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A Parallel Computing Model for Segmentation of Vehicle Number Plate through Watershed and Visualization Technique

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ABSTRACT

This paper presents an integration of a series of sequential and parallel computations for vehicle number plate segmentation from vehicle image based on watershed and visualization techniques. The work is modeled into five stages. In the first stage a sequential computation is performed to make an initial segmentation through computing gradient magnitude, applying watershed transformation and reconstruction of image using morphological operations. In the second stage regional maxima and watershed ridge lines are obtained in parallel. The third stage performs sequential computation from the outputs of the second stage by applying watershed transformation to obtain markers and objects in image. The fourth stage extracts required features and identify probable candidate regions in parallel. The fifth stage takes the outputs of the fourth stage and segments the number plate from the image using visualization technique. The result of the proposed model is compared with the results obtained from the sequential model for analysis. The experimental results show computational performance is relatively 1.6 times faster than the sequential model on similar machines.

KEYWORDS - *Parallel Computing; Regional Maxima, Morphological operations, Sequential computation, Visualization*

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I. INTRODUCTION

The Intelligent Transportation Systems has impact on human life in terms of improving the safety and mobility. In the existing environment, it is necessary to incorporate new ideas and technologies. The intelligent transportation system require vehicle number plate recognition as an important role in traffic surveillance systems, such as traffic law enforcement, real time monitoring, parking systems, road monitoring and security systems [1]. Many researchers have suggested good number of techniques [2] in the above application domain. The task of recognizing specific object in an image is one of the most difficult and challenging issue in computer vision and digital image. processing. Recognizing the number plate of a vehicle from a natural image is one particular application case. The vehicle number plate detection is widely used for detecting speeding cars, security control in restricted areas, unattended parking zone, traffic law enforcement and electronic toll collection. Last few years have seen a continued increase in the need for the use of vehicle number plate recognition. Though good number of researchers have worked on this problem, still many issues are not addressed especially for generic solution. The number plate recognition system has plenty of challenging avenues for research because of its complexities like poor illumination, varied weather condition, dust, occlusion etc.

Major phase in traffic control system is to segment the vehicle number plate specifically. In this regard we require a fast, accurate and automatic segmentation method to analyze the vehicle number plate images. In case of image processing techniques, it is typically to have a trade off between complexity, robustness, automation and speed. Fast segmentation methods are often not sufficiently robust or require large amounts of user interaction. In image processing systems, the segmentation process is considered to be a time consuming operation. Related to this problem many authors extensively proposed sequential algorithms [3] along with supporting hardware to minimize the problem. But real time applications such as surveillance and navigation, the sequential algorithms are not suitable to get quick and good accuracy in segmentation process. Very limited literature is available on parallel and distributed image processing for vehicle number plate recognition system compared to other applications. The focus of research using parallel algorithms in the image processing is the new way to solve image processing problems that needs large processing time or handling large amount of information especially in real time applications [4-5]. This motivated us to extend parallel computing in traffic surveillance system, to achieve better computational efficiency.

In parallel processing, a program is able to create multiple tasks that work together to solve the problem [6]. The main idea of parallel image processing is to divide the problem into simple tasks and solve them concurrently, this way the total time is divided between the total tasks. In the application of number plate recognition system using parallel and distributed computing reduces the computational time and gives result relatively faster. Many researchers have proposed general purpose algorithms for localization of vehicle number plate segmentation [7]. The proposed model is based on watershed algorithm and visual technique that incorporates parallel computation technique. The proposed work is implemented using two parallel processing methods: task parallel and data parallel. The performance of the two methods are evaluated to study the superiority of segmentation.

II. LITERATURE SURVEY

In the literature, different approaches are proposed to segment vehicle number plate image. These approaches are classified as color based [8], fuzzy logic based [9], generic programming [10] and neural network [11]. In color based methods [12-16] it is quite difficult task to achieve success in color segmentation, though it gives good segmentation solutions and high degree of accuracy for natural scene as color. These methods fail for unstable lighting conditions. Since these methods are generally color based, they fail at detecting various number plates with varying colors. An enhanced color texture-based method for detecting vehicle number plate images was presented in [17]. The system analyzes the color and textural properties of vehicle number plate using a Support Vector Machine (SVM) and locates their bounding boxes by applying a Continuous Adaptive Mean Shift (CAMShift) algorithm. The combination of CAMShift and SVMs resulted efficient number plate detection but are time consuming. The time consuming texture analysis is presented in [18] gives execution time unacceptable for number plate recognition. A method for number plate segmentation based on the Gabor Transform is presented in [19] shows 98% for digital image acquired strictly in a fixed and specified angle.

Some researchers have explored parallelization of clustering techniques to achieve fast execution in different application area of image processing. Several implementations of a parallel K-Means clustering [20-23] have been analyzed and have achieved faster results. Another method is made to exploit algorithmic parallelism of mean shift [24-26] and deterministic annealing [27] on grid computing or Single Instruction and Multiple Data (SIMD) architectures. A fuzzy connectedness approach to perform a segmentation in medical images [28] using OpenMP on a SMP system resulting in a speed up of nearly 50% using four processors. Although many grid or multi-core implementations scale fairly well, they suffer in power, cost, and resource limitation at high speed up factors. For instance, in [29], the speed up factor of several parallelized algorithms is linearly related to the number of processors. On the other hand, K-means and mean shift have been analyzed on GPU architectures. We could not find much work in progress about parallelization on number plate segmentation for better performance of traffic control system.

The rest of the paper is as follows, Section 3 gives proposed model that enlighten the two parallel processing methods applied to sequential watershed algorithm and visualization technique for localization of vehicle number plate image. In section 4 experimental results are discussed and section 5 draws conclusion on the work.

III. PROPOSED MODEL

The proposed work is the extension of the work proposed by Veena M.N *et al* [30]. The work proposed in [30] is remodelled by parallelizing the computation where ever it is possible and required to get better computational efficiency. The reworked parallel model for vehicle number plate segmentation is shown in Fig1

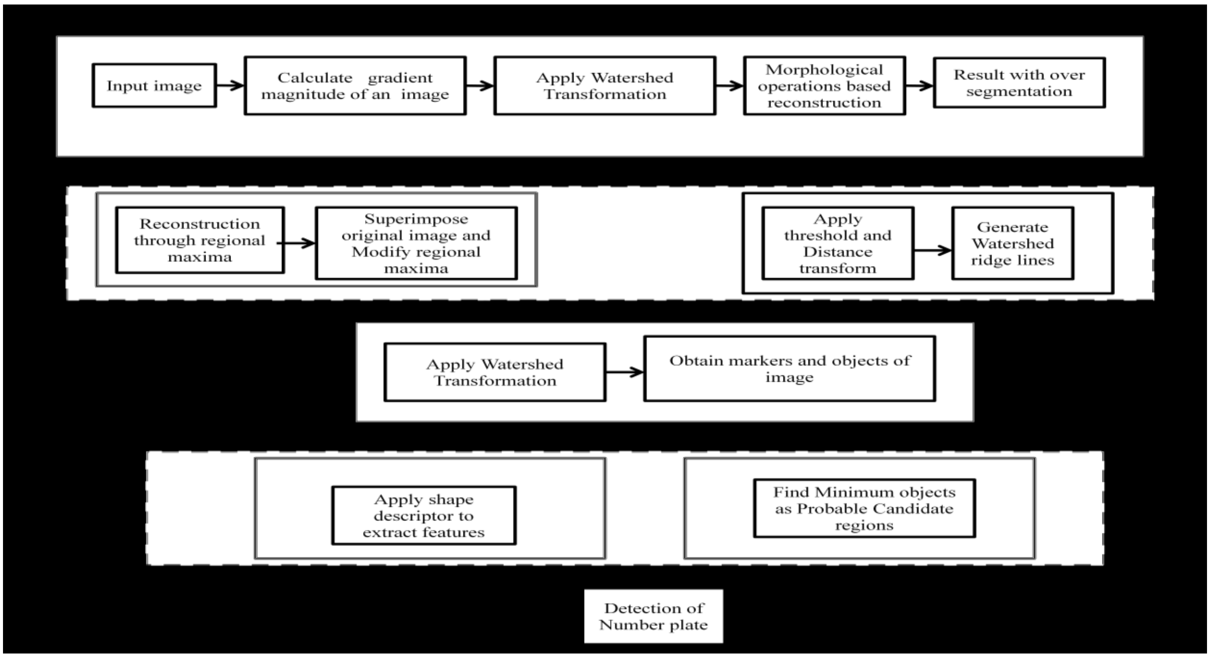


Fig.1. Parallel Model for Vehicle Number Plate Segmentation

The proposed model takes image of vehicle containing the number plate as input. The input image is assumed to be free from noise and image intensity is adjusted to preserve the information through median filter and converted to gray scale. First a sequential process is carried to compute, the gradient magnitude of the image. Normally, the gradient is high at the borders of the object and relatively less inside the objects. When watershed algorithm is applied on the gradient magnitude of the image, segmentation of objects in image gets structured and in majority of cases it results in over segmentation. These activities are done sequentially and the same is illustrated in the first block of Fig.1.

Next, activities are executed in parallel by functional decomposition, one to reduce distortions in resulted segmentation through effective morphological opening and closing operations, without affecting the overall shapes of the objects in the image. Regional maxima [31] are determined for each region to obtain foreground markers to improve the segmentation. The effective morphological operations on over segmented region have the background markers which are very close to the edges of the objects in the reconstructed image are eliminated through thresholding. The second task is consider by applying the distance transformation [32] to obtained from the resulting image to split the regions with several sub regions connected through small line or bunch of pixels. This process fades out the edges and foregrounds by preserving the region centres. Combining the resulting image with the result of watershed algorithm generates the watershed ridge lines. The reconstructed image from regional maxima is superimposed on original image to reestimate regional maxima for better segmentation. Next, the image with watershed ridge lines, modified regional maxima along with initial gradient magnitude are considered to calculate modified gradient magnitude.

In the next stage, a sequential process is carried out to find the modified gradient magnitude and is used in watershed transformation to get markers and objects of an image. The resulting image is superimposed on original image to get color watershed label matrix containing objects which are in different shapes. This label matrix used for object extraction in image in next stage.

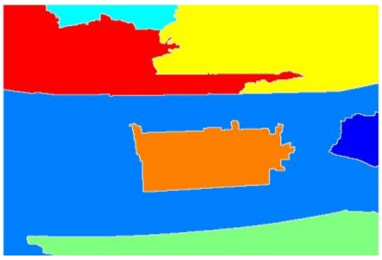
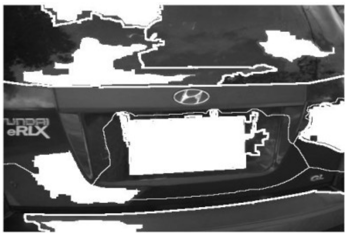
Parallel decomposition is made to perform two tasks in the fourth stage. First task is to find all the identified regions in the resulted image are considered as candidate regions. The probability of plate available in these regions are high. In order to locate number plate in these regions shape descriptors [33] are used to segment the regions. Second task is to extract each regions using object area and perimeter. The results of these parameters are used to find metric that indicates an object. When the metric value tends to be less than one the object is assumed to be rectangular.

Finally the fifth stage, leads to segment the number plate by cropping the object using maximum and minimum area of the object which happen to contain the number plate.

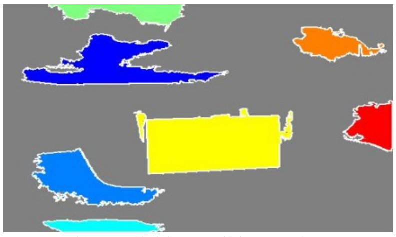
IV. EXPERIMENTAL RESULTS

The Fig.3a through 3i shows the experimental result on real data which segments number plate through various stages.

3a) Input Image 3b) Gradient Magnitude 3c) Watershed transform of gradient magnitude

3e) Watershed ridge lines 3f) Markers and object boundaries superimposed 3g) Colored watershed label matrix superimposed on
on original image original image



3h) Available candidate regions

3i) Detection of Number plate

In order to study and analyze the performance of vehicle number plate segmentation with parallel processing on watershed and visual technique experimentation was conducted with the samples that were used in [30]. On an windows 7 platform having Intel(R) Core(TM) i5-3210 M CPU @2.50 GHz and 6 GB of RAM. Matlab is used as programming tool and Matlabpool enables the parallel language features in MATLAB 2010 language by starting a parallel job that connects MATLAB client with a number of labs. Matlabpool open starts a worker pool using the default parallel configuration with the pool size four.

Experimental results using real time data demonstrate the superiority of the parallel proposed model achieving an average accuracy. The tests have demonstrated the effectiveness of proposed parallel model using boundary and colored features handling real traffic images including noisy, cluttered, snowy, rainy and scenes containing bad illumination conditions. These above conditions are considered in comparison table of sequential and parallel model Table.1 illustrate the average computational time obtained during experimentation for sequential and parallel models. It is evident that computation time for proposed parallel processing, is relatively 1.6 times faster than sequential model.

Table 1. Computation times of sequential and parallel processing for segmentation result of the figure 3

Image Taken	**Time**	**Sequential Model (Time Sec)**	**Parallel Model (Time Sec)**	**Parallel Seed=(Sum of Sequential time)/Parallel Time**	**Efficiency=Parallel Speed/No. of Processor**
Parking Area	Day/Night	2.743	1.766	1.553	0.38831
Road Side Traffic Scene	Day/Night	2.830	1.735	1.63112	0.40778

V. CONCLUSIONS

The proposed work is an implementation of a series of sequential and parallel computations to segment number plate from vehicle images. The parallel computations are integrated in the approach where ever possible to improve the speed for segmentation process. The proposed work shows an average of 39% improvements in computation time. The accuracy of segmentation is same as that of the sequential approach and is more suitable for real time applications. These results allow the exploitation of the vast processing power of current processor with multiple cores. In future, the intension is to use the same with new segmentation and recognition algorithms for vehicle number plate images.

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