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A Video Surveillance System for Speed Detection of Vehicles and Law Enforcement using Automatic Number Plate Recognition

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***Abstract:* — The aim of the research work presented in this paper is to develop a system for speed detection of vehicles and law enforcement using automatic number plate recognition. The image processing has been used for smart traffic surveillance system .Overall work for system comprises of software development and hardware development. Approach uses a single camera system mounted on a pole or traffic light which detects the over speeding vehicle and extracts its number plate. The system works by capturing the video frame of the moving object and by using image processing obtain its differencing image, binary image. Algorithm then proceeds to label all connected components, bounding box and center of image is extracted to calculate its speed. The algorithm is designed to estimate speed of vehicle on linear and circular path. The algorithm also captures the frame of moving vehicle for its record. On speed violation algorithm detects the number plate information using optical character recognition technique.**

***Keywords*— Background subtraction, bounding box, Image Processing, MATLAB, Speed detection, number plate recognition, Optical Character Recognition.**

I. INTRODUCTION

A novel approach of speed detection and automatic number plate recognition is presented here. This concept analyses the speed of vehicle and recognize the number plate of over speeding vehicle using image processing. This approach is also helpful in finding out fraud activities in traffic control systems. Speed monitoring is required for the enforcement of speed laws and to reduce high rate of road accidents. From past evidences it becomes almost clear that driver always blame bad road condition and equipment failure for the cause of road accidents they never blame over speeding as their mistake. To handle such cases it becomes sole responsibility of traffic management systems to impose speed limits. The system requires two components for speed detection – video camera and a process to control the system. The camera is mounted on a pole, physical distance which this camera covers is already measured. The speed of the vehicle is then measured with in the known distance. If the case of over speeding takes place then system recognizes the number plate automatically. Old methods for speed detection techniques includes radar- or laser based devices to measure speed of vehicles such techniques are usually more expensive as compared to passive camera system. Here a single image is captured with vehicle motion and is used for speed measurement as well as for automated number plate recognition. The paper describes the approaches of object detection , object tracking , speed calculation on linear and circular path , capturing image frame, number plate extraction technique - This research uses differencing image concept , background subtraction, labeling, gray scale image and binary image concept, bounding box , dilated and eroded concept and optical character recognition technique. This is easily concluded by using MATLAB. Inexpensive image processing technique is used for this system because it does not require any special hardware. Key features of research work includes the following - Proposed unit is a stationary unit in form of single camera mounted on poles or traffic light or any other suitable location that detects the speed of moving objects , In case of over speeding by vehicles buzzer alarms for intimating interceptor or any other law enforcement unit. LCD display the of moving object , This system focuses on finding speed of vehicles on curved path as well as on linear path ,New algorithm developed can measure speed of more than one vehicle at any point of time ,System also captures the frame of moving object which provides us with snapshot of moving object at a particular instant, Automated Speed detection technique is integrated with law enforcement using automated number plate recognition. While detecting a vehicle crossing speed limit system by using number plate recognition technique displays the number of speed violating vehicle, this system may reduce manpower involvement in traffic management systems. This system when used on commercial scale proves to be a helping hand to traffic police in managing traffic as well as maintain law and order by controlling fraud cases.

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II SYSTEM DESIGN AND RESEARCH

System design is divided into five phases – moving object detection, object tracking, speed calculation, frame extraction, number plate recognition.

A. Object Detection

Hybrid algorithm for detecting moving vehicles is used. The algorithm is based on combination of adaptive background subtraction technique with three-frame differencing algorithm. The combination overcomes the major drawback of using adaptive background subtraction alone. It makes no references for the stationary objects which tends to start moving in the target region. Although when such objects are detected they tend to leave Holes behind where newly exposed background image differs from the existing background model. When the background model adapts to such Holes false alarm is generated for short period of time. It is not an effective method to find entire shape of moving object .To overcome this in this paper we suggest two methods-a) Constructing motion matrix- It construct a matrix that corresponds to the current frame. This step is done to decide what pixels of the object are moving and which pixels are stationary. Here the probability that moving pixel will represent foreground pixel and stationary pixel will represent background pixel is high b) Background subtraction -A three frame differencing is used to construct motion matrix and it is followed by background subtraction. . Let us consider a video stream available from a stationary mounted camera. Let Is*(x,y)* represents the intensity value of pixel position *(x,y)* at any time t=n. According to three differencing rule a pixel is legitimately moving if its intensity is changed significantly between both the current image frame (Is) and the last frame (Is-1) and the current image (Is) and the next-to-last frame (Is-2) significant intensity change at a pixel position (*x,y*).

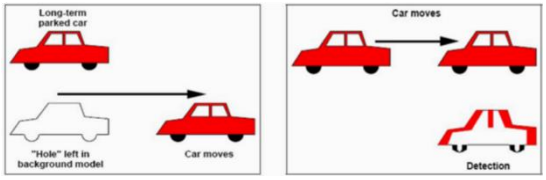

Figure 1: Shows background subtraction leaves hole when stationary object moves and frame differencing does not detect whole object

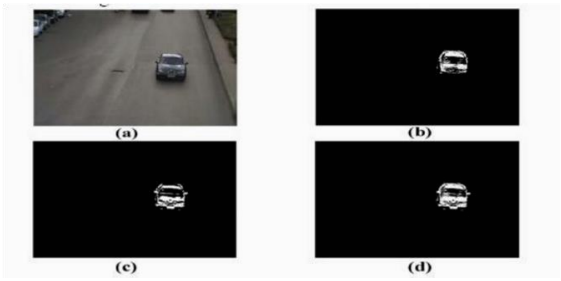

Figure 2: a) Simple image of moving object. b) Foreground image after masked subtraction. c) Foreground image after using two frames differencing. D) Combination of both images.

B. Object Tracking

Moving Object can be traced by using object segmentation, object labeling, and center extraction. a) Object segmentation- it works on connectivity of objects in order to segment foreground image it must be seen that every object is connected as single component. Else segmentation will leads to many several objects. Since there are no connected objects our goal is to detect the area that surrounds the objects. This area can be treated as excellent representation to non-connected moving objects in simple words the operation aims to map the object into a rectangular box representing it. This method comprises of successive iterations and in each iteration there are two main parts- horizontal scanning & vertical scanning. Horizontal scanning initiate from the top left most pixel at the foreground image Fg (0,0) it then scans the foreground image horizontally. In case of no foreground pixel also called white pixel is found it will mark the whole line scanned. The same process is followed by vertical scanning.

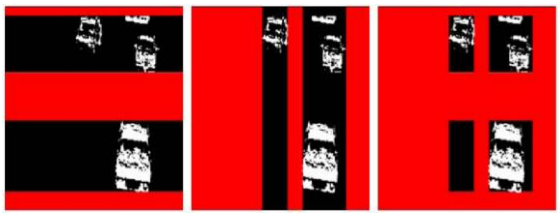

Figure 3: Shows vertical and horizontal scanning

b) Object labeling - To track moving objects labeling becomes as essential process. Object labeling becomes important because each object should be represented by a unique label with a condition that the object must preserve its label without any change. From the moment object enters the scene at frame F_0 that is the starting frame till it leaves the scene at the end frame.

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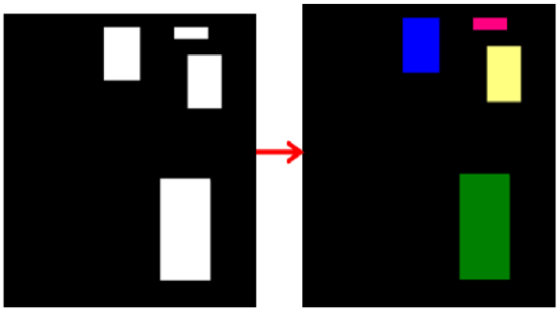


Figure 4: Shows segmentation of objects with labeling

c) center extraction Considering optimization there is no need to track whole object pixel to pixel we just need a descriptive point that represents the object this point is object's center also refers to as centroid it represents the whole object and object can be tracked and mapped easily.

C. Speed Calculation

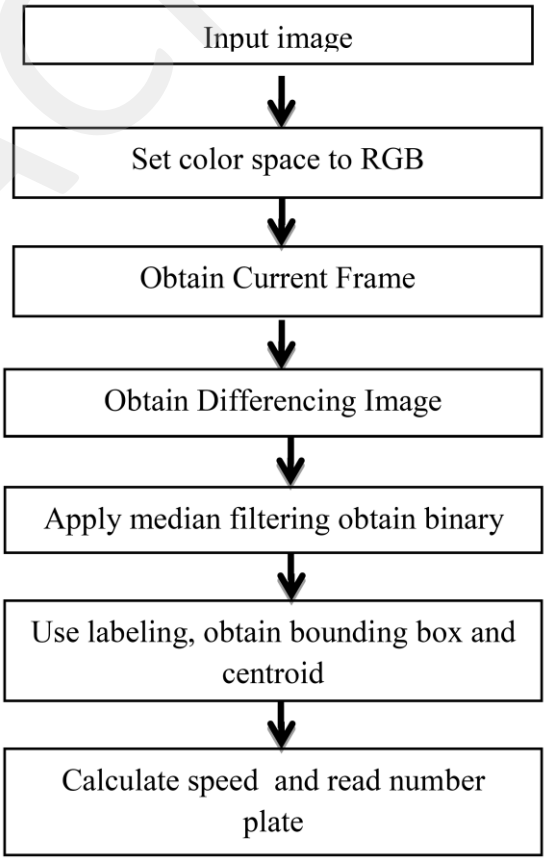
Once all these image processing methods have been applied to moving objects, they become ready to for speed estimated. The speed can be calculated by using various MATLAB functions .In case of over speeding system generates an alarm.

D. Automatic Number Plate Recognition

Automated number plate recognition is unique characteristic of optical character recognition. License plate recognition allows user to read automatically the registration no. of vehicles. LPR is image-processing technique used to identify number of vehicles. This technology has its advantage in various security and traffic applications. LPR units are works on images of the front or rear number plates. The information contained in the image is read by the LPR unit and is analysed automatically. The image given below is taken from the front side of the car is made up of 256 grey levels ranging from black to white. A typical format comprises of 768 X 288 pixels or about 0.2 Million elements. Such large information is processed by the number plate recognition software in order to read number plate automatically.
The computer processor needs to work on entire image for detecting the number plate, zooms into the data to handle the minute details and finally extract the registration number plate. The result of the recognition process is contained in a string.

Figure 5: Shows enhanced number plate image

III. ALGORITHM FOR SPEED CALCULATION



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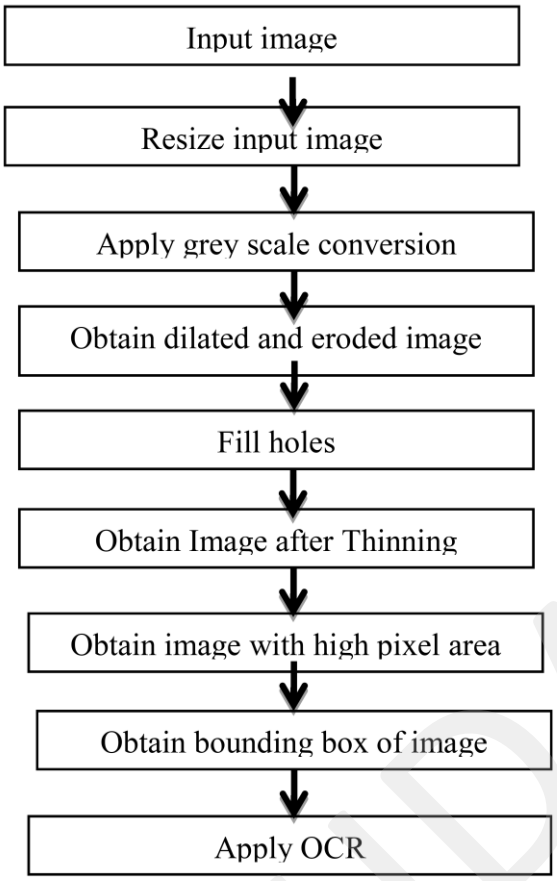
IV. ALGORITHM FOR NUMBER PLATE RECOGNITION



The new algorithm for speed detection focus on determining speed of vehicle on circular and linear track. It uses a single mounted high resolution camera for this purpose. Firstly current frame from video stream is obtained from which differencing image is obtained. For this purpose three frame differencing and masked subtraction technique of image processing is used. Binary image is generated and all connected components are labeled using bounding box method. Out of all labeled objects center of each object is extracted. Using some MATLAB functions speed is calculated at this moment if vehicle is found over speeding the system calls for automatic number plate recognition. Number plate recognition uses OCR technology to read license plate. Algorithm takes input image, resize it and converts to grey scale image after that eroded and dilated images of input image are obtained. After filling holes applying thinning operation high pixel area image is obtained. All these operations used above improves the quality of image and make it ready for further processing. By applying OCR characters from number plate are detected. The system defined here is an integrated system that comprises both speed detection and number plate recognition.

V. RESULT

A. Result for speed detection at linear path

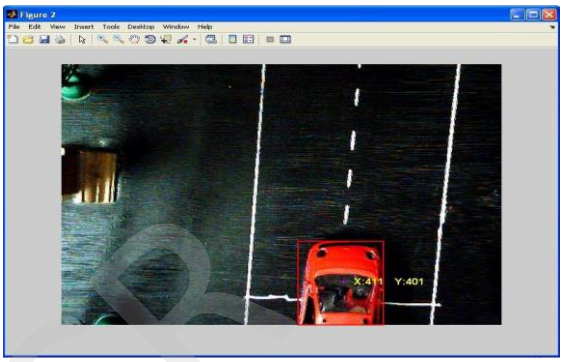


Figure 6: Starting frame coordinate of vehicle

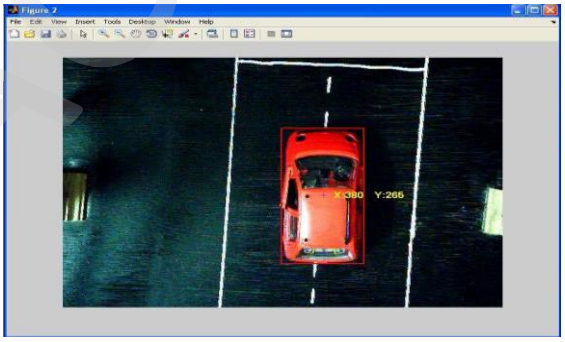


Figure 7: Vehicle tracking by centroid

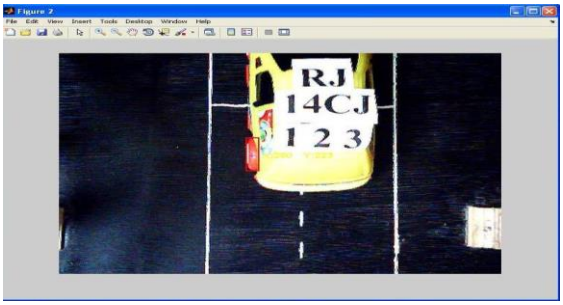


Figure 8: Capturing frame of speed violating vehicle

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B. Speed detection at circular track

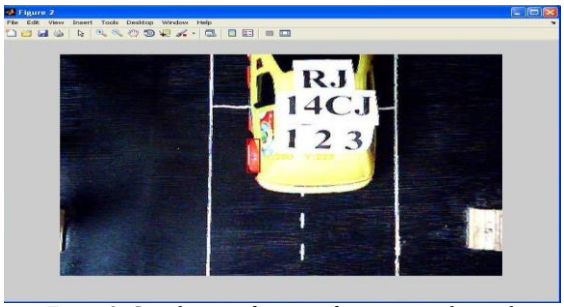

Figure 9: Coordinates of starting frame at circular track

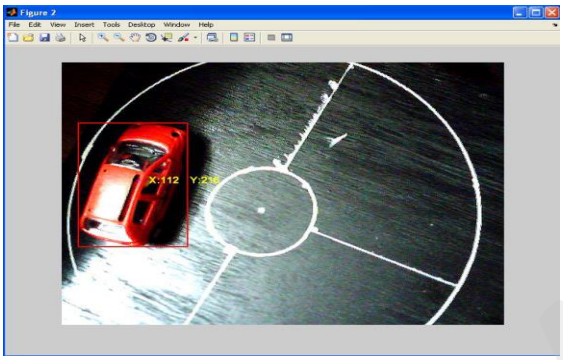

Figure 10: Tacking of vehicle on circular track

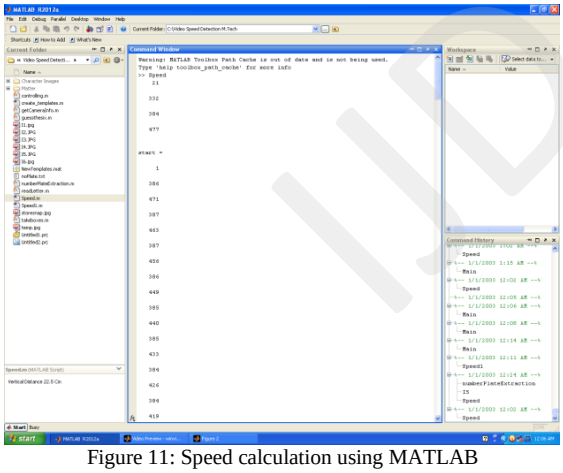

Figure 11: Speed calculation using MATLAB

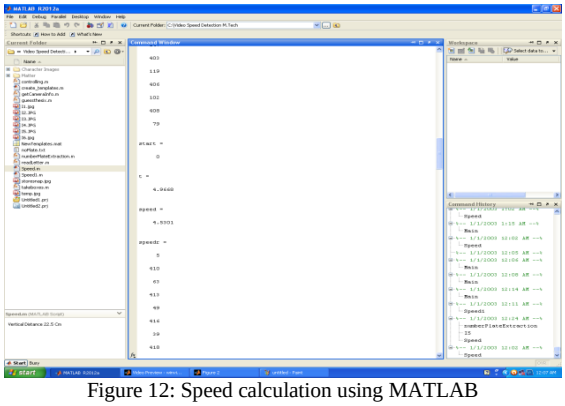

Figure 12: Speed calculation using MATLAB

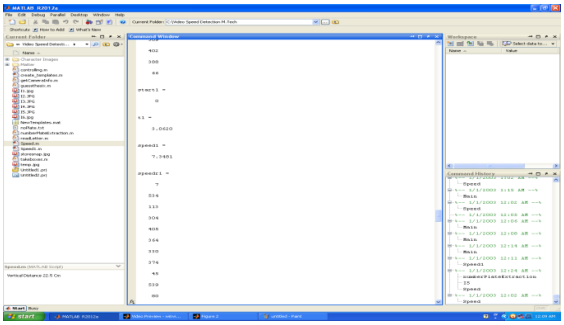

Figure 13: Speed calculation

C. Number Plate Extraction

Figure 14: Input image

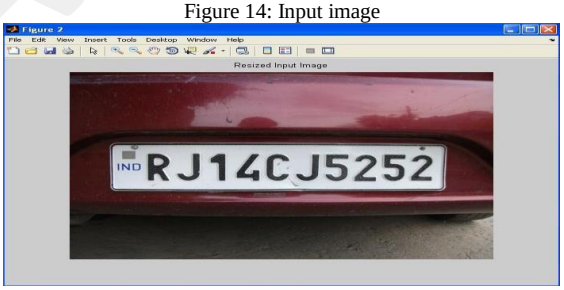

Figure 15: Resized input image

Figure 16: Grey scale image

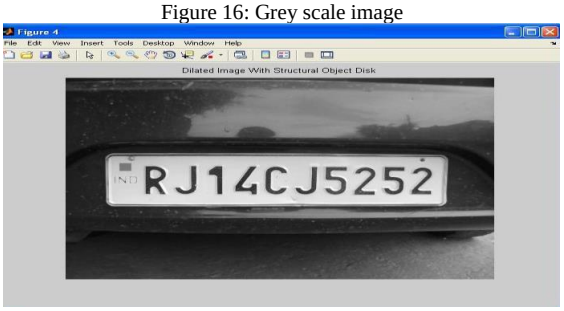

Figure 17: Dilated image with structural object disk

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Figure 18: Eroded image with structural object disk

Figure 19: Morphological gradient

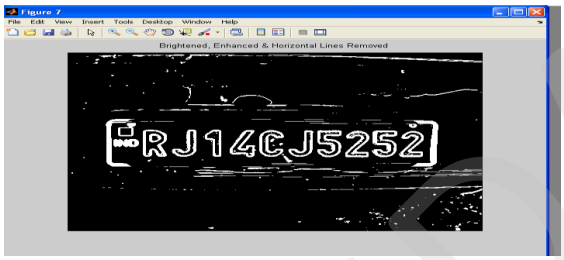

Figure 20: Brighten, enhanced with horizontal lines removed

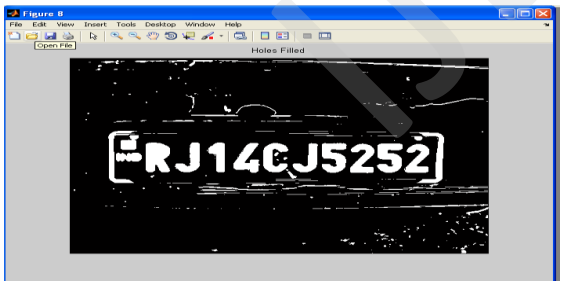

Figure 21: Holes Filled

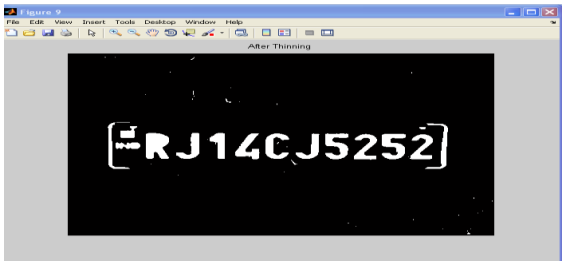

Figure 22: Image after Thinning

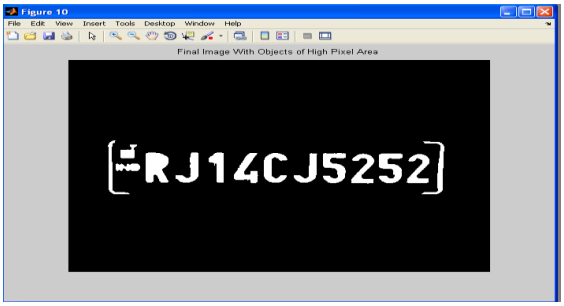

Figure 23: Image with high pixel area

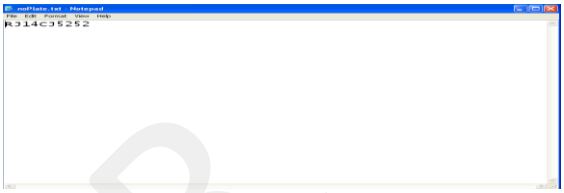

Figure 24: Characters of number plate

VI. CONCLUSION

The research uses various concept of image processing and tools of MATLAB to detect a vehicle under the range of high resolution camera to retrieve its number plate. The use of high resolution camera has overcome traditional sensor based system for speed detection. This research work is outcome of an integrated system that integrates video surveillance system for speed Detection and its law enforcement using automatic number plate recognition. The system detects moving objects on the road , derive its other parameters , label all its connected components which helped in obtaining the centroid of the moving object Finally, the vehicle speed is calculated using various MATLAB functions and is based on the imaging geometry and camera pose of the image . The system works in a fine way for speed determination of local as well as highway traffic. The system uses various techniques of image processing such as background subtraction, binary image formation, grey scale image formation etc. For license plate detection it uses OCR technique. The research work is proven with implementation on hardware set up which makes it a real time solution for commercial traffic control system.

VII. ACKNOWLEDGEMENT

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