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Recognizing The Moving Vehicle While Driving On Indian Roads

Mr.S.Karthiprem [#1]

Assistant Professor Department of IT Vivekanandha College of Engg for Women Tiruchengode, Namakkal Dt karthiprem@gmail.com

Dr.S.Selvarajan [*2]

Principal Muthayammal College of Engineering Rasipuram, Namakkal Dt drselva65@gmail.com

Mr.S.Sankar [*3]

Assistant Professor Department of CSE Jayam College of Engg & Tech, Dharmapuri Dt sankarcsharp@gmail.com

Abstract
The proposed system is a novel approach for moving vehicle speed control. Semi-automated moving vehicle speed control attracts interest of very few researchers. However, it suffers from few considerable limitations like inaccurate prediction of vehicle while overtaking, uncertain environment and sudden change in climate like snow fall, fog and illumination. To overcome these limitations, a novel approach is proposed in this paper. The proposed system gets the input as video sequence and background subtraction is performed to segregate the foreground object with the help of Blob detection using thresholding technique. The foreground object is identified either as 2D or 3D object using Height Breadth Length (HBL) growing algorithm. The speed of the vehicle is controlled if a 3D object is identified as a foreground object by the proposed system else the speed is maintained. The proposed system performance is validated in different situations and better results obtained as well.

Keywords: Two Dimension, three Dimension, Height Breadth Length growing algorithm, thresholding technique

Introduction

Moving vehicle detection is a challenging task using un-calibrated camera. Recently, many of the papers address the problem of vehicle shape reconstruction, vehicle classification and recognition. In video surveillance system, the camera is located statically and segregation of the vehicle is based on the background subtraction method. Very few papers [1] [2][3] addresses the problem of moving vehicle capturing in front of vehicles. It is very difficult because it depends on various factors such as dynamic background, unfavorable weather condition, and noisy low quality videos. The proposed work deals with
all the factors stated above and it accurately detects the vehicle as either 2D or 3D objects in the scene. This work mainly captures the images on Indian roads in different category such as rural, urban and etc and accurately detects the vehicle.
The video frame rate taken in this work is 25-30fps. The frame rate determines the object deviation from previous frame to current frame. Decreasing the frame rate affects the object deviation where as object deviation increases from the previous frame to current frame.
The coverage area entirely depends upon the camera elevation. The camera focal area is determined by the elevation. While increasing the camera elevation, the focal area is increased and the object's size is automatically decreased [4][5][6].
A shape is the form of an object or outline of object or external boundary of object [7]. 2 Dimensional object contains the parameters length and breadth. But 3 Dimensional object contains the parameters length, breadth and Height or Depth. The object is 2D or 3D is determined by the factor height. The 3D shape formation that makes use of n number of 2d Planes.

Overview

The proposed system gets the input as video sequence. 3 x 3 mask window is used to perform the blob detection. Then thresholding technique is used to remove the object overlap. The threshold value is dynamically tuned based on the environment situation. The 8-connected component algorithm is used to remove the dots and discontinuity from the video frame. The foreground object is identified either as 2D or 3D object using Height Breadth Length (HBL) growing algorithm. The speed of the vehicle is controlled if a 3D object is identified as a foreground object by the proposed system else the speed is maintained.

Related Work

Length based vehicle classification using images from un-calibrated video [8] cameras works with considering the length of the vehicle and classify it as long vehicle and smaller one. Wei et al. classifies vehicles by using a parameterized model, using neural networks, which is more complex and consumes time. It makes use of vertices and their topological structure as the key features, and vehicles were recognized based on multilayer perception networks. In the work Vehicle-Component Identification Based on Multi-scale Textural Couriers, the textural couriers are generated based on the localized variances of the foreground vehicle image and a

new scale-space model is to provide a topological structure of the vehicle. Here a stable calibrated camera is used [9]. Vehicle Detection Using Normalized Color and Edge Map is a work proposed by-Wei Tsai et al. in which the vehicle are identified from the static images by taking the color values of the cars [1][10][11]. It pre calculates the vehicle pixel elements by taking the color values and the car/ vehicle is identified in a static picture in varying conditions. But here in the proposed work the vehicles are identified in moving conditions on road. Vehicle detection and tracking using the block-matching algorithm [12] is a BMA-based approach and it uses normalized cross correlation as a similarity measure to determine the motion using a fixed value of threshold. Segmentation and tracking of piglets in images [13] makes use of a recursive technique to estimate the median to construct adaptive background and it identifies the motion in low-resolution videos but is suitable when the background conditions are favorable and it works poor on dynamic weather conditions in outdoor applications.

PROPOSED WORK

The proposed system gets the input as video frame. Then blob detection is performed using 3 x 3 mask window to subtract the background portion and segregate the foreground object. Height Breadth Length (HBL) growing algorithm is used to find whether the foreground object is 3D or 2D shape. If the detected object is 3D then the system controls the vehicle speed. The proposed work flow is shown in figure 1.

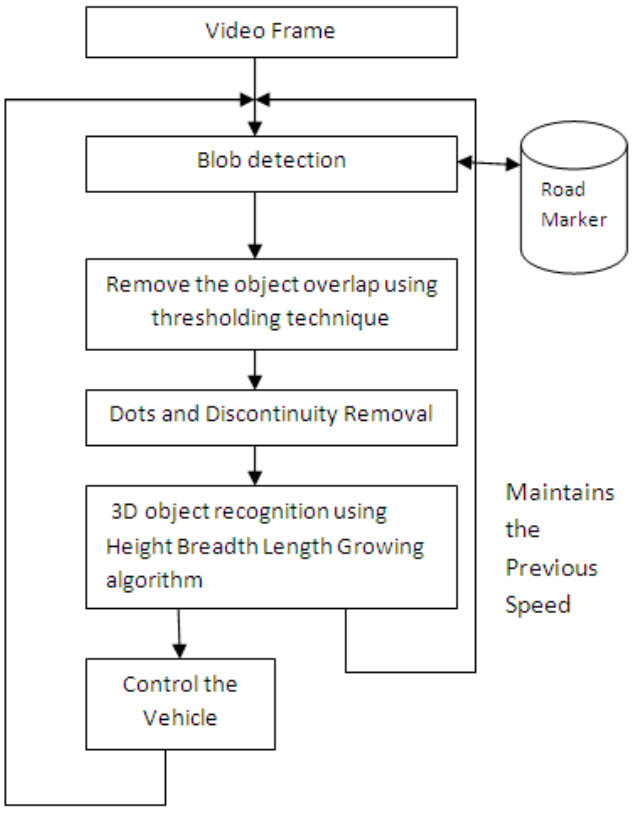


Fig 1. Block Diagram

i. Input

The proposed system gets the input as 2D color image or video frames. The input images or video frames are collected from various standard data sets and also taken by us in Indian roads. The sample video frame is shown in the figure 2.



Fig 2. Sample Video Frame

ii. Blob Detection

The proposed system gets the video frame as input. 3* 3 mask window is applied and compared with current video frame (i^{th} frame) and previous video frame ($i\text{-}1^{th}$ frame). If both the mask windows are nearly same pixel value then it will be

assigned the pixel value as zero or else assigned the difference value of the frame. The blob detection is almost detects the moving vehicle. The blob detection output is shown in figure 3.



Fig 3. Blob Detected Output Image

iii. Remove the Object Overlap using Thresholding Technique

In this phase, the proposed system gets the input as blob detected image. Thresholding technique is used to remove the overlapped objects based on the threshold value. The threshold value is dynamically changed based on the environment factor such as morning, afternoon, night, sunny, rainy etc. If the RGB pixel value is less than certain threshold (T) value then assign the pixel value as 0 (black) or else assigns the pixel value as 255(white).

The thresholding value is represented and shown in table 3. This is based on the different environment and various studies are made to finally arrive at the values.

Table-1 Threshold value

Environment	Threshold value
Morning	70
Day	00
Night	30
Evening	60

The general form of threshold equation is represented in Equation.

f(x, y, k) = 0 where T < Threshold value (1)

255 where T > Threshold value

The proposed system removed the object overlapped and the output is shown in figure 4.

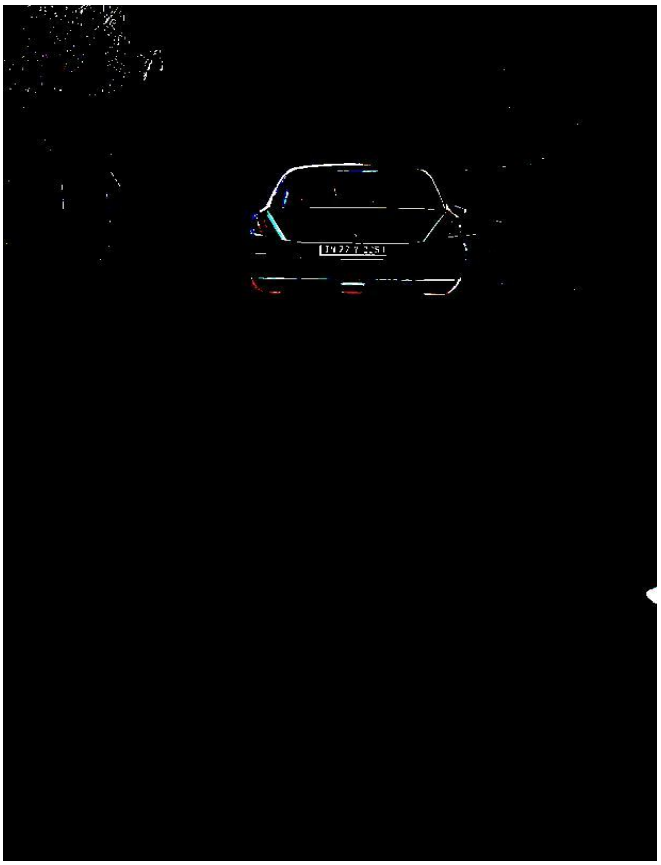


Fig 4. ***Remove the Object Overlap Output image***

iv. Dot's and Discontinuity Removal

This phase gets the input image from the object overlap removed module. The input image has some dots and discontinuity pixel i.e. outliers. The 8-Connected component algorithm is used to remove the dots and discontinuity from input image [14]. Dots and discontinuity removed output is shown in figure 5.

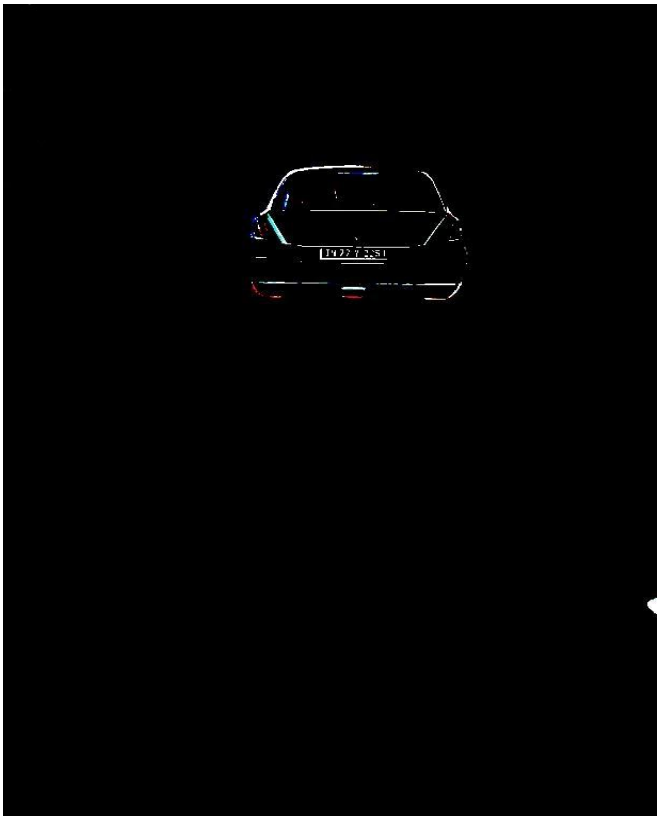


Fig 5. Dots and Discontinuity Removal Output Image

v. Height Breadth Length (HBL) Growing Algorithm

In this phase, the proposed system gets the input as dots and discontinuity removed image. Height Breadth Length (HBL) Growing Algorithm is used to grow the height, breadth and length region. The proposed system represented the 3D shape model and it is shown in figure 6.

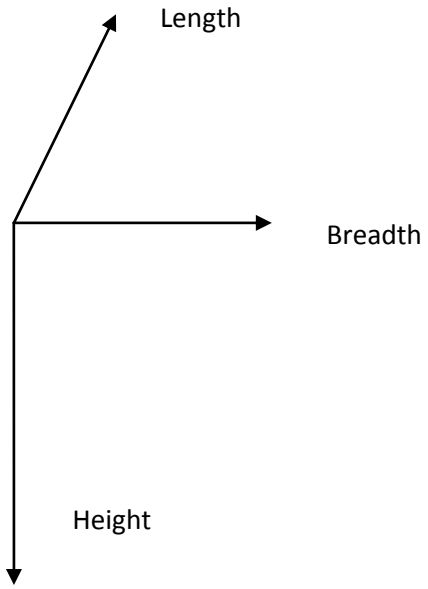


Fig 6. 3D shape Model

The proposed system maintains the various templates of road markers, which is stored inside the database. Whenever it is performed the blob detection automatically subtracts the road markers. Then it searches the RGB pixel value which is nearly 255 from first row and first column onwards until the process is continued to meet nearly white color. Then the white color pixel is considered as origin of 3D shape model.

The regions are growing until changes in the color value occur. The X-Axis is considered as Breadth, Y-Axis is considered as Height and Z-Axis is considered as Length. Here the height is major factor and it is taken into account. If the height region got grown up to certain pixel then the proposed system considers the object as 3D object. It detects various vehicles on Indian roads and finds the 3D object accurately. The 3D shape output is shown in figure 7.

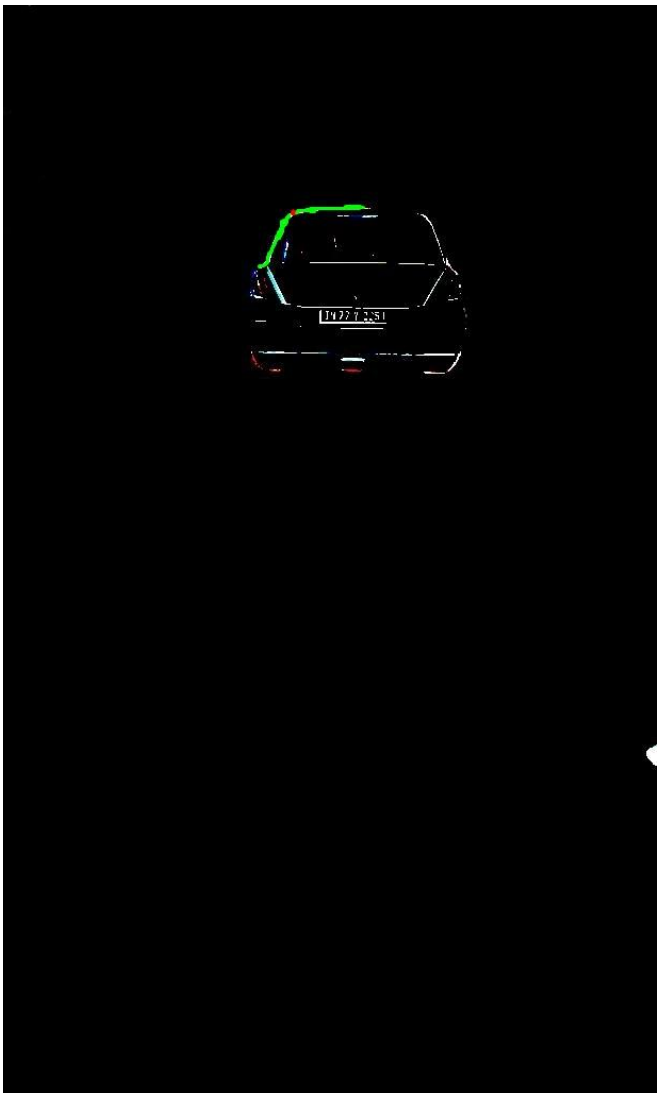


Fig 7. HBL Growing Algorithm output

The HBL Growing algorithm initially takes the origin x=285 and y=25 for this image which is the top left start of the car image and it is shown in Table2.

Table-2 HBL Growing Algorithm Pixel Count

Origin: X= 285 and Y=25		
No. of Pixels Grown		
Height (H)	Breadth (B)	Length (L)
20	82	0

vi. Vehicle Speed Control

In this phase, the proposed system gets the input as 2D or 3D object recognized information. If the vehicle does not find any object in front of the vehicle, it maintains the previous speed until and it stops the vehicle only there if changes take place in the environment. If the system founds any 3D object and then vehicle speed is controlled.

Results and Comparison

A. Object Recognition Process

The Object recognition system gets video frame as the input image and performs the following in a sequence the blob detection, Removal of the overlapped object, Dots and Discontinuity Removal and HBL Growing Algorithm. The Object recognition process is shown in figure 8.

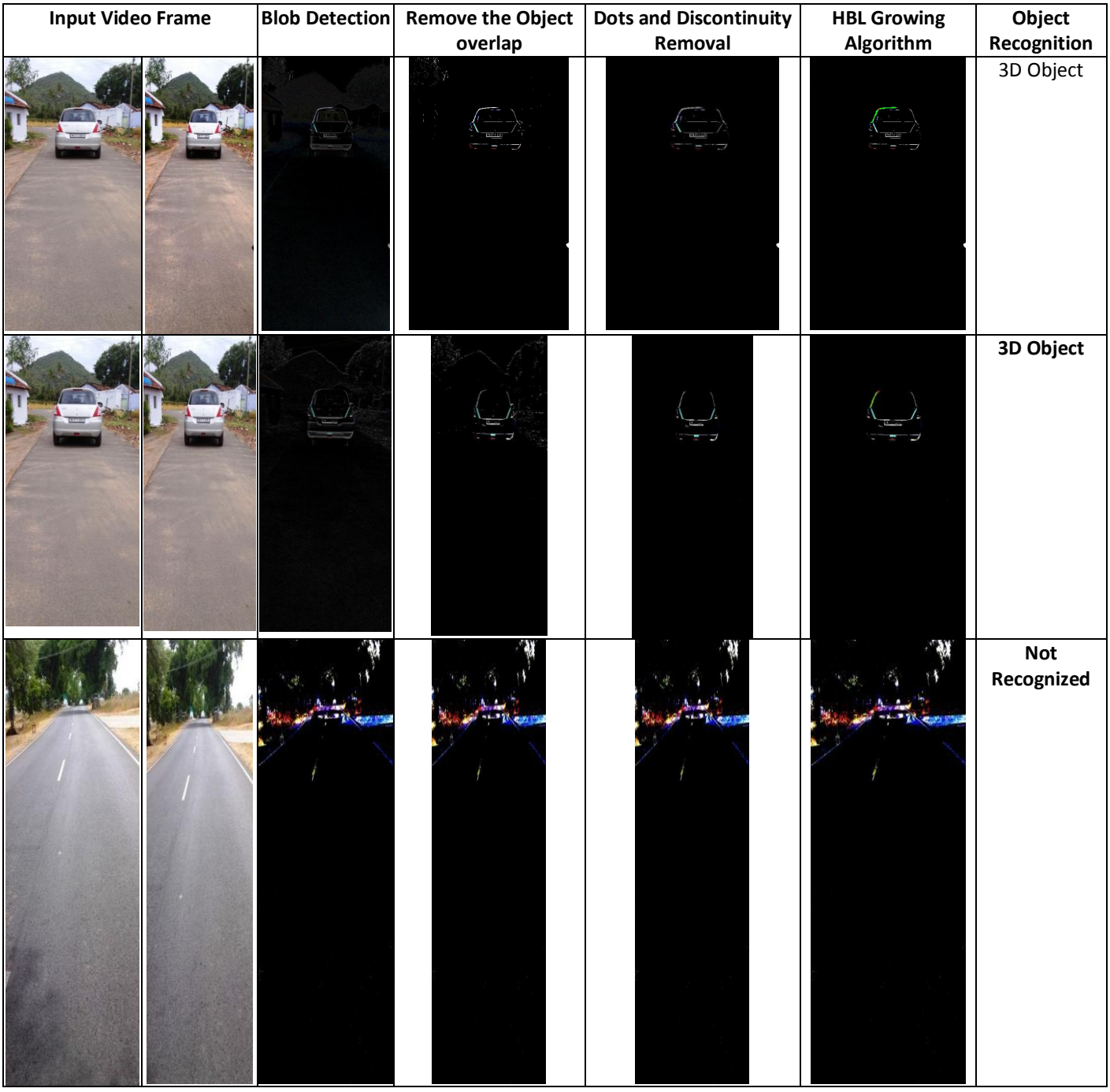


Fig 8. Object Recognition Process

B.HBR Growing Algorithm

The region grown based count the number of pixel count in Height, Breadth, length wise and is shown in figure 9.

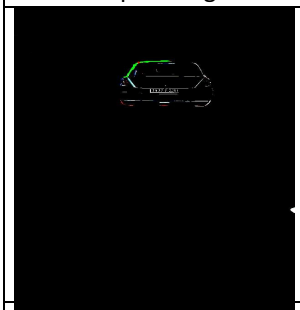
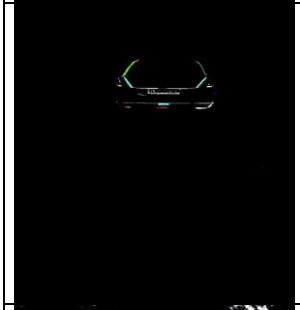
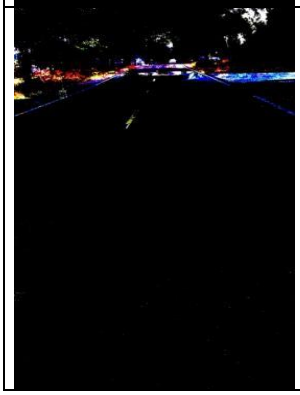
HBL Growing Algorithm Output Image	No. of Pixels grown		
	Height (H)	Breadth (B)	Length (L)
	20	84	0
	0	0	0
	0	0	0

Fig 9. Height, Breadth, Length wise Pixel count

C. Object Recognition Accuracy

The proposed system gets an input as a video frame. The Object recognition operation is done by using blob detection, thresholding technique and HBR growing algorithm. The Object recognition accuracy is compared with the Precision and recall.

$$\text{Precision} = \frac{\text{True Positive}}{\text{True Positive + False Positive}}$$

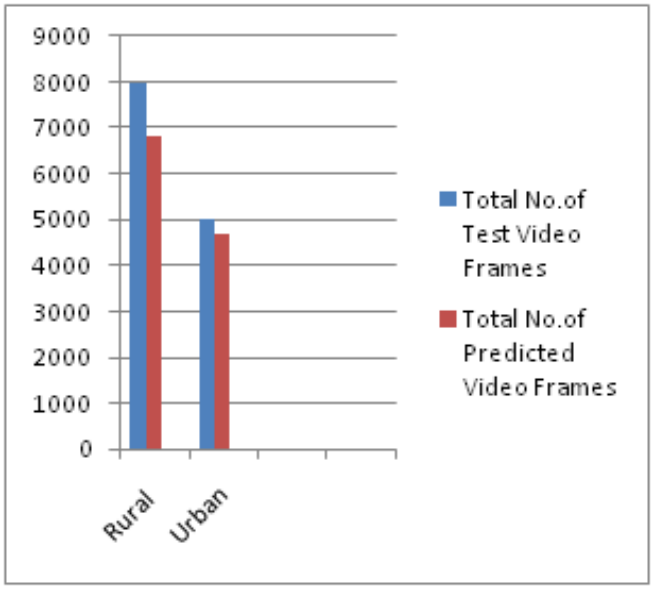
$$\text{Recall} = \frac{\text{True Positive}}{\text{True Positive + False Negative}}$$

Precision and Recall are used to validate the proposed model. This system gets the own Dataset on Indian Roads and it produces better accuracy level while compared to Urban than Rural. The proposed methods accuracy rate is shown in Table 3.

Table-3. Accuracy Rate of Object Recognition

Type of Road	Total No. of Images (or) Video Frame	Total No.of Test Video Frames	Total No.of Predicted Video Frames	Object Recognition Accuracy Rate
Rural	10000	8000	6800	85%
Urban	20000	5000	4700	94%

The performance of Object Recognition based on Precision and Recall is shown in the graph 4.1. The proposed system performance is evaluated in different situations and the accuracy results are found out as 85% in rural areas and 93% in urban areas at various environmental conditions and it is tabulated, presents as a bar chart below.



Graph 4.1. Object Recognition Accuracy

Conclusion

The proposed system is a novel approach for moving vehicle detection and speed control. The proposed system gets the input as video sequence. Background subtraction is performed to segregate the foreground object with the help of Blob detection using thresholding technique. The foreground object is identified either as 2D or 3D object using Height Breadth Length (HBL) growing algorithm. The speed of the vehicle is controlled if a 3D object is identified as a foreground object by the proposed system else the speed is maintained. The proposed system performance is evaluated in different situations and the accuracy results are found out as 85% in rural areas and 93% in urban areas at various environmental conditions on Indian roads.

Future Enhancement

The proposed system is a novel approach for moving vehicle detection and speed control. The future work may proceed towards identifying the gap between the vehicles. Inference rule may be applied to control the vehicle speed based on the vehicle distance which in turn may increase the efficiency of the work further more.

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