An Artificial Neural Network Based Vision System for Vehicles Number Plate Recognition

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***Abstract* - This paper presents how an artificial neural network system can be used for recognition in number plate recognition of vehicles. This paper also describes in detail various practical problems encountered in implementing this particular application and the methods used to solve them. In reality, fraudulent practice is rather common and brings important losses to companies which manage parking areas and garages. The system has showed the following performances (on average) on real-world data: successful plate location and segmentation about 99%, successful character recognition about 98% and successful recognition of complete registration plates about 80%. Thereby using this system eliminates the use of security externally.**

***Key Words* - Image processing, Neural network, OCR recognition, Car license plate**

I. INTRODUCTION

One can imagine a system which recognizes automatically the car number plate when the car enters the parking area and stores somehow the registration number on the ticket. Later, when the car leaves the parking lot, the system can check the correspondence between the information on the ticket and the registration number of the car. It is easy to appreciate that such a system would eliminate completely both fraud situations described above or at least, reduce their number. In these situations, such a system adds a further level of security by granting entrance only to registered vehicles. A system able to recognize registration plates can be used to identify vehicles which transit through the toll gates. Such a system can be used to achieve two types of goals.

Firstly, the system can be used in conjunction with a database containing registration data and owner's information in order to debit the amount due directly into the car owner's account. This can greatly reduce the running costs of the toll bridge or motorway by reducing or eliminating the need for a human presence. Next, such a system can be used as a back-up system which deals only with fraudulent vehicles. For instance, in Italy, the motorway system is run by a private company called "Autostrade spa".

This company has perfected a remote sensing system called "Telepass" which is able to identify certain vehicles which are fitted with a special device. Those vehicles are allowed to transit without stopping through certain dedicated channels at the toll gates, thus eliminating queuing. However, fraudulent users can transit those dedicated channels without having the device fitted to their cars thus trying to avoid paying the toll. In such cases, a Visicar-like system can be triggered. The system would automatically identify the car and, in conjunction with a database, can identify the owner of the car and even issue a fine. One can imagine a system which recognizes automatically the car number plate when the car enters the parking area and stores somehow the registration number on the ticket. Later, when the car leaves the parking lot, the system can check the correspondence between the information on the ticket and the registration number of the car.

II. DESCRIPTION & FUNCTIONING OF THE SYSTEM

This system comprises of a camera, a frame grabber, a general purpose computing device and software for image analysis and character recognition. This system is triggered by an external signal it acquires and stores the image of the car. The major steps involved in functioning of the system are image acquisition and enhancement, vehicle plate location and segmentation, character recognition, validation, and registration number validation.

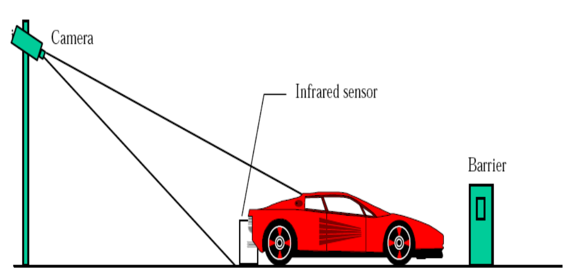

Fig.1 Example of a System set up for vehicle parking

III. METHODOLOGY OF THE PAPER

The below figure shows the methodology of the paper which has the neural network architecture trained learning and the output is given to Optical Character recognition centre. Simultaneously the image is sent from the frame Grabber. Here image acquisition &enhancement is done and is further preceded to character & plate segmentation. This output is given to character recognition & validation process. Thereby the final output is obtained which recognizes the register number of the vehicles.

IV. PROCESSING OF THE SYSTEM

Initially the system recognizes the horizontal images present on the vehicle, by this method15 pixels are determined by the resolution of the camera and the same image is filtered using Gaussian filter to eliminate the noise present on it. The filtered image is again scanned for checking concentrations of high gradient areas. Now the images are converted into Gray scale images by image acquisition & enhancement process [1].The image of the number plate is scanned horizontally for repeating contrast between the characters and to check that the background of the plate is good. Here Gaussian filter is applied to the scanned images which removes the blur noise present on the images. Now the histogram of the images are calculated by applying the formula

new_pixel=pixel*gamma + beta

where gamma and beta are calculated such that the histogram processed image ranges in the gray level from (0 to 255).

V. BINARISATION OF THE IMAGES

The actual processing performed for the binarisation can be described briefly as follows:

- Calculate the histogram and smooth it with a repeated Gaussian filter in order to eliminate small local peaks and troughs.
- Look for high, non-local peaks. High, non-local peaks are peaks which differ from the nearest local minimum by a certain minimum amount which is taken to be a percentage of the vertical size of the interest area.
- If the highest two peaks correspond to intensity values which differ by a minimum amount (i.e. the histogram has at least two modes) and the median falls in-between the two peaks, then the threshold is set midway between these peaks. If the difference between the heights of these two highest peaks is larger than a certain relative limit (given as a percentage of the highest peak), correct the threshold with a bias adjustment factor.
- If the highest two peaks correspond to intensity values which are closer than the minimum amount (they belong to the same mode), or if the median does not fall in-between the two peaks, ignore the second highest peak and try to find another one which satisfies the condition. If such a peak is found, proceed as before. If such a peak is not found (the histogram is unimodal), scan the histogram from its peak down until the width becomes sufficient (say 75% of the 0-255 range.; recall the fact that the histogram has been stretched so that it covers the whole range). Take the threshold at half the width and check whether this value is close to the median. If yes, accept this value as the threshold. If no, reject this value and rely on the adaptive binarisation.
- In the first approximation, it is considered that there are more background pixels than character pixels in the area of interest. Use this assumption and the position of the chosen threshold with respect to the median to decide whether the plate contains light characters on a dark background or dark characters on a light background. If the assumption is wrong, the recognition will fail later on. However, due to the feedback connection implemented in the system, this failure will determine the reversal of the colours and a second attempt at recognition.
- Perform another binarisation, adaptively. For each pixel, take into consideration a small neighborhood (say 4 by 4) and calculate a local range. Set the local threshold in the middle of this local range. During this operation, also compute an average threshold and the number of black/white pixels resulted from this adaptive binarisation. The results of the adaptive binarisation are correlated with the results of the previous binarisation and with the feedback given by the segmentation and recognition modules.

After obtaining this binary image of the interest zone, the system performs the following steps:

- Find the number and location of the horizontal group(s) by projecting horizontally (one horizontal line is projected to a unique value) the binary image and analyzing the resulting lateral histogram.
- For each horizontal group, find the number and location of the characters by projecting vertically (one vertical line is projected to a unique value) the binarised image of the interest zone.

- Any failure will be reported back to the previous module which can re-adjust the binarisation and the plate segmentation.
- The result of this stage is a number of character positions described by the co-ordinates and sizes of the character boxes. These co-ordinates will be used by the system to feed the character recognition module with the appropriate areas of the original image.

Image from Frame Grabber

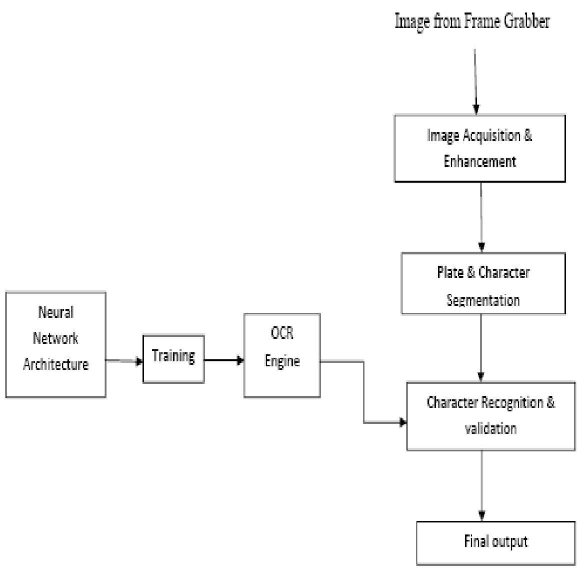

Fig 2: Methodology of the Paper

The below figure (3) shows the images of number of the vehicles before and after histogram process. Now the segmentation process is done by calculating the magnitude and absolute gradients of the images in both X and Y directions. After the Histogram process thresholding is done further to improve the quality of the image [3]. Character segmentation is done in two simple sequences that are given by,

(i) Sorting out the number & location of the horizontal group using binarisation and lateral histogram analysis

(ii) For individual horizontal group, find the number and location of the characters, this forms a group using lateral histogram analysis [4].

Thereby character segmentation is done. After Segmentation process the images are passed through the Gaussian filter to clear the blur noise present in the images. By several repetition process of histogram and thresholding at various levels of the binary data the output image in both horizontal and vertical co-ordinates are recovered.

Fig 3: Number plate Recognition before & after Histogram process

The above figure shows the example of the numbers before & after histogram process. After the character segmentation, character recognition is done. For this process trained recognition engine by neural network is used [2]. Here each character is divided into 8X 16 rectangles and these are fed into the input as OCR engine. This engine uses Feed forward neural networks with sigmoid functions for processing. This network can be trained off-line with various training algorithms such as error back propagation. The standard back propagation network used had architecture with 3 layers and 129, 20 and 36 neurons on the input, hidden and output layers respectively.

An example of difficult Histogram is shown below

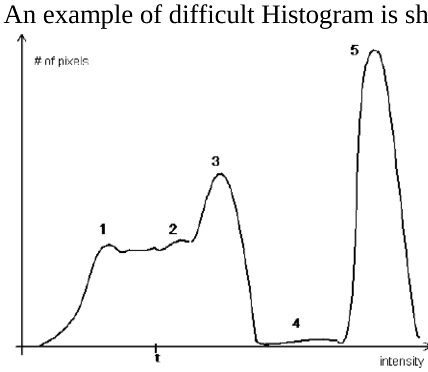

Fig 4: An Example of Histogram process

After this the output is given as input for the process of character validation. The main purpose of this stage is to reject the patterns which are entirely different from the known patterns[5]. Such an approach uses the implicit assumption that the samples used in the training set are uniformly distributed in the input space[6]. Finally Registration number validation is done. The role of this module is to check whether the recognized plate satisfies known a priori conditions about the structure of the registration number (such as the number of letters, the number of digits, their order, etc.).

If the recognized plate does not satisfy these requirements, the information is passed back to the plate segmentation module which can decide to choose an alternative segmentation and the process can be re-iterated. If the registration number recognized by the system satisfies the known a priori conditions, the system can use the individual character recognition confidence values together with the registration number confidence value to calculate a global confidence value. If the recognition is successful, the output of the system will be the recognized registration number, a global confidence value and individual character confidence values.

VI. CONCLUSION

This paper presents a system in which a neural network with image processing technique is used to determine the registration number of the vehicle.

The main features of this system are given as:

(i) Neural Network with both offline and online trained networks can be used.

(ii) Self assessment of the output with reliability.

(iii) High reliability for multiple feedback.

(iv) Thus by using this method the vehicle plate number recognition can be done for some circumstances in practice.

REFERENCES

1. Draghici S., The constraint based decomposition training architecture, World Congress on Neural Networks, San Diego, 1994, volume III, pp. 545-555.

2. . http://www.parsytec.de/solutions/saab.html

3. I.E. Abdou, W.K. Pratt, Quantitative design and evaluation of enhancement/thresholding edge detectors, Proc. IEEE 67, 753-763, 2009.

4. J. Kittler, J. Illingworth, J. Foglein, Threshold selection based on a simple image statistic. Comp. Vision Graph. Image Process. 30, 125-147, 1985.

5. J. S. Weska, A survey of threshold selection techniques, Comput. Graph. Image Process. 7, 259-265, 1979

6. J. S. Weska, R. N. Nagel, A. Rosenfeld, A threshold selection technique, IEEE Trans. Comput. 23, 1322-1326, 1974.

7. R.Thilepa and M.Thanikachalam "A New process of colour images recognition using ART-1 network" Canadian Center of Computer and Information Science Vol 4,No.1; January 2011