A Systematic Performance Comparison of Artificial Intelligence Techniques used for ALNPR System

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Abstract. For transport planning and engineering systems, the Automated Licensed Number plate Recognition (ALNPR) can provide a valuable data source. From the different survey points the multiple tasks can be handled by ALNPR systems. The captured image of the vehicle licensed number plate, the registration number plate location and recognition can be analyzed by the Automated Licensed Number Plates based system. The parameters of the ALNPR systems are affected by the different problems observed while implementing this system by using techniques which are used for number plate detection and character recognition. The detection from the deviation between crossing vehicle and original vehicle number plate was examined. The detection rate cannot be emphasized because it depends on the variable factors like intensity and angle of the sun, low illumination situations, speed of vehicle, deformed or dirty number plates and shading on the characters of the number plate. The performance of the system can also be affected by detection rate of controllable factors like resolution of the camera, camera angle related to horizon, distance between the number plate and camera. Although by passing through all these problems, the authors gave the innovative criteria for the license plate recognition based on neural network, Fuzzy logic, Fourier transform, Genetic algorithms and wavelet theory.

Keywords: Automated Licensed number plate recognition(ALNPR), Character extraction of license plate, License plate localization, median filter, Image Correlation, image recognition, template matching, License number plate identification, RBF Neural Network, wavelet transforms, Ant colony algorithm.

1. Introduction

Researchers have used various image processing techniques by using MATLAB. The ALNPR systems can be used for different applications such as vehicle classification, travel time measurements, through traffic surveys, route choice observations etc. For operators of urban roads or motorways a permanent installation would significantly improve the traffic state and incident detection. This can be used to inform the drivers and to optimize traffic control systems. At the same time the systems would provide valuable information on travel patterns. This system could be implemented in surveillance systems, detection of stolen vehicles and checking of vehicles at toll plazas, posts, barriers and other entry points.

In recognisition of ALNP, the image is captured by high quality camera which is to be suitable for image processing using user system interface. Then the image sampling of captured image having coordinates $f(x, y)$ must be done by digitalization of the spatial coordinates (x, y). The gray-level quantization of image is done by using amplitude digitization. Then preprocessing of the captured image is done to improve the image in ways like size conversion, gray processing and removal of noise by using median filters. By using the number plate region extraction the input data converted to a form suitable for user system interface

processing and features are extracted results in some quantitative information of interest. Segmentation of character in the extracted number plate can be done horizontally, vertically or by more difficult method like neural network [17]. Character recognition is to assign a label to an object based on the information provided by its descriptors. For the character recognisition various techniques like OCR

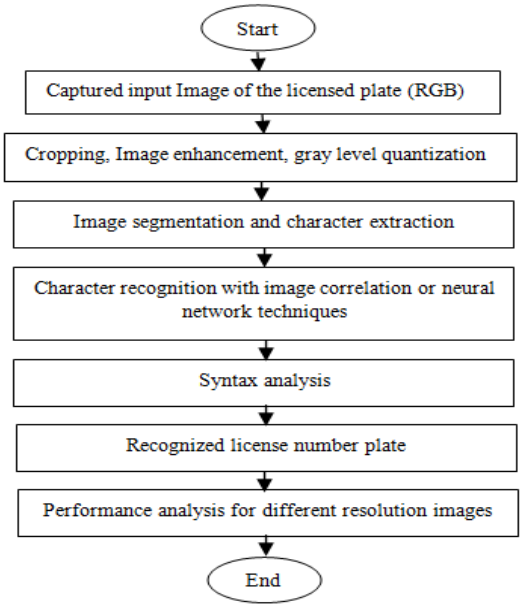

Fig. 1 : Flow chart of basic ALNPR system

and template matching method to match the individual characters obtained from the observed image. The basic ALNPR system plate processed through the different steps as shown in the flow chart fig. 1.

2. Artificial Intelligent Techniques used for ALNPR system

With some block characters to detect a license plate [3]. For rapid detection the tiling histogram algorithm or morphological function is very effective infrared camera images [4]. Morphological algorithms give excellent performance in infrared photos, although not in normal color images. Neural networks based artificial intelligence methods used for detection of license plate location. The image surface was blurred as well as swept via a dynamic window while the licensed plate location was detected by using the neural network [5], [6]. There is another method which is used to detect the number plate location is known as Template matching. When the licensed plate's exact image, characters and signatures are used as the template, then the performance of template matching method is very low because it becomes highly static [7], [8], [9]. There are other methods and algorithms used to detect the location of that use plate signature [10], fuzzy logic [11], [12], [13], geometric parameters and window movement [14], [15]. When the license plate is close to camera, the Morphological functions also gave acceptable results. From the literature, it is clear that mostly hybrid methods were used to achieve more accurate and faster license plate detection.
In Template-matching algorithm, the entire image surface is swept to find the object via a template or its description [8], [16]. A template-matching system is neither flexible nor expandable enough to process the images of any size [8]. The colored image of license plate is converted into gray level but the conversion in black and white or binary level is not necessary. In image processing, the detection of an object within its image is always difficult [8]. In template-matching methods an image swept pixel by pixel or window by

window. For comparing a template with a part of the image convolution is used. The candidate for matching takes the part with the lowest error rate. A heavy overhead on the system is imposing by the whole process [16]. Therefore, it is necessary to find a scale and rotation invariant approach that can sweep the entire image surface at high speed.

In 2004, S.L. Chang et al. presented a automated license plate recognition system which could also worked under the variable illumination situations, variable speed of vehicle, non-stationary backgrounds and non-designated routes [11]. By considering some possible environmental conditions, this system was implemented by using fuzzy logic and neural network techniques. This paper suggested the supervised neural network techniques to minimize the complexity of the system. The observed location rate of license plate was 97.6% and character identification rate was 95.6%.

In 2007, C. C. Lin et al. proposed an algorithm for the location of number plate with Vertical Median Filter and character recognition by using Template Matching [18]. In the gray level image, the edge color information was used to separate the extracted edge points. To de-interlace the input image, the vertical median filter was used. For the detection of the number plates, canny edge detection filter was used. The license plate edges were located by using the histogram approach. Author was tested the 368 images in two hours test by using this approach, out of which 11 images were not located by the system. The calculated success rate of license plate location was 97%.

In 2008, F. Wang et al. proposed a fuzzy logic based algorithm for recognition of colored licensed number plates by considering the challenges such as appearance of the color plate affected by illumination, camera characteristics [12]. The accuracy and adaptability of this system was improved by using fuzzy logic in the hue, saturation, value color space and learning algorithm used for integration. Fuzzy sets were used to map the hue, saturation and value space by using membership functions. For different combination of colors like blue/black and yellow/white, different membership functions was established for hue, saturation and value. The degrees of these membership functions gave the color information of licensed number plate. The performance parameters accuracy and recognition time were evaluated by using FCRA, FISHER, CM and Vhsv learning algorithms and compared with Bayesian, V1 and V2 algorithms. For the comparison three test sets named as Shanghai, Shenzhen and Beijing based on different colored license plate classes were considered. The DSP based license plate recognition system used to check the performance of the purposed algorithms.

In 2008, C. N. E. Anagnostopoulos et al. presented a paper which consists of literature survey of various techniques and methods used for automated license plate region extraction, plate character segmentation and character recognition for video and still images [19]. The methods used for the various techniques were compared on the basis of their performance parameters like accuracy and recognition time. As a result, it had been declared that neural network, fuzzy logic and GA based techniques were more effective in the ALNPR system.

In 2009, V. Abolghasemi et al. proposed the methods for image enhancement and license plate detection [20]. In this paper, for image enhancement Edge Density method was used because intensity invariance method for image enhancement did not improve the quality of the image. For edge density enhancement method, Bilinear Interpolation algorithm was used to decrease the computational complexity. The filter based on Gaussian functions filtered out the information in form of plate edges even in very dark nights or foggy weather, because it was used very low threshold for detection and it gave the plate's vertical edge density information. The MNS (multimodal neighborhood signature) method was used to characterize the color information in plate. The observation of experimental result confirmed the proposed system was well performed in severe weather or atmospheric conditions, but it was very complex system for colored plate detection.

In 2010, M. J. Ghasemi et al. proposed Iranian national number plate recognition system in which Neural Network and Fuzzy Logic techniques were used for recognition [21]. In this work, for the plate segmentation the fuzzy logic was used and for the character recognition, a hybrid technique using Multi Layered Perceptron Neural Network (MLPNN) and direct torque control Neural Network (DTCNN) was used. The

performance of the system was calculated on the basis of recognition rate, error produced and the rejection rate. Research results shows the accuracy of the system was 97% to identify the automated licensed number plate.

In 2011, K. Yilmaz et al. presented a new hybrid technique for the recognition of the license plate in which character classification was done by using Image correlation and Learning Vector Quantization Neural Network (LVQNN) [22]. The Blob Extraction and Image Binarization techniques were used for the licensed plate recognition. To find the characters of license plate number, this hybrid system used morphological image processing methods complemented by the novel algorithm. When image correlation is insufficient in case of noisy images, LVQNN performs better to produce good results.

In 2014, A. H. Asthari et al. proposed a new approach on a modified Template-matching technique for the Iranian vehicle license plate recognition System characters by using hybrid classifier [23]. This method was improves the detection response time because of the minimization of the rotation and scale dependent time consuming algorithms. The observed number plate detection rate of the system was 96% and performance of the overall system was 94%.

In 2014, J. Sharma et al. proposed a new hybrid technique in which Wavelet Transform used for Decomposition of image and Radial Basis Function Neural Network (RBFNN) used for recognition of license plate [24]. The proposed method work contained pre-processing the Number Plate and Character Recognition of Number Plate. The Optimized Feature Selection process improved the detection ratio and Neural Network improved the recognition time of number plate recognition system.

In 2014, M.U.M. Bhutta et al. presented a rapid intelligent method based on the correlation Optical Character Recognition (OCR) and multiple layered perceptron neural networks (MLPNN) models for the recognition of Pakistani vehicles licensed plates with combination of colored regions [25]. It was robust real time feature based algorithm for the different font style and colored license plate localization as well as recognition. To detect white regions of the enhanced image, optimal threshold was applied. The performance analysis of system was measured by the time required for localization and recognition using proposed algorithms. For OCR based system, the overall performance time was 2.44 and for MLPNN based system, it was 2.74.

In 2015, S. Dewan et al. presented a image edge detection based on the number plate extraction method by using Ant colony optimization (ACO) technique [26]. This technique processed by pheromone matrix which was generated by the movement of the ant spices. This technique performs better for extraction of the number plate from the captured image. The final vehicle license number was recognized by a character recognition model. 30 experiments were performed by using the proposed technique based system to check the performance of the system and 92.6 % performance rate was observed.

3. Performance comparison

Table 1 describes the performance analysis of various Artificial Intelligence techniques used for ALNPR

Table: 1 Performance comparison of different techniques

S. No.	Authors	Size of image (Pixels)	Techniques used			Performance parameters		
			Plate Recognition	Image enhancement	Character recognition	Recognition time	Computation time	System performance (%)
1.	S.L. Chang et al.	640X480 768X512	Fuzzy logic	---------	Neural network	----------	---------	98.8% 96.7% Overall: 97.7%
2.	C. C. Lin et al.	720X480	Vertical median filter	---------	Template matching	----------	---------	97%

3.	F. Wang et al.	Shanghai (720X576) Shenzhen (768X576) Beijing (768X576)	Fuzzy Color Recognition Algorithm (FCRA)	---------	Vehicle's hue, saturation and value (Vhsv)	975.2(ms) 1136(ms) 1135(ms)	---------	95.83% 94.65% 93.27%
4.	V.Abolghasemi et al.	640X480	--------	Bilinear interpolation algorithm	MNS method	---------	1.1(s)	96.6%
5.	M. J. Ghasemi et al.	640X480	Fuzzy logic		MLP and DTCNN	---------	---------	97%
6.	K. Yilmaz et al.	2592X1944	Blob extraction and image binarization	----------	Image correlation and LVQNN	----------	----------	96.64%
7.	A. H. Asthari et al.	M X N size image segmented into 6X4 tiles	Modified template matching technique	----------	SVM and Decision tree	0.25(s)	0.75(s)	94.4%
8.	J. Sharma et al	M X N size image	Wavelet Transform and RBFNN	---------	Neural Network	0.673	---------	97.86%
9.	M.U.M. Bhutta et al.	Different style vehicle images	Correlation OCR MLPNN	---------	Segmentation algorithm	0.21 0.51	---------	85% 98%
10.	S. Dewan et al.	M1 X M2 size image	Ant colony algorithm	---------	Neural network	---------	---------	92.6%

(Automated licensed number plate recognition) system based on the performance parameters like recognition time, computation time and percentage detection of number plates. Different techniques were used for plate recognition and the resultant image processed through the character recognition process. Then overall accuracy of the system was calculated on the real test images of different styles, dimensions or segments.

4. Conclusion

Researchers were worked on different advance techniques which were used for the detection of plate regions and also proposed some advanced techniques for the detection algorithms to minimize its computation cost. A number of texture based approaches and machine learning methods were also combine to evaluate plate candidates of the ALNP. They believed that the speed and accuracy of these algorithms could improved by these approaches. From literature it is clear that neural network gives the better results for noisy images and for noiseless images image correlation performs better than neural network. The neural network based techniques recognize the image fast and fuzzy logic based techniques produced more accurate output as compared to conventional techniques.

5. Future scope

Various literatures elaborates the various Artificial Intelligence techniques used for the automated licensed number plate recognition but research work on Indian licensed number plate recognition did not found because the Indian number plates have not any particular standard format. For unsuccessful localized number plate, the plate recognition failed because the size of the image increased by the computational time. To overcome the limitations of conventional methods, there is need to do more research in this field which performs the recognition of the ALNPR with different formats. In future, ALPNR systems can also be designed by using hybrid techniques using fuzzy logic and neural network based genetic algorithms, neural network and BFO or some advanced transforms of DSP which reduces the recognition time, computation time and increase the overall efficiency of the system.

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