International Journal on Recent and Innovation Trends in Computing and Communication
Volume: 4 Issue: 5
ISSN: 2321-8169
302 – 305

FPGA Based Localization and Recognition of License Plate Number

Sheetal Israni[1]
Department of E&Tc Engineering,
DMIETR
Sawangi Meghe, Wardha.
Sheetalisrani2109@gmail.com

Swapnil Jain[2]
Department of E&Tc Engineering,
DMIETR
Sawangi Meghe, Wardha.
swapniljain@rediffmail.com

Abstract :This paper presents the license plate localization and recognition using embedded platform like FPGA. The Number plate localization is a very important step in an Automatic Number Plate Recognition (ANPR) system and it is comparatively intensive task. The algorithm used for plate localization is targeted to be of low complexity and high detection rate. This system can be implemented and tested using the FPGA Spartan 3 kit. The localization is done using morphological operations. The edge detection is done by using sobel operator. The recognition is done by using genetic algorithm. An adaptive threshold method is used to overcome the dynamic changes of illumination conditions when converting the image into binary. The Connected component analysis technique (CCAT) is used to detect candidate objects inside the unknown image. A scale-invariant geometric relationship matrix is used to model the layout of symbols in any LP that simplifies adaptability of the system when applied in different countries having different plate styles. The problems , such as touching or broken bodies in CCAT, are minimized by modifying the GA to perform partial match until reaching an acceptable fitness value. This system is implemented using MATLAB and Xillinx.

*****

I. INTRODUCTION :

An automatic Number Plate Recognition (ANPR) system has the function of tracking, identifying and monitoring moving vehicles. The steps involved in an ANPR system are image capture, image processing and plate recognition. The image processing phase, includes two tasks , i.e. plate localization and character recognition. Plate localization basically requires two major tasks. The first one is to separate Number Plate (NP) area from Non-Number Plate (Non-NP) area and second one is the plate adjustment. The plate recognition stage requires a pre-processing step which is plate segmentation in this the symbols or characters will be separated from the NP so that only useful information are retained for recognition in which the image format will be converted into symbols or characters by pre-defined Transformation models. All the developed techniques can be classified according to the selected features upon which the detection algorithm was based. The Color-based systems have been built to detect specific plates having fixed colors [1]–[2]. The External-shape- based techniques have been implemented to detect the plate based on its rectangular shape [3]–[4]. The Edge-based techniques were developed to detect the plate based on the high density of vertical edges inside it [5]–[6]. The Research carried out in [7] and [8] was based on the intensity distribution in the plate's area with respect to its neighborhood where the plate is considered maximally stable extremal region. Different research has been tried at different levels to minimize the search space of genetic algorithms (GAs). The Researchers in [9] based their GA on pixel color features that segments the image depending on stable colors into plate and non-plate regions, which is followed by shape dependent rules to identify the plate's area. In [10], GA was used to match the best fixed rectangular area having the same texture features that is present in the prototype template. The technique used lacks in invariability to scaling because fixed parameters were used for the size of the plate's area. In [11], GA was used to locate the plate in vertical direction after detecting the left and right limits based on horizontal symmetry of the vertical texture histogram present around the plate's area. This method has a drawback that it is sensitive to the presence of other objects above or below the vehicle that can create disturbance in the texture histogram. GA in [12] was only used to recognize the LP symbols not to detect the LP.

ANPR is a computationally intensive task and often has to be under real-time constraint, the common hardware choice for its implementation is often high performance workstations. The cost, compactness and power issues motivate the search for other platforms. Recent improvements in low-power high-performance Field Programmable Gate Arrays (FPGAs) and Digital Signal Processors (DSPs) for image processing have motivated researchers to consider them as a low cost solution for accelerating such computationally intensive tasks.

II. RELATED WORK:

The proposed system is composed of two phases:
1. image processing phase and
2. GA phase.

The flowchart in Fig. 1 depicts the various image processing stages that finally produce image objects to the GA phase.

 ISSN: 2321-8169
302 – 305

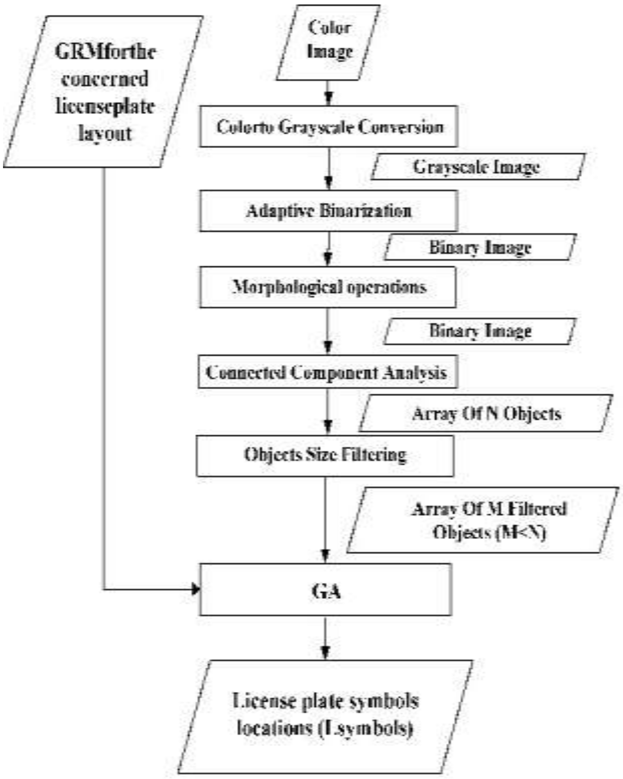

Fig 1.overall system flowchart for localization of LP symbols.

1] Image Processing Phase:
In this an input color image is exposed to a sequence of processes to extract the relevant 2-D objects that represents the symbols present in the LP. These processes are carried out in different stages that are:

a) Color to Grayscale Conversion:
The input image that is captured as a color image by taking into account further processing of the image to get the other information relevant to the concerned vehicle. Color (RGB) to grayscale (gs) conversion is obtained using the standard NTSC method that eliminates the hue and saturation information and retains the luminance as follows:

$gs = 0.299*R + 0.587*G + 0.114*B$………………………. (Eqn 1)

b) 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 neighborhood of the pixel.[16]

c) Morphological operations
Morphological operations such as dilation and erosion are important processes required for pattern recognition systems to eliminate noisy objects and only retain the objects expected to represent the targeted patterns. In LP detection,the closing operation is performed to fill noisy holes inside candidate objects and to connect broken symbols and on the other hand, opening operation is applied to remove objects that are thinner than the LP symbols.

d) Connected Component Analysis (CCA)
CCA is a well-known technique in image processing that scans an image and groups the pixels in labeled components based on pixel connectivity[17].The output of this stage is an array of N objects.

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

$W_{min} \le W_{obj} \le W_{max}$ and $H_{min} \le H_{obj} \le H_{max}$……………………..(Eqn2)

where Hmin and Wmin are the values below which a symbol cannot be recognized and Wmax can be taken as 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 .

2] Genetic Algorithm Phase:
GA selects the optimum License plate symbols locations depending on the input geometric relationship matrix (GRM) that indicates 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.

III. NUMBER PLATE LOCALIZATION ALGORITHM:

The proposed algorithm is basically depended on two open and a close morphological operations, the first open operation is used to extract the features of the NP, the second open operation is used to remove noise, the close operation is then used to fuse the pixels in the number plate region together.

This algorithm consists of two major stages:

1. Morphological operations used for extracting plate features
2. Selection of candidate regions.[14]

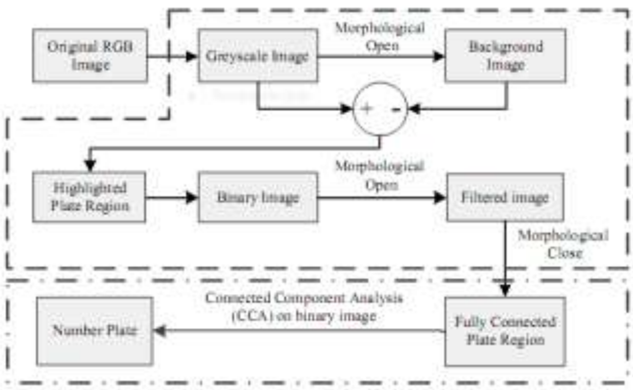

Fig. 2 shows a block diagram of the proposed NPL system.

1. Plate Feature Extraction
The proposed algorithm mainly uses three morphological operations to reduce the pixels of the non-plate region and to enhance those of the plate region. The original RGB image is first converted into a grey scale image, which is used as an input for the following block where the first morphological open operation is used. The morphological open operation is an erosion followed by a dilation and the opposite operation is the close operation that is a dilation

followed by an erosion. The shape of the morphological operations is based on a suitable structuring shape considered as a probe called the Structuring Element (SE)[15]. Open and close operations can be performed as shown in equations (1) and (2) respectively.

Io=(I ʘ SE) ϴ SE ……………………………… (Eqn3)
Ic=(I ϴ SE) ʘ SE ……………………………… (Eqn4)
where I denotes a greyscale input image,ϴ denotes a dilation operation and ʘ denotes an erosion operation:
2. Selection of Candidates Plate Region :
The output image from the previous stage consists of a set of groups of connected pixels. A labeling algorithm CCA is used to mark these pixels. In the proposed work, the CCA uses a '4-connectivity' method, and labels them using different numbers. Once all the groups of pixels have been determined, each pixel is labeled based on the group it belongs to. Therefore, a set of potential candidates can be selected from the image using the known geometrical conditions, which mainly consist of the width, height and ratio of the plate region.[14]

IV. PROPOSED NUMBER PLATE LOCALIZATION ARCHITECTURE:

Morphological operations based architecture consists mainly of an image reader, three morphological operations and CCA. Therefore, this architecture can be designed using the following modules:
- Memory Reader Module;
- Converter Module;
- Morphological Operations Module; and
- CCA Module.[14]

The structure of the proposed architecture is shown in Fig. 3

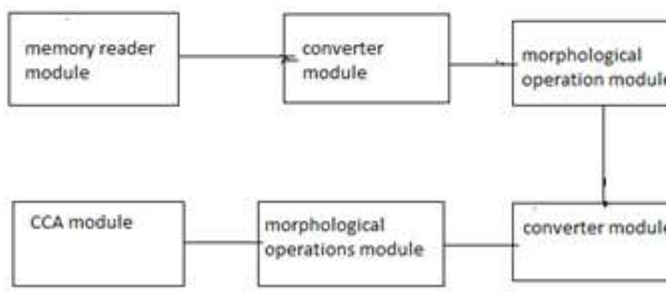

Fig.3. Proposed Number Plate Localization Architecture

Memory Reader and Converter Module:-
The first module in the proposed architecture is the memory reader and converter. The memory reader part of the module is used to read the RGB values for each pixel from the original RGB image which has a size of 640*480 and to assign a position coordinate.[14]

Morphological Operations Module:-
The morphological operations module consists of the morphological open and the morphological close sub-modules. According to the equation (3) and (4), the morphological open operation and the morphological close operation can be divided into two sub-filters respectively, i.e. the morphological dilation and the morphological erosion sub-filters, where the order in each case decides whether the morphological operation is open or close. The gray scale dilation calculates the maximum pixel value in a specific SE. On the contrary, the gray scale erosion calculates the minimum value in a specific SE.[14]

CCA Module:-
The CCA module is used to mark and select a candidate plate region from the entire binary image. Basically, the pixels of the input pixel stream are divided into several groups by the CCA module. This grouping is based on the pixels' connectivity.[14]

RESULTS:

The different software platforms that are used include the MATLAB and the XILINX. Xilinx ISE (Integrated Software Environment) is a software tool used for synthesis and analysis of HDL styles, enabling the developer to compile styles, perform timing analysis, examine RTL diagrams, simulate a style's reaction to different stimuli, and configure the target device. MATLAB is a high-level language and interactive environment for numerical computation, visualization, and programming. The key advantage of VHDL, when used for systems design, is that it allows the behavior of the desired system to be described (modeled) and verified (simulated) before synthesis tools translate the look into real hardware (gates and wires). The proposed architecture for NPL can be simulated using Xilinx . After simulation, the architecture can be implemented and verified using the FPGA like spartan 3.The external memory data width is 32 bits, which means every pixel value can be saved on a single memory location. Every clock cycle one data pixel is passed from one block to the next. The results show a similar performance compared to the software implementation in terms of NPL rate where the entire overall rate is 97.8%.

CONCLUSION :

An ANPR system can be divided into three main image processing stages: NPL, NP segmentation and character recognition. All three stages are computationally intensive tasks. But FPGAs have become a viable solution for performing computationally intensive tasks. Owing to the importance and the use of ANPR systems in law enforcement, an efficient NP localization algorithm can be proposed for FPGA implementation. By comparing the parameters of PC and FPGA-based implementations of the such algorithm, it can be found that FPGA can have fast speed with close accuracy; therefore, the proposed FPGA-based system can be used as a viable solution. Therefore proposed work can be implemented on FPGA to get advantage on cost, size and energy consumption.

REFERENCES

[1] A. Ahmadyfard and V. Abolghasemi, "Detecting license plate using texture and color information," in *Proc. Int. Symp. Telecommun.*, 2008, pp. 804–808..
[2] X. Shi, W. Zhao, Y. Shen, and O. Gervasi, "Automatic license plate recognition system based on color image processing," in *Lecture Notes on Computer Science*,

Berlin, Germany: Springer-Verlag, 2005, vol. 3483, pp. 1159–1168.

[3] M. Deriche, "GCC license plates detection and recognition using morphological filtering and neural networks," *Int J. Comp. Sci. Info Security*, vol. 8, no. 8, pp. 263–269, Dec. 2010.

[4] A. Theja, S. Jain, A. Aggarwal, and V. Kandanvli, "License plate extraction using adaptive threshold and line grouping," in *Proc. ICSPS*, Jul. 2010, vol. 1, pp. 211–214.

[5] P. Tarabek, "Fast license plate detection based on edge density and integral edge image," in *Proc. Int. Conf. Appl. Mach. Intell. Inform.*, 2012, pp. 37–40.

[6] S. Roomi, M. Anitha, and R. Bhargavi, "Accurate license plate localization," in *Proc. Int. Conf. Comput. Commun. Electr. Technol.*, 2011, pp. 92–99.

[7] W. Wang, Q. Jiang, X. Zhou, and W. Wan, "Car license plate detection based on MSER," in *Proc. Int. Conf. Consumer Electron. Commun. Netw.*, 2011, pp. 3973–3976.

[8] H. W. Lim and Y. H. Tay, "Detection of license plate characters in natural scene with MSER and SIFT unigram classifier," in *Proc. IEEE Conf. Sustainable Utilization Develop. Eng. Technol.*, 2010, pp. 95–98.

[9] S. K. Kim, D. W. Kim, and H. J. Kim, "A recognition of vehicle license plate using a genetic algorithm based segmentation," in *Proc. Int. Conf. Image Process.*, 1996, vol. 1, pp. 661–664.

[10] J. Xiong, S. Du, D. Gao, and Q. Shen, "Locating car license plate under various illumination conditions using genetic algorithm," in *Proc. ICSP*, 2004, vol. 3, pp. 2502–2505.

[11] Z. Ji-yin, Z. Rui-rui, L. Min, and L. Yinin, "License plate recognition based on genetic algorithm," in *Proc. Int. Conf. Comput. Sci. Software Eng.*, Dec. 2008, vol. 1, pp. 965–968.

[12] V. P. de Ara´ujo, R. D. Maia, M. F. S. V. D'Angelo, and G. N. R. D'Angelo, "Automatic plate detection using genetic algorithm," in *Proc. 6th WSEAS Int. Conf. Signal Speech Image Process.*, Sep. 2006, pp. 43–48.

[13] G.A.Smara, F.Khalefah:Localization of License Plate Number Using Dynamic Image Processing Techniques and Genetic Algorithms. IEEE Trans. Evolutionary Computation,2014,Vol.18(2): 244– 257.

[14] X. Zhai, F. Bensaali and S. Ramalingam"Improved number plate localisation algorithm and its efficient FPGA implementation" in School of Engineering & Technology University of Hertfordshire Hatfield, UK.

[15] Shih, F. and Wu, Y. 'Decomposition of arbitrary gray-scale morphological structuring elements', Pattern Recognition, Dec. 2005, 38, pp. 2323-2332 .

[16] M. Sezgin and B. Sankur, "Survey over image thresholding techniques and quantitative performance evaluation," *J. Electron. Imaging*, vol. 13, pp. 146–165, Jan. 2004.

[17] S. E. Umbaugh, *Computer Vision and Image Processing*. Englewood Cliffs, NJ, USA: Prentice-Hall, 1998, pp. 133–138.