Efficient Recognition of Non-standard Car Number Plates Using Hybrid Approach

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***Abstract*— Car number plate recognition systems are employed to automate surveillance, access control, vehicle abuse prevention, help law enforcement agencies etc. The development history of license plate recognition systems dates back to 1976 and the first arrest of a stolen car through detection was made in 1981 in UK. These systems work well in the first world countries where car plates are standardized by law. There are many countries without any strict law for plate formats and no generic number plate recognition system exists that solves the localization and number plate recognition for all multi font, multi colored plates. This paper introduces a comprehensive method for the recognition of generic car number plates. Many researchers in the past have tried to address this issue but most of them either focused on specific formats or limited their research to specific color license plates. The Proposed system in this paper adopts a hybrid approach for the localization and recognition of car number plate. The composite approach allows the proposed system to be more adaptive and robust in various conditions without losing the accuracy especially in the localization module. The Recognition of license plates is carried out through different classifiers in order to enhance the overall efficiency and precision of the system. In contrast to other techniques, this system is not only more effective and reliable but also operates accurately and efficiently even under poor illumination and low resolution images.**

Keywords-component; Number Plate Recognition and localization, MSER, Shape Analysis, Aspect Ratio, character recognition.

I. INTRODUCTION

To maintain law and order in the prevalent security conscious environment in the third world countries like Pakistan, automated vehicle monitoring has cropped up as a significant challenge. Number of techniques have been proposed during the years to overcome this problem however these methods are either computationally expensive or carries inadequate efficiency and accuracy. Besides, there are also certain limitations which include illumination conditions, camera resolution, and distance of the object from camera and above all there are different format/standards of number plates. Automatic License Plate Recognition System can be utilized for multiple applications like border crossing, vehicle monitoring, and prevention of vehicle abuse and access control.

Figure 1: Examples of lack of format for Pakistani car # plates

In the recent past certain approaches have been adopted to address this issue but to generalize an algorithm is a very difficult task for example in Pakistan people come up with different colors and different signature number plates (Figure 1) this makes it seemingly impossible to make a generic algorithm for localization and recognition but lately some authors have addressed this issue as Donosar et al [1] introduced a novel real-time framework which can detect, track and recognize a car number plate in a video sequence .They proposed an algorithm based on the analysis of MSER(Maximally Stable Extremal region)which was introduced in Donosar et al[2]. Shapiro et al[3]in their paper proposed a complete Number Plate Recognition System. The localization stage yields a plate clip followed by character segmentation and recognition .In their recognition module two algorithms were combined (adaptive iterative thresholding with a template-matching algorithm) however their system worked best for Israel and Bulgarian number plates only. Adaboost learning techniques have also been used for example by Zhang et al[4] but experiments have shown that these techniques are relatively slow as compare to other techniques such as edge based methods. In the work of Jia et al[5] images were segmented through mean shift algorithm and were subsequently classified as plate or not, but this algorithm could not work Internationally since most of the countries have their own standard formats. Color edge and fuzzy logics have also been used as by Chang et al[6] but these techniques could only work on specific color number plates. Ryung et al[7] used color histogram it worked well under good lighting conditions but failed under diverse lighting conditions.

Recently research done on Automatic Number Plate Recognition System generally focused on specific number plates as Ali et al[8] their research work suggested an intelligent algorithm for recognizing Pakistani number plates only. Duc et al[9] used Hough transform for the localization of

number plates but this algorithm worked well only if the car color and license plate color are different. All these factors add up which makes the standing problem i-e a common algorithm for different number plates throughout the world all the more challenging and complex.

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II. PROPOSED FRAMEWORK

This section elaborates the proposed methodology for localization and recognition of number plates as in figure 2. The main contribution of this paper is that a Hybrid technique has been proposed for number plate localization and then recognition of its contents. Accuracy of recognition module is directly correlated with the accuracy of number plate localization module. The proposed system involves three steps to detect number plate. First different threshold levels are applied to a grey scale image and then regions that remain stable for at least 30 consecutive threshold levels are taken into account as initial candidates for number plates. In the Second phase filtering based on "width to height ratio" is applied which gets rid of many unwanted objects. At last the edge data of the remaining objects are evaluated and checked, only those which qualify to be a quadrilateral are sustained while others are discarded, this will ensure that only number plate region is segmented out. The benefit of this algorithm is that it can be widely used since it looks for quite a generic breed of possible number plate shapes.

The recognition is done through four steps. First to eliminate shadows, reflections or non-uniform illumination changes on the number plate the image obtained after localization is passed through adaptive thresholding, different threshold levels for different regions of the image are adaptively calculated. Secondly the image is converted into binary using the previously computed regional thresholds, morphological operations are done to eliminate noise and fill in tiny gaps and connected component analysis is performed to extract the individual digits. In the third step text and lines are found in the image and lastly recognition is done through character adaptive character classifier and static character classifier.

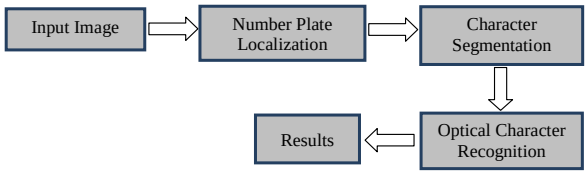


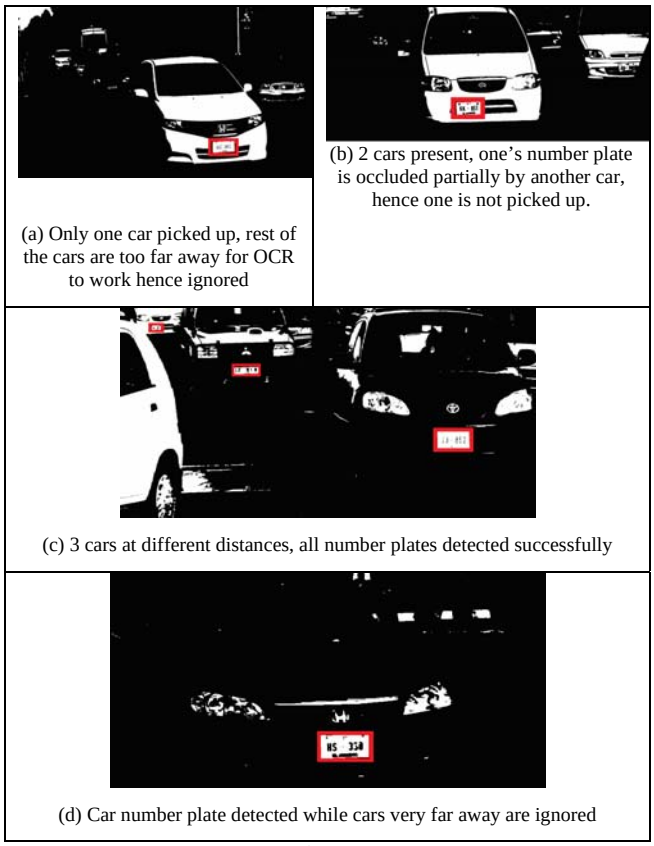
Figure 2: Simple Block Diagram of Proposed Methodology

A. *Number Plate Localization*

License plate localization was done in three steps. In the first step a range of different threshold levels were applied as inspired by [2,10] to grey level input image. Initially the threshold level were ranging from 0 up to 255 but experiments showed that regions starts to stay stable after the 80th threshold level and remain stable till 220 so 115 initial and final iterations were removed which made the proposed system more quick and robust. The second improvement in the efficiency was achieved by reducing images to be analyzed in size (Image pyramids) and then applying the threshold ranges on an image of 1/4th to 1/8th of the original size. Objects that did not change their shape drastically or merge into other objects for 30 consecutive threshold levels were categorized as stable regions.

Secondly filtering based on width to height ratio also known as aspect ratio filtering was implemented , license plates have certain width to height ratios therefore applying aspect ratio filtering enabled the removal of many unwanted objects, we test a width to height ratio between 4:3 to 20:5 as un-standardized number plates have all sorts of dimensions and sizes.

Lastly an analysis on the basis of geometrical shape is performed only those regions were sustained which qualify to be a quadrilateral were labeled as car number plates.



(a) Only one car picked up, rest of the cars are too far away for OCR to work hence ignored

(b) 2 cars present, one's number plate is occluded partially by another car, hence one is not picked up.

(c) 3 cars at different distances, all number plates detected successfully

(d) Car number plate detected while cars very far away are ignored

Figure 3: Results of car number plate localization

B. *Number Plate Recognition*

The final step of our proposed methodology is to recognize individual characters on localized license plates. Recognition is done through four steps . In the first step of recognition

process we apply adaptive thresholding to a grey scale image to get binary image, adaptive thresholding removes the effects of shadows and reflections to some extent. Secondly morphological operators are applied to remove any noise in between character boundaries which may result in false recognition. In the third step after segmentation using connected components we apply static character classifier which uses outline fragments as features .Broken characters are easily recognized by small to large matching process in classifier. In the last phase Adaptive character classifier just like static character classifier uses training samples but addition to training samples it also uses classified samples. Adaptive character classifier works similar to static character classifier apart from normalization method at the end of this module characters are recognized and assembled on basis of their original occurrence in the license plate.

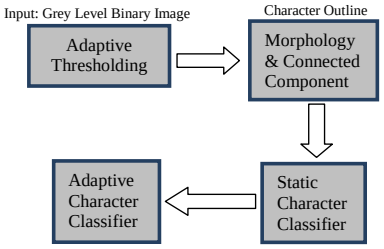


Figure 4 : Flow chart Recognition Process

The complete system working is given in the following diagram

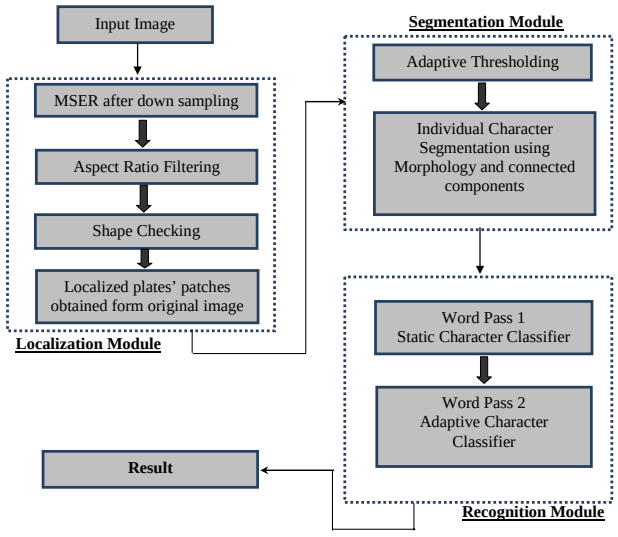


Figure 5: Complete Flow chart of Proposed System

III. RESULTS

In order to evaluate the robustness and efficiency the proposed system was tested on number plates of 121 Pakistani cars passing in video sequences. Even with the poor lightening conditions and with image resolution was as low as (200x189) the proposed system accurately localized the number plate and results were compared in Table 1.

The proposed system worked more robustly and efficiently as compared to other techniques such as Donosar [1], in case of un-structured pakistani number plates. These localization results were even further improved as compared to other techniques when the resolution of the image was low, but due to the low details in the image the recognition was not as accurate. Hence the localization part was very robust to illumination changes. Under good resolution (above 5 mega pixels) the overall accuracy of the proposed system was around 91.78% as given in figure 6.

Method	**Localization Time (seconds)**	**Recognition Time (seconds)**
Window Edge Search	0.18 s	-
Donosar et al[1]	0.070 s	0.006 s
Rastegar et al [2]	2.3 s	0.4 s
Saquib et al[12]	0.025 s	0.0045 s
Direction sensitive edge search	2.37 s	-
ATH versions + search (fine localization)	0.06s	-
Our proposed method (Hybrid Approach)	0.020 s	0.0045s

Table 1: Comparison of processing costs of the proposed technique with others. All experiments were done on a standard Intel core i-3 processor with 4GB ram

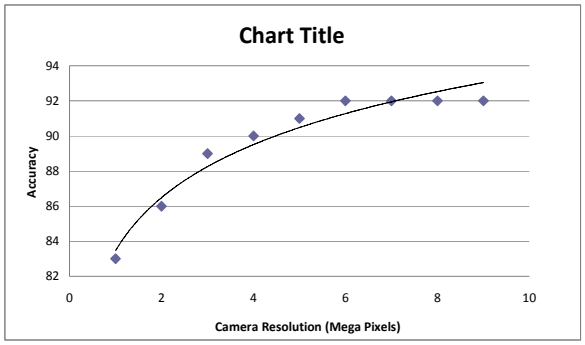


Figure 6: Graph showing an increasing detection rate with increase in resolution, but its non linear and almost no improvements are seen after certain higher resolutions.

IV. CONCLUSION

Proposed paper introduced a novel framework which utilizes a Hybrid Approach to localize and recognize car number plate. License Plate localization is handled through a hybrid algorithm which is robust, efficient, works under low resolutions and illumination conditions and can be used in

number of other surveillance applications such as toll collection, prevention of vehicle abuse and access control. Experiments have shown that number plate recognition through adaptive character classifier and static character classifier improves the overall efficiency of the recognition portion. The proposed algorithm also addressed the issue of varying lightening condition, low resolution cameras and worked efficiently under these circumstances and overall time of the proposed system is 0.0245 seconds with 91.78% accuracy. The experimental evaluation on a challenging dataset revealed encouraging and promising results, The localization part can work with any efficient character recognition algorithm so we intend to experiment with different character recognition algorithms to include multi language support including Arabic, and Urdu fonts as well in the future.

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