International Journal of Multidisciplinary Research and Modern Education (IJMRME)
ISSN (Online): 2454 - 6119
(www.rdmodernresearch.org) Volume II, Issue I, 2016

ARTIFICIAL INTELLIGENCE BASED IRAQI LICENSE PLATE RECOGNITION SYSTEM

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Abstract:

The LPR (license plate recognition) is very important technology in our life because it have such a lot of sufficient applications which work to save and help the people by playing a major part in applying the law and save order in fast and accurate approach. An automatic recognizer for Iraqi plate numbers is proposed in this paper. The general procedure was developed in some stages.

Index Terms: Neural Network, Plate Recognition & Artificial Intelligence

1.Introduction:

The LPR is an image processing technology used to identify vehicles by their license plates only and it is belong to the ITS (Intelligence Transportation System). They have a wide impact in people's life as their aims to improve transportation safety and mobility and to enhance productivity through the use of advanced technologies. ITS is made up of 16 types of technology based systems. These systems are divided into intelligent infrastructure systems and intelligent vehicle systems. Some of the ITS applications are: Advances in navigation systems, Electronic toll collection systems, Assistance for safe driving, Optimization of traffic management, and Support for emergency vehicle operation. LPR system should operate fast and accurate enough to satisfy the needs of ITS. [1]

In this paper, we present a new automatic and simple algorithm for recognizing Iraqi license plates. Basically, this algorithm consists of four main stages:

- ✓ Image acquisition.
- ✓ Pre-processing including cleaning of plate region from any noise by using median filter and removing unwanted lines by using morphological algorithms.
- ✓ Segmentation of cleaned plate into its characters and numbers by using horizontal and vertical projection profiles.
- ✓ Recognition of the isolated plate number.

1.1. LPR Elements:

- ✓ A camera to taking pictures for cars license plates.
- ✓ A computer having software to process the pictures and recognize the numbers.
- ✓ Finally it is recommended to have a data base to compare the recognition numbers, and that make the system simulated to the reality.

1.2. LPR Applications:

License Plate Recognition have a wide range of applications, it is used to create automated solutions for various problems. Among these applications [2].

- ✓ **Stolen Cars Tracking:** a list of stolen cars is used to identify a passing stolen car. The 'black list' which can be updated, provides immediate alarm to the police force. The LPR system is deployed on the roadside, and performs a match between the passing cars and the list. When a match is found a siren or a display is activated and the police officer is notified about the detected car and stopping it.

- ✓ **Traffic Control:** The system can be used to traffic control management in recognizing vehicles that commit traffic violation, such as crossing red light, breaking speed limits.
- ✓ **Access Control:** electronic gates are automatically open for authorized members in a secured area; such system is used for assisting the security guard. The access control events are stored in a database (DB) and they could be retrieved to investigate the history of events.
- ✓ **Parking:** the plate number is used to automatically enter pre-paid members and calculate parking fee for non-members (by comparing the exit and entry times).
- ✓ **Border Control:** the car number is automatically registered at the entry or exit gates to the country. LPR can be used to monitor the border crossings. They can shorten the border crossing time.
- ✓ **Marketing Tool:** the cars plates may be used to compile a list of frequent visitors for marketing purposes, or to build a traffic profile (such as the frequency of entry verses the hour or day).
- ✓ **Travel:** a number of LPR units are installed in different locations in city routes and the passing vehicles plate's numbers are matched between the points. The average speed and travel time between these points can be calculated and presented in order to monitor municipal traffic loads. Additionally, the average speed may be used to issue a speeding ticket.
- ✓ **Airport Parking:** in order to reduce ticket fraud or mistakes, the LPR unit is used to capture the plate number and image of the cars. The information may be used to calculate the parking time or provide a proof of parking in case of a lost ticket—a typical problem in airport parking which have relatively long (and expensive) parking durations.

2. Acquisition of the Wanted Cars Images:

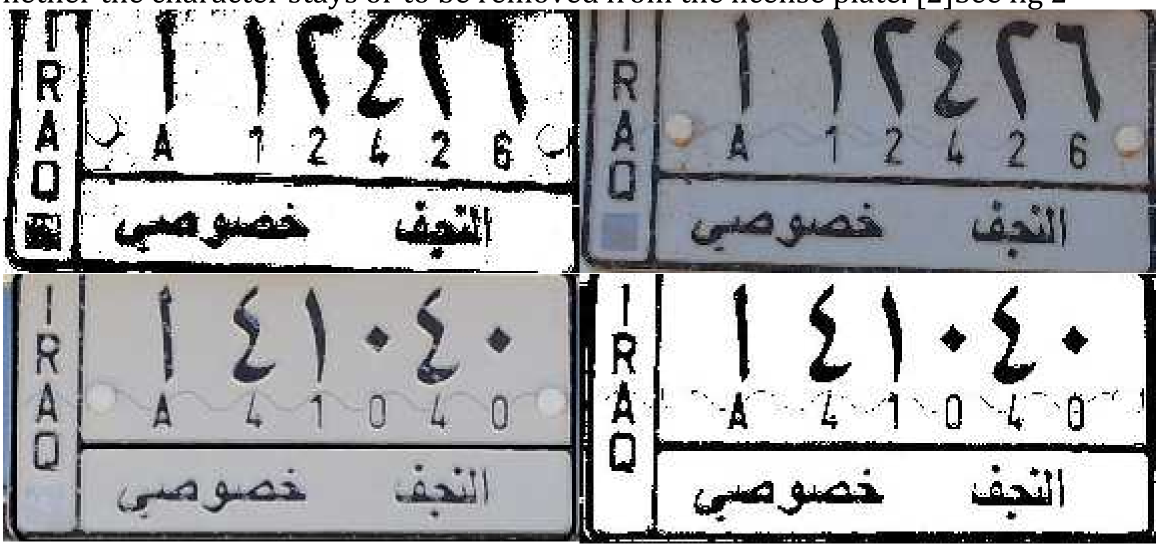
This is the first and the primary stage in LPR the aim of it is to capture the front or the back side of the car where the license plate usually placed then applies the captured image to the next stage of the system.

There are several ways to do this operation and the choosing of which way is the suitable one, is depend on the application that the LPR is use to do it, An example if the LPR is use to catch the license plate of the cars that break the speed limit in specific street, an box consist of camera and speed sensor should place on the sidewalk of that street, and it work to send the captured pictures to the violation center where fee should record. See Fig (1)

Figure1: Acquisition Images

3. Localization and Pre-Processing the License Plate Image:

After the picture is captured the system work to localize the license plate in the image, the goal of this phase is to find candidate region(s) with high probability of containing a license plate, or in other word, allocating license plate area within the vehicle image [3], the license plate region(s) found by the length to width ratio as well as some formulas and procedures, In order to recognize the elements of the license plate accurately, and because the images of vehicles are expected to be taken in different day time the first necessary stage after image acquisition stage is pre-processing stage. It involves all tasks required to make the process of allocation and extraction of license plate possible [4], so that image enhancements are required. Those enhancements include cleaning of plate region from any noise by using median filter and removing unwanted lines. This stage starts by converting the color image into binary image. By thresholding the pixel values of 0 for all pixels in the input image with luminance less than threshold value and 1 for all other pixels. Median filter was used to remove significant noise then Sobel operator has been used, which is composed of two 3 × 3 masks, to determine the edge of the license plate. The plate may contains hard noise that the median filter couldn't remove because it is so enormously large, for that reason we calculate the number of columns, number of rows and the rate between them for each character found in the filtered binary image. By thresholding, we can determine whether the character stays or to be removed from the license plate. [2]See fig 2



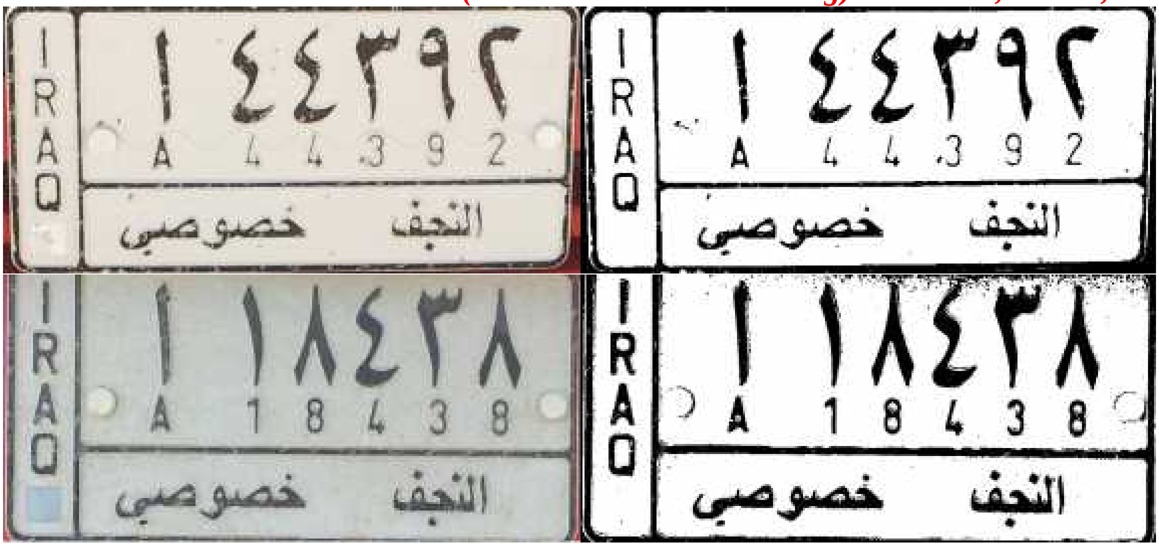


Figure 2.License plate image after localization and pre-processing

4. Numbers Recognition:

After locating the license plate, the next important step is to segment each character individually, which means extracting characters from license plate image, and then the characters are recognized, the recognition stage was done by using neural network.

4.1 Artificial Neural Network:

The human brain can be described as a biological neural network an interconnected web of neurons transmitting elaborate patterns of electrical signals. Dendrites receive input signals and, based on those inputs, fire an output signal via an axon as shown in fig 3. Or something like that. How the human brain actually works is an elaborate and complex mystery. We can simply be inspired by the idea of brain function.

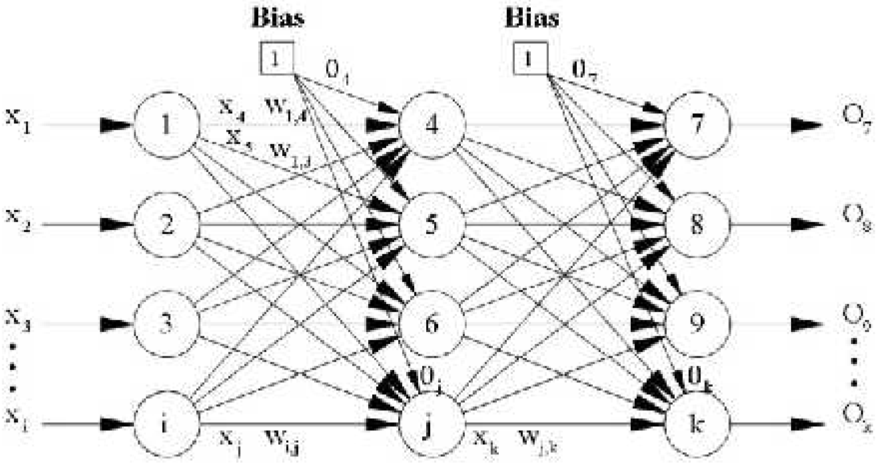


Figure 3: The neural network layers

When a specified training pattern is fed to the input layer, the weighted sum of the input to the jth node in the hidden layer is given by

$$Net_j = \sum w_{i,j} x_j + \theta_j \quad \text{........ (1)}$$

Where x, w and θ are the value of inputs, weight and bias respectively and where i is the index of the source node, j is the index of the target node. Equation (1) is used to calculate the aggregate input to the neuron. The θ_J term is the weighted value from a bias node that always has an output value of 1. The bias node is considered a "pseudo input" to each neuron in the hidden layer and the output layer, and is used to overcome the problems associated with situations where the values of an input pattern are zero. If any input pattern has zero values, the neural network could not be trained without a bias node.

To decide whether a neuron should fire, the "Net" term, also known as the action potential, is passed onto an appropriate activation function. The resulting value from the activation function determines the neuron's output, and becomes the input value for the neurons in the next layer connected to it. Since one of the requirements for the Backpropagation algorithm is that the activation function is differentiable, a typical activation function used is the Sigmoid equation:

$$O_j = x_k = \frac{1}{1 + e^{-Net_j}} \quad \text{...... (2)}$$

It should be noted that many other types of functions can, and are, used:- hyperbolic tan being another popular choice.

Similarly, equations (1) and (2) are used to determine the output value for node k in the output layer.

4.1.1 Introduction and Applications:

Computer scientists have long been inspired by the human brain. In 1943, Warren S. McCulloch, a neuroscientist, and Walter Pitts, a logician, developed the first conceptual model of an artificial neural network. In their paper, "A logical calculus of the ideas imminent in nervous activity", they describe the concept of a neuron, a single cell living in a network of cells that receives inputs, processes those inputs, and generates an output.

Their work, and the work of many scientists and researchers that followed, was not meant to accurately describe how the biological brain works. Rather, an artificial neural network was designed as a computational model based on the brain to solve certain kinds of problems.

It's probably pretty obvious to you that there are problems that are incredibly simple for a computer to solve, but difficult for you. Take the square root of 964,324, for example. A quick line of code produces the value 982, a number Processing computed in less than a millisecond. There are, on the other hand, problems that are incredibly simple for you or me to solve, but not so easy for a computer. Show any child a picture of a cat or dog and they'll be able to tell you very quickly which one is which. Say hello and shake my hand one morning and you should be able to pick me out of a crowd of people the next day. But need a machine to perform one of these tasks? Scientists have already spent entire careers researching and implementing complex solutions.

The most common application of neural networks in computing today is to perform one of these "easy-for-a-human, difficult-for-a-machine" tasks, often referred to as pattern recognition. Applications range from optical character recognition (turning printed or handwritten scans into digital text also LP to digital numbers) to facial recognition.

The individual elements of the network, the neurons, are simple. They read an input, process it, and generate an output. A network of many neurons, however, can exhibit incredibly rich and intelligent behaviors.

This ability of a neural network to learn, to make adjustments to its structure over time, is what makes it so useful in the field of artificial intelligence. Here are some standard uses of neural networks in software today.

Pattern Recognition:

It's probably the most common application. Examples are facial recognition, optical character recognition and license plate recognition etc.

Time Series Prediction:

Neural networks can be used to make predictions. Will the stock rise or fall tomorrow? Will it rain or be sunny?

Signal Processing:

Cochlear implants and hearing aids need to filter out unnecessary noise and amplify the important sounds. Neural networks can be trained to process an audio signal and filter it appropriately.

Control:

See obviously in recent research advances in self-driving cars. As obvious the pattern recognition is the application of the neural network that we use it here. See fig 4

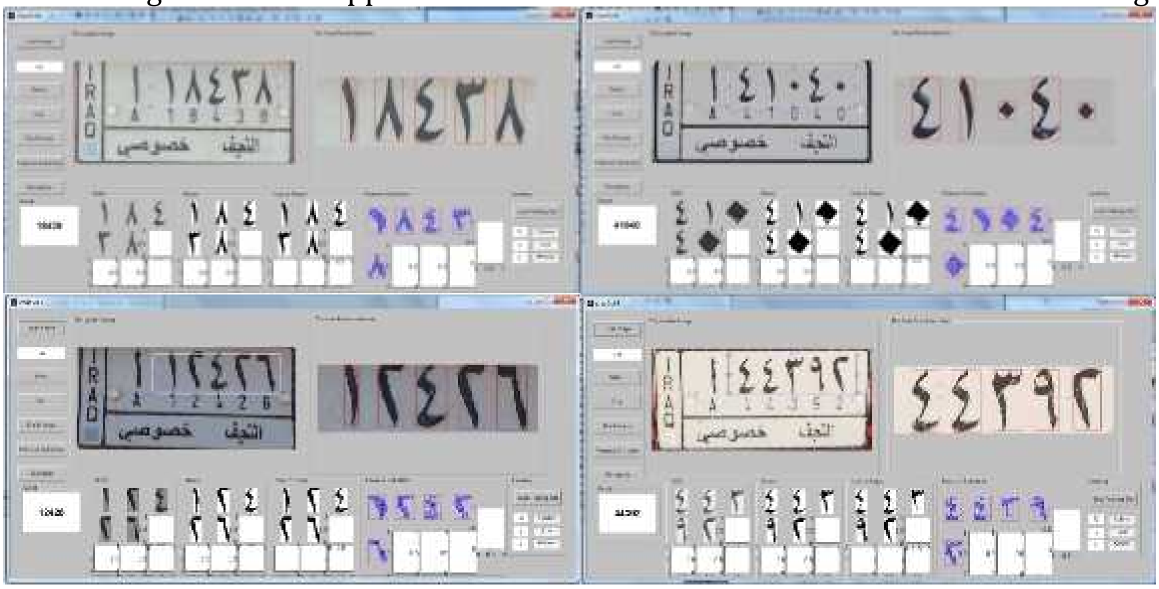
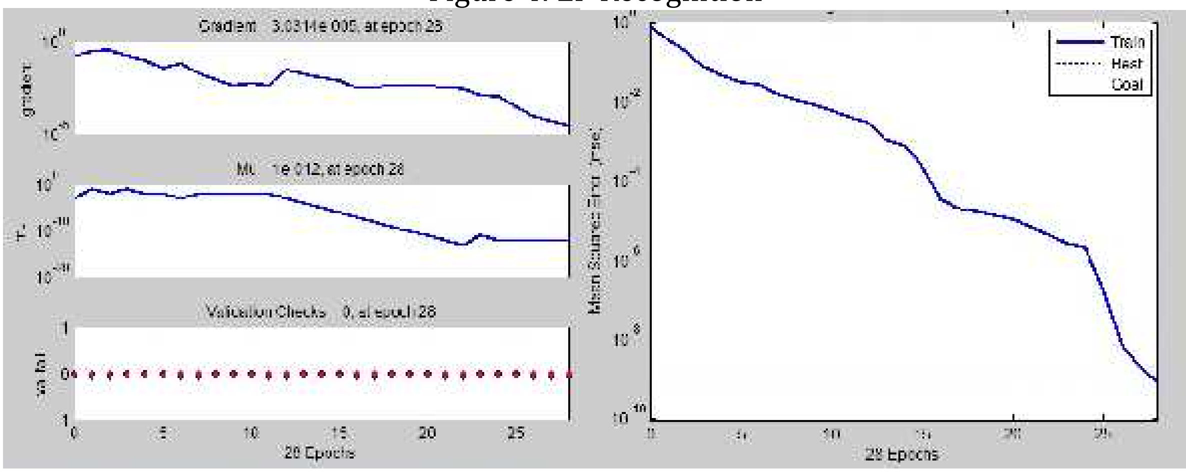


Figure 4: LP Recognition



a. Training stateb Performance

Figure 5(a,b): Shows the neural network specification

5. Conclusions:

In this paper we introduce such a new, accurate and adaptive algorithm to recognize Iraqi license plates. The experimental work and tests samples were taken under different circumstances and effecting parameters like image size, the distance from the car and illuminations, the result were proved that the system very accurate with accuracy ratio of 97%.

6. References:

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