل هذه الأنظمة مع تعريف لوحة ترخيص السيارة أمرًا بسيطًا مثل التقاط أرقام لوحات المركبات بواسطة الكاميرا (توليد صورة) ثم استخراج رقم اللوحة في الصورة باستخدام خوارزميات معالجة الصور. لكن، تواجه هذه العملية عدة تحديات بسبب الاختلافات في أنماط وأشكال لوحة الأرقام وجودة الصور من حيث الإضاءة والمسافة وكذلك الغبار الذي قد يكون على اللوحة، بالإضافة إلى مشكلة التعرف على الحروف العربية.

تقترح في هذه الورقة آلية للتعرف الآلي على لوحة ترخيص المركبات القائمة على النظام الليبي لترقيم لوحات السيارات باستخدام التعرف البصري على الأحرف (OCR) مع نهج Walsh-Hadamard Transform (WHT). وكانت نتائج التجارب واعدة من حيث المعدلات العالية للنجاح فى التعرف على السيارات من خلال قراءة لوحات الترخيص بشكل صحيح. كانت معظم أسباب الأخطاء تتعلق بانخفاض جودة الصور المدخلة والتي تسببت في قراءات خاطئة.

Abstract:

One of the most important systems in our life today is the vehicle license plate recognition system, which is used to identify cars based on plate numbers. This process faces several problems due to the differences in the plate number shapes, lighting and dust, in addition to the problem of recognizing the Arabic letters. An automatic license plate recognition mechanism based on the Libyan system of numbering cars license plates is proposed in this paper by using an optical character recognition (OCR) with the Walsh-Hadamard Transform (WHT) approach. The results of the experiments were promising in terms of identifying cars via reading (recognizing) the license plates correctly. The major errors were related to the low quality of input images which caused wrong readings.

Keywords: license plate recognition, optical character recognition, image processing, Walsh-Hadamard Transform.

Introduction:

License plate recognition (LPR) systems have a lot of attention from researchers driven by the commercial demand on its applications. Recently, LPR has formed the core part of intelligent transport systems because of its potential applications to areas such as highway electronic toll collection, traffic management / monitoring systems, security

purposes, and so on. Operating such systems with vehicle license plate identification can be as simple as capturing plate numbers of vehicles by a camera (generating an image) and then extracting the plate number in the image by an image processing algorithm.

In most countries, vehicle plates consist of two metal plates that are displayed at the front and rear of all vehicles with a unique serial number (a unique identifier number) that is used to differentiate vehicles from each other (called vehicle plate number). The most used pattern for numbering the plates consists of two parts (each can contain numbers and/or letters), in addition to some limited special characters/symbols. The first part of most used pattern, usually refers to the country/city (where the vehicle is registered); the second part is a unique serial vehicle number (may contain letters) representing a sequence in the registry of the Local/National Traffic Department.

Therefore, vehicle plate number recognition techniques depend on studying, analyzing and understanding the local used shapes/patterns for vehicle plate numbering systems. Taking in account, the parts of the numbering, the language used, special characters allowed, and the standard different shapes of the plates.

Most published research regarding the identification of vehicles' metal plates characters covers English language characters. In Libya, Arabic is the Approved language for numbering vehicle plates. Due to limitations in conducted research targeting reading vehicle plates in Arabic, we have responded to the need to address a system for identifying Arabic vehicle metal plate numbering in Libya.

Related work:

There are several common algorithms of vehicle license plate recognition. Sarbjit Kaur and Sukhvir Kaur presented a paper on" An Efficient Approach for Number Plate Extraction from Vehicles Image under Image Processing" [7]. In this paper an approach of preprocessed vehicle input image using morphological operations, thresholding, sobel vertical edge detection, and connected component analysis is used for number plate extraction. It works well under low resolution, noisy and low contrast images.

Othman Khalifa, Sheroz Khan, Rafiqul Islam and Ahmad Suleiman [5] produced a paper on "Malaysian Vehicle License Plate Recognition, the international arab journal of information technology". The authors performed recognition of license plates under any environmental conditions, with no assumptions about the orientation of the plate or its distance from the camera . A simple texture-based approach based on edge information is used for solving the problem of localization of a license plate. Then a simple multi-layer Perceptron neural network was used to recognize the segmentation of characters. Simulation results were shown to be an efficient method for real time plate recognition.

Birmohan Singh, Manpreet Kaur, Dalwinder Singh and Gurwinder Singh [2] published a paper on "Automatic number plate recognition system by character position method". A system for developing robust Automatic number plate recognition was suggested in this paper. It depends on proposed a new algorithm for number plate localization which is based on character positioning method. Character recognition is carried ou with a support vector machine. Asyntactic analysis of number plate format for a particular geographical region was used to solve the problem of similar shape characters.

Ganesh R. Jadhav, Kailash J. Karande [4] wrote on "Automatic Vehicle Number Plate Recognition for Vehicle Parking Management System". They discussed using different morphological operations in such a way that the number plate of a vehicle can be identified accurately.

Safaa S. Omran, Jumana A. Jarallah, [6] presented paper on" Car License Plate Recognition Using OCR" in this paper, they proposed an automatic license plate recognition system for Iraqi car license plates using (OCR) with a correlation approach and templates matching for plate recognition. This was the same approach used by Sharma in G [8] in his paper titled "Performance Analysis of Vehicle Number Plate Recognition System Using Template Matching Techniques" in terms of recognition pattern.

The proposed approach:
Before we dive into the proposed approach of this paper, it is worth noting that the Walsh-Hadamard Transform (WHT) is used as an effective technique in our approach. Therefore, we will start by introducing this technique.

Walsh-Hadamard Transform (WHT):

WHT is used in a wide variety of scientific and engineering applications. It is employed in image processing, speech processing, filtering, and power spectrum analysis. It is very useful for reducing bandwidth storage requirements and spread-spectrum analysis [3]. The Walsh-Hadamard transform (WHT) is an orthogonal transformation that decomposes a signal into a set of orthogonal, rectangular waveforms called Walsh functions. The transformation has no multipliers and is real because the amplitude of Walsh (or Hadamard) functions has only two values, +1 or -1. Therefore, WHT can be used in many different applications [1] .
The Walsh-Hadamard transform (WHT) was used in this paper because it gave a better result in Arabic character recognition [9]

Libyan Vehicle Number Plate Recognition:

The process of recognizing the metal plate starts from taking the image of the plate and then using clarity enhancement processing techniques to get the best possible clear picture, as most errors occurred due to the lack of clarity of the image, either due to climatic conditions (such as dust), lighting (day/night), or even due to movement. After that, the process of separating the contents of the image and matching it to the previously stored database begins.

There are two standard shapes for Libyan car license plates written in Arabic, as shown in Figures [1] and [2].

Fig. 1. The first shape of Libyan Plates

Fig. 2. The second shape of Libyan Plates

The stages of the proposed approach:

The recognition of Vehicle Number Plate images can be divided into three main stages:

1. Preparatiojn of the database;
2. Processing the image of the Vehicle Number Plate;
3. Recognizing the contents of the Vehicle Number Plate.

The first stage: preparation of the database:

A database was created and fed with all the letters, numbers and words that are known to be used on the Libyan Vehicle Number Plate. Some sets of the plates had complete words (string of characters), where others have just one letter only. To give an idea of those words and letter, here is an illustrated list:

a. Numbers from 0 to 9.
b. Dash (-)
c. Words (... شرطة ، حكومي ،ليبيا)
d. Characters (ر ، ن)
e. Characteristics of each letter or number above, such as length and width, and WHT spectrum coefficients [9]

The second stage is preparing the Vehicle Number Plate image includes:

1- The image was captured by the camera is converted from RGB and Gray-scale image to a binary image

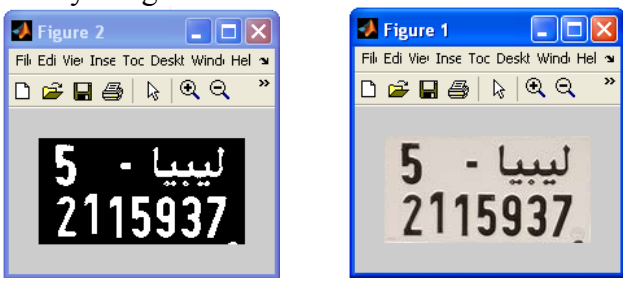

Figure 3: Converted image from RGB and Gray-scale image to a binary image

2- As Known, the Vehicle Number plates in Libya are not all in the same format. Some plates are narrow in shape with one line and others are wide with two lines, so the

image of the plate with two lines is separated into two sub-images, each consisting of one line.

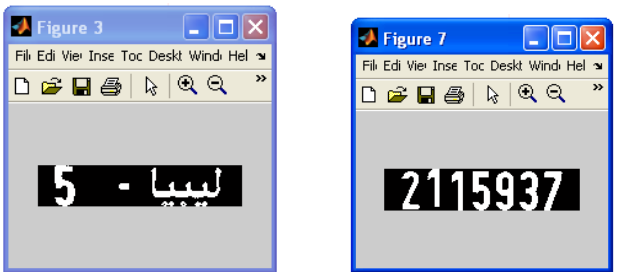

Figure 4: Sub-images of converted two-line Libyan plate to one line

3- The data in the previous image is separated into sub-images where each contains an individual letter or number or word. Now, the plate is ready to be Recognized.

Figure 5: Sub-images of letter, number, and word separated from plate

The third stage: image recognition

1- Select a character from the form the preparing characters in the previous stage, then extract the character features. Find the WHT spectrum coefficients for it. [9]

2- Compare selected coefficients with stored database coefficients, if the selected coefficients are similar to that of the reference character, Put it in the output.
3- Repeat for all next characters of image, until end of Vehicle Number Plate image.

EXPERIMENTAL RESULTS:

This method is applied to different types of Libyan Vehicle Number Plates using the Walsh Hadamard Transform for recognition of plate characters. The images for the input to the system are colored images with variable sizes. The test images were taken under various conditions obtained from different distances from the camera and with different angles and lighting ratios.

The database used to test the system was 75 images; 68 images were obtained correctly with 90.67% success. The major errors were related to bad quality input images which caused wrong input in the second stage.

(a) (b)

Figure 6: Experimental Results (a) Input plate (b) System output

Conclusions:

Although there are many systems for recognizing various plates all over the world (country-based designs), the proposed effort is directed to Libyan license plates. The license plate recognition involves image acquisition, license plate extraction, segmentation, and recognition phases. Beside the use of Arabic, Libyan license plates have several unique features that had to be taken care of in the recognition phases.

In this paper, a system of Vehicle Number Plate Image Recognition was proposed. Preparation captured plate image, then the data was separated into sub-images where each one contained a letter, number or word WHT spectrum. coefficients were compared with stored database coefficients. If the selected coefficients were similar to that of the reference character, the system stored the character. This was repeated for all the next characters of image until Vehicle Number Plate image is completed. The proposed approach was tested over a large number of car number plates and the ratio of success was 90.67%. Bad input images caused most errors.

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