IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 6, Issue 11, November 2017

# Localization of License Plate Number and Character Recognition based on Embedded System

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**Abstract:** This project presents the license plate localization and recognition using embedded platform like FPGA. An Automatic Number Plate Recognition (ANPR) system has the function of tracking, identifying and monitoring moving vehicles. These systems are applicable for a vast number of applications such as automatic congestion charge systems, access control, tracing of stolen cars, or identification of dangerous drivers. The Number plate localization is a very important step in an Automatic Number Plate Recognition (ANPR) system. Previously the algorithms used for localization of license plate number and character recognition have low detection rate and requires more time. The objective is to use the system that requires algorithm having high detection rate and requires less time. This system is implemented and tested using the FPGA (cyclone II DE2) board. The localization is done using morphological operations. The edge detection is done by using Sobel operator. The recognition is done by using genetic algorithm. This system is implemented using MATLAB R2013b and Quartus II software's.

**Keywords:** ANPR, FPGA, genetic algorithm, morphological operation, segmentation, etc

## I. INTRODUCTION

Today there is a need for intelligent traffic management systems to deal with the continuously increasing traffic on the roads. Information about current situations can be automatically extracted by image processing algorithms. Along with vehicle detection and tracking, the identification through license plate recognition is important for a variety of applications like automatic congestion charge systems, access control, tracing of stolen cars, or identification of dangerous drivers.The detection stage of the license plate (LP) is the most critical step in an automatic vehicle identification system. Much research has been carried out to overcome many of the problems faced in this area, but there is no general method that can be used for detecting license plates in different places or countries, because of the difference in plate style or design [1].An ANPR system involves various steps that are image capturing, image processing and plate recognition. The image processing phase performs two tasks that are plate localization and character recognition .Plate localization normally performs two major tasks. The first task is to separate number plate area from non-number plate area and the second task is plate adjustment [2]. Before plate recognition stage plate segmentation is performed. In plate segmentation the symbols or characters will be separated from the NP so that this information is used for recognition where the image format will be converted into symbols or characters [3].

## II. LITERATURE SURVEY

Genetic algorithms have been used rarely because of their high computational needs. Different research has been tried at different levels under some constraints to minimize the search space of genetic algorithms (GAs). Researchers based their GA on pixel color features to segment the image depending on stable colors into plate and non-plate regions, followed by shape dependent rules to identify the plate's area. A success rate of 92.8% was recorded for 70 test samples [5]. In [6], GA was used to search for the best fixed rectangular area having the same texture features as that of the prototype template. The used technique lacks invariability to scaling because fixed parameters have been used for the size of the plate's area. In [7], GA was used to locate the plate vertically after detecting the left and right limits based on horizontal symmetry of the vertical texture histogram around the plate's area. The drawback of this method is its sensitivity to the presence of model identification text or other objects above or below the vehicle that can disturb the texture histogram. Another group of researchers tried to manipulate the problem from the texture perspective to differentiate between text and other image types [8][9].

## III. PROPOSED WORK

The flowchart in Fig. 1 depicts the various Image processing stages that produce image objects at the end to the GA phase [1].

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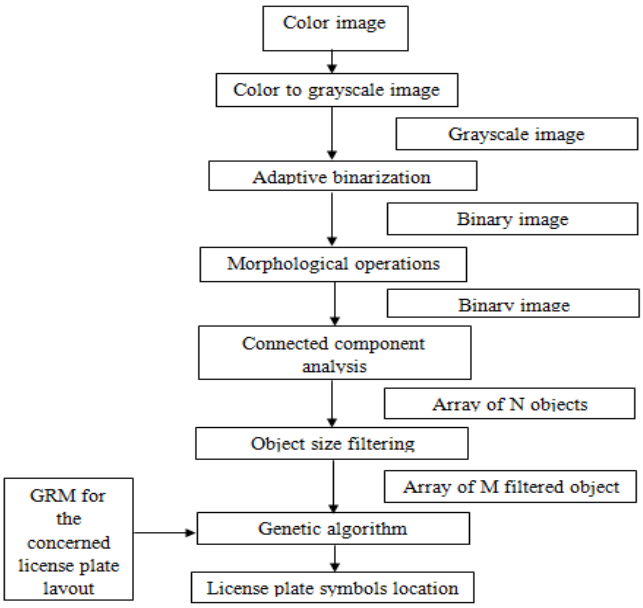


Fig. 1 Overall system flowchart for localization of LP symbols [1]

A. Image Processing Phase

In this phase, an input color image is exposed to a sequence of processes to extract the relevant 2-D objects that may represent the symbols constituting the LP. These processes are carried out in different stages that are:

- Color to Grayscale Conversion: The input image is captured as a color image by taking into account further processing of the image to extract other information relevant to the concerned vehicle. Color (RGB) to grayscale (gs) conversion is performed using the standard NTSC method by eliminating the hue and saturation information while retaining the luminance as follows:

$$Gs = 0.299*R + 0.587*G + 0.114*B \quad (1)$$

- Gray to Binary Using Dynamic Adaptive Threshold: A local adaptive method is used to determine the threshold at each pixel dynamically depending on the average gray level in the neighbourhood of the pixel.
- Morphological operations: Morphological operations such as dilation and erosion are important processes needed for most pattern recognition systems to eliminate noisy objects and retain only objects expected to represent the targeted patterns. In LP detection, closing operation (dilation followed by erosion) is performed to fill noisy holes inside candidate objects and to connect broken symbols. On the other hand, opening (erosion followed by dilation) is applied to remove objects that are thinner than the LP symbols.
- Connected Component Analysis (CCA) and Objects Extraction: CCA is a well-known technique in image processing that scans an image and groups pixels in labeled components based on pixel connectivity. The output of this stage is an array of N objects.

- Size Filtering: The objects extracted from the CCA stage are filtered on the basis of their widths Wobj and heights Hobj such that the dimensions of the LP symbols lie between their respective thresholds as follows:

$$W_{min} \leq W_{obj} \leq W_{max} \text{ and } H_{min} \leq H_{obj} \leq H_{max} \quad (2)$$

Where, Hmin and Wmin are the values below which a symbol cannot be recognized and Wmax can be set to the image width divided by the number of symbols in the license number.These above methods are used for license plate localization that are implemented and verified using FPGA .

B. Genetic Algorithm Phase

GA selects the optimum LP symbol locations depending on the input geometric relationship matrix (GRM) that defines the geometrical relationships between the symbols in the concerned LP. This method is used for character recognition that is also implemented and verified using FPGA [1].

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## IV. OVERALL BLOCK DIAGRAM OF LOCALIZATION AND RECOGNITION

Fig. 2 shows the overall block diagram showing localization and recognition.

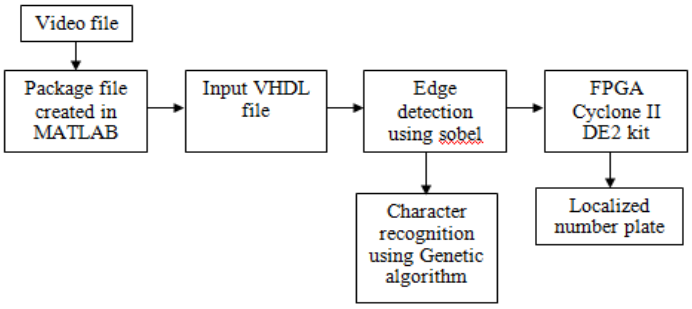


Fig. 2 Overall block diagram showing localization and recognition

The MATLAB program is used to generate VHDL file called as package file consisting information related to rows, columns, and frames. Firstly the video file is selected in the MATLAB R2013b so as to process it to get the pixel value of the selected frame. Then this package file is given as input to VHDL platform.The edge detection is performed using Sobel operator and character recognition is performed using genetic algorithm. These three files ie package file, edge detection file and number plate recognition file are simulated using Modelsim SE plus 6.3f platform and implementation is done using quartus II platform to get number plate output on the LCD display of the FPGA kit (cyclone II DE2 board).

A. Edge Detection Using Sobel Operator

The Sobel Edge Detection consists of two masks, one mask identifies the horizontal edges and the other mask identifies the vertical edges. Each of the masks has the effect of calculating the gradient in both vertical and horizontal direction [9].Initially the image is read i.e. its pixel values are read. Then that image is convolved with the filter. After that horizontal and vertical mask of the operator are convolved with the original image. Let the horizontal and vertical convolution be Gx and Gy respectively. The mask values for Gx and Gy of Sobel operator are [10].

Gx =

| | | |
|---|---|---|
| -1 | 0 | 1 |
| -2 | 0 | 2 |
| -1 | 0 | 1 |

Gy =

| | | |
|---|---|---|
| 1 | 2 | 1 |
| 0 | 0 | 0 |
| -1 | -2 | -1 |

Equation (5) shows convolution of input image with horizontal mask whereas Equation (6) shows convolution of image with vertical mask.

$$G_X=\{F(X+1,Y-1)+2F(X+1,Y+1)\}-\{F(X-1,Y-1)+2f(x-1,y)+f(x-1,y-1)\} \quad (5)$$

$$G_Y=\{F(X-1,Y-1)+2F(X,Y-1)+F(X+1,Y-1)\}-\{F(X\,1,Y+1)+2F(X,Y+1)+F(X+1,Y+1)\} \quad (6)$$

These masks can then be combined together to find the absolute magnitude of the gradient at each point. Therefore the gradient magnitude is given by the equation [11]

$$|G| = \sqrt{(\,[\![G_X]\!]\,\hat{}\,2+[\![G_Y]\!]\,\hat{}\,2\,)} \quad (7)$$

B. Character recognition using Genetic algorithm

Genetic algorithm is used for character recognition .GA selects the optimum LP symbol locations depending on the input geometric relationship matrix (GRM)that defines the geometrical relationships between the symbols in the concerned LP.[1] GA performs template matching and display the number plate symbols or character in the text format. Template matching is a method in which the individual image pixels are used as features. Classification is performed by comparing an input character with a set of templates (or prototypes) from each character class. Each comparison results in a similarity measure between the input characters with a set of templates. One measure increases the amount of similarity when a pixel in the observed character is identical to the same pixel in the template image. If the pixels differ the measure of similarity may be decreased. After all templates have been compared with the observed character image, the character's identity is assigned the identity of the most similar template [12].

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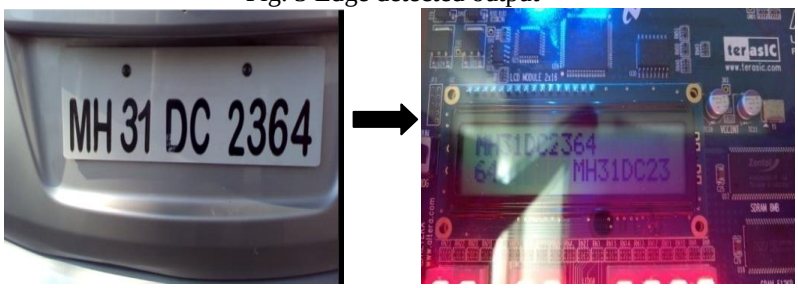
## V. RESULTS

A MATLAB program is used to generate VHDL file called as package file consisting information related to rows, columns, and frames. Firstly the video file is selected in the MATLAB R2013b so as to process it to get the pixel value of the selected frame. Then this package file is given as input to VHDL platform. The edge detection is performed using Sobel operator and character recognition is performed using genetic algorithm. These three files ie package file, edge detection file and number plate recognition file are simulated using Modelsim SE plus 6.3f platform and implementation is done using quartus II platform to get number plate output on the LCD display of the FPGA kit(cyclone II DE2 board). The Sobel edge operator has an advantage of smoothing effect to the random noises in the image. As it is differentially separated by two rows or two columns, therefore edge elements on both sides have been enhanced and make the edge seems thick and bright.


Original Image Edge detected output

Fig. 3 Edge detected output




Original image Number plate output on kit

Fig 4. Number plate output displayed on FPGA kit

After testing various samples of number plate in different environmental conditions the success rate obtained during MATLAB implementation (%) and Hardware implementation (%) is given in the table I as below.

TABLE I
SUCCESS RATIO FOR DETECTION OF PLATES IN DIFFERENT CONDITIONS

| **License Plate Conditions** | **Success using MATLAB Implementation (%)** | **Success using Hardware Implementation (%)** |
|---|---|---|
| Sunlight | 100% | 90% |
| Shade | 100% | 80% |

To calculate the various parameters like area utilization and power consumption, the same process was followed in Xillinx ISE 13.2 software using three VHDL codes.

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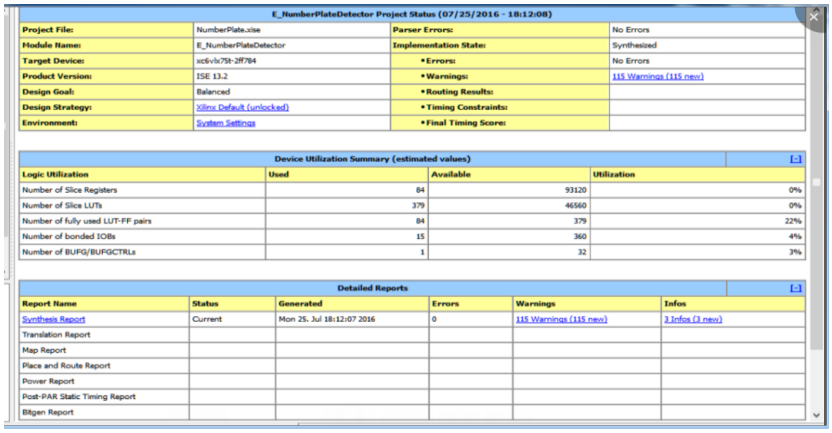

E_NumberPlateDetector Project Status (07/25/2016 - 18:12:08)

| | | | |
|---|---|---|---|
| Project File: | NumberPlate.xise | Parser Errors: | No Errors |
| Module Name: | E_NumberPlateDetector | Implementation State: | Synthesized |
| Target Device: | xc6vlx75t-2ff784 | • Errors: | No Errors |
| Product Version: | ISE 13.2 | • Warnings: | 115 Warnings (115 new) |
| Design Goal: | Balanced | • Routing Results: | |
| Design Strategy: | Xilinx Default (unlocked) | • Timing Constraints: | |
| Environment: | System Settings | • Final Timing Score: | |

Device Utilization Summary (estimated values) [-]

| Logic Utilization | Used | Available | Utilization |
|---|---|---|---|
| Number of Slice Registers | 84 | 93120 | 0% |
| Number of Slice LUTs | 379 | 46560 | 0% |
| Number of fully used LUT-FF pairs | 84 | 379 | 22% |
| Number of bonded IOBs | 15 | 360 | 4% |
| Number of BUFG/BUFGCTRLs | 1 | 32 | 3% |

Detailed Reports [-]

| Report Name | Status | Generated | Errors | Warnings | Infos |
|---|---|---|---|---|---|
| Synthesis Report | Current | Mon 25. Jul 18:12:07 2016 | 0 | 115 Warnings (115 new) | 3 Infos (3 new) |
| Translation Report | | | | | |
| Map Report | | | | | |
| Place and Route Report | | | | | |
| Power Report | | | | | |
| Post-PAR Static Timing Report | | | | | |
| Bitgen Report | | | | | |

Fig. 5 Shows device utilization summary using xilinx ise 13.2 software

The above figure shows the summary of device utilization. After observing from the table 3, therefore the area utilization is calculated by taking utilization shown above i.e. 22%, 4% and 3%. Finally area utilized is 9.7% i.e. 10% (approx).

## VI. CONCLUSION

Localization of license plate number and character recognition can be performed using Sobel operator and genetic algorithm. The Sobel operator is used for edge detection and genetic algorithm is used for character recognition. Therefore proposed work is implemented on FPGA (cyclone II DE2) kit to get advantage of high detection rate, reduction in processing time and area utilization power consumption. By observing these parameters of FPGA-based implementations, the detection rate is 90% in sunlight and 80% in shade with time 2.5 ms and 10 % (approx.) area utilization.

## ACKNOWLEDGEMENT

This work was supported by **Dr. Rajendra Rewatkar**, Associate Professor,(Head of department) and **Prof. Dipti Bhade**, Assistant Professor in Electronics Engineering department, Datta Meghe Institute of Engineering, Technology & Research (DMIETR), Wardha.

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## BIOGRAPHY

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