

# Automatic License Plate Recognition Using Multi Layer Back Propagation Neural Network

Asha Sukumaran

<sup>1</sup>Lecturer in Computer Engineering, Govt.Polytechnic College, Kayamkulam,Kerala

*Abstract— Automatic License plate recognition is software, which enables the computer systems to read automatically the registration number of vehicles from digital pictures. In this paper we discuss the implementation of automatic character recognition system using Multi Layer Back propagation Neural Network. The system takes segmented images as input and invokes the training algorithm to automatically learn the structure of the image and produce the text characters as output. It is one of the important applications of digital image processing. The performance of the proposed algorithm has been tested on real images, including infra red images.*

**Keywords— Automatic License Plate Recognition, Image Processing, Back Propagation, Supervised learning, Artificial Neural Network.**

## I. INTRODUCTION

License plate is the unique identification of a vehicle. Automatic number plate recognition provides automated access of the content of the number plate for computer system to manage the databases and process the information for different applications. It is easy for human to read the content of a number plate. But for a machine, it is only an image. Hence it requires complex mathematical image processing techniques to identify the number plate. Automatic license plate recognition (ALPR) is a form of automatic vehicle identification. It is widely used in many applications such as traffic monitoring, security control and stolen vehicle verification, entrance to parking area etc... A typical LPR process consists of four stages such as License Plate Localization, Image Enhancement, Character segmentation, Character Recognition

In License Plate Localization stage the license plate part will be extracted from the captured whole image.

In image enhancement stage some contrast enhancements and skew corrections will be applied into the plate image outputted from the first stage to give the image more clarity.

Character Segmentation part separates each character in the license plate for identification.

Character Recognition stage identifies each character obtained in above stage and finally outputs the recognized license text.

Character recognition plays a very important role in the automatic license plate recognition (ALPR) system. Detection of number plate characters is not easy because of different shape, size, and spacing between each character. It is difficult to recognize the characters when they touch each other or the ink is faded. So for accurate character recognition we need a properly skewed segmented image first. So in character recognition segmented images are taken for further processing. From this segmented image we need to recognize the actual characters and numbers.

## II. ARTIFICIAL NEURAL NETWORK

An Artificial Neural Network process the information like brain. It is composed of a large number of highly interconnected processing elements called neurons to solve specific problems. ANNs learns the objects by example like people. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. In brain, Learning involves adjustments to the synaptic connections that exist between the neurons. The same way ANN works .Neural network is able to provide solution to the complicated or imprecise data. So it can also be used in extracting patterns and detect characters that are too complex to be noticed by humans. A trained neural network is an expert system because it has the ability to learn how to do tasks based on the data given.

Neural networks take a different approach to problem solving than that of conventional computers. Conventional computers use an algorithmic approach. Computer follows a set of instructions in order to solve a problem. Without specific steps computer cannot solve the problem. For ANN, if we know the relationship between inputs and outputs we can model it directly .At first we have to learn it the input/output relationship through training. The functionality of a neural network is determined by the interconnection of different neurons or nodes in the layers and the weights of the connections within the network. The weights are determined by a

certain training algorithm. The process of adjusting the weights to make the network learn the relationship between the inputs and output is called learning, or training. Many learning algorithm have been invented to help find an optimum set of weights that results in the solution of the problems. They can roughly be divided into two main groups as Supervised Learning and Unsupervised Learning

#### Supervised Learning

Here the network is trained by providing it with inputs and desired outputs. These input output pairs are provided by an external trainer. The difference between the real outputs and the desired outputs is used by the algorithm to adapt the weights in the network. The aim is to find a function that matches the desired response for each training input.

#### Unsupervised Learning

In unsupervised learning, there is no feedback from the environment to indicate if the outputs of the network are correct. It is the duty of the network to discover features, possible existing patterns, or categories in the input data automatically. In unsupervised learning, the targets are the same as inputs. While discovering, these, the network may change its parameters. Learning is often not possible in an unsupervised environment.

### III. PROPOSED METHOD FOR CHARACTER RECOGNITION

The algorithm is designed to recognize the number plate of the vehicles automatically. The image of the vehicle captured by a camera is the input. This image is processed through different steps and gives its output to the segmentation part. The separation of image characters is done in the segmentation part. The output of this is fed to the character recognition part and this part recognizes the images and giving result as plate numbers.

This software takes segmented image as input. This image format is then translated into binary format, where each 0 and 1 represents the individual pixel of the segmented image. This binary data is then fed to a neural network and trained to make an association between image data and numeric value corresponds to the character using back propagation algorithm. Output from the neural network is then match with a trained set of values. Take the best match and output is a text corresponds to the image.

The black pixel denotes 1 and the white pixel denotes 0 of a gray scale image. This set of binary value of the entire

image is fed into the neural network system. In the system it implements a Back Propagation Algorithm. A weight and activation function is implemented to process the input data in each neuron or node. Finally the system recognizes the image and produces the plate numbers.

#### Back propagation Algorithm

This is a supervised learning algorithm. In the proposed system, neural network consists of multiple layers. One input layer, one output Layer and two hidden layers.

1. Initialize the network, with all weights set to random numbers between  $-1$  and  $+1$ .
2. Present the first training pattern, and obtain the output.
3. Compare the network output with the target output.
4. Propagate the error backwards.

(a) Correct the weights of output layer using the following formula

$$Wh2O = Wh2O + (\eta \delta o Oh2) \quad (1)$$

Where  $Wh2O$  is the weight connecting hidden unit  $h2$  with output unit  $O$ ,  $\eta$  is the learning rate;  $Oh2$  is the output at hidden unit  $h2$ .  $\delta o$  is error given by the following.

$$\delta o = Oo(1 - Oo)(To - Oo) \quad (2)$$

where  $To$  is the target value of the output neuron and  $Oo$  is the actual output value of the neuron

(b) Correct the hidden layer weights using the following formula.

$$Wh1h2 = Wh1h2 + (\eta \delta h2 Oh1) \quad (3)$$

where  $Wh1h2$  is the weight connecting two hidden layers with,  $Oh1$  is the input at node of the second hidden layer,  $\eta$  is the learning rate.  $\delta h2$  is calculated as follows.

$$\delta h2 = Oh2(1 - Oh2) \sum (\delta o Wh2o) \quad (4)$$

(c) Correct the input weights using the following formula.

$$Wih1 = Wih1 + (\eta \delta h1 Oi) \quad (5)$$

Where  $Wih1$  is the weight connecting node  $i$  of the input layer with node of the first hidden layer,  $Oi$  is the input at

node of the hidden layer,  $\eta$  is the learning rate.  $\delta h_1$  is calculated as follows.

$$\delta h_1 = Oh_1 (1 - Oh_1) \sum (\delta o W_{h1h2}) \quad (6)$$

5. Calculate the error, by taking the average difference between the target and the output vector.

6. Repeat from 2 for each pattern in the training set to complete one proration

7. Repeat from step 2 for a specified number of times, or until the error ceases to change.

#### Activation Function

The activation function of a node is used to produce an output from that node for a given input or set of inputs. If a multilayer network consists of a linear activation function in all neurons, this function is binary—that is, either the neuron produces output or not. , then it is easily proved with linear algebra that any number of layers can be reduced to the standard two-layer input-output model. So each neuron uses a nonlinear activation function which produces the capability like biological neurons in the brain. Most common activation functions are the logistic and hyperbolic tangent sigmoid functions.

The project uses hyperbolic tangent function:

$$f(x) = \frac{2}{1 + e^{-\lambda x}} \quad (6)$$

$$f'(x) = f(x)(1 - f(x)) \quad (7)$$

#### IV. IMPLEMENTATION

##### 1. Formation of the network and weight initialization

The Network implemented for the purpose of this project is composed of 4 layers, one input, two hidden and one output. The input layer constitutes of 100000 neurons which can receive pixel binary data of 100x100 symbol pixel matrix. The size of this matrix was decided taking into consideration the average height and width of character image that can be mapped without introducing any significant pixel noise.

The two hidden layers constitute of 1000 neurons each whose number is decided on the basis of optimal results on a trial and error basis. The output layer is composed of 36 neurons corresponding to the 16-bits of Unicode encoding.

2. Pixel analysis of images for symbol detection by scanning from top left of the image input to bottom right.

3. Loading routines for training input images in multidimensional arrays by choosing a comfort size and corresponding desired output characters in special files named character trainer sets

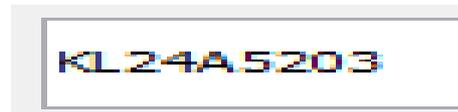
4. Loading and saving routines for trained network

5. Character to binary and vice versa conversion routines

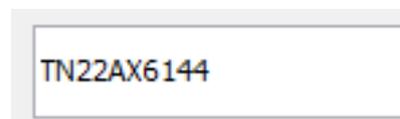
6. Error, output and weight calculation routines.

Some of the Recognized images

**K L 24 A 52 0 3**



**T N 2 2 A X 6 1 4 4**



#### V. CONCLUSION

It can identify the image such as O, 0, Z, 2, Q etc...It can identify some of the images even if they blurred and tilted. Accuracy of using multiple layers is more than single hidden layer. As the number of hidden layers increases accuracy also increases, but as the time taken to process the neuron increases, the speed of the training process decreases. If we can minimize the error more mathematically while error calculation, more accuracy can achieve. If accuracy is not a factor, then network having single hidden layer should be used.

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