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Smart Toll Rate determination in Real Time system

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Abstract: **— The paper discusses to some difficulties of worldwide applications in electronic toll collection systems for highways an expressways. The public or private road for which toll is certain for the way is called toll road. The toll rate charged for the usage of services such as a tunnel or a bridge is usually relative to the number of axles controlled by a vehicle. The price of the toll based upon several vehicle types, weight or number of axles because toll rate is proportional to the number of axles to have a vehicle. It is difficult to calculate the number of a vehicle by a toll booth operator so proposed an automatic system for detecting axles by Hough transform method for detecting a circle. According to this method the toll rate can be determined in a toll way. This system must be able to determine the fix amount for toll use Weather Sensor for calculating the average rain on the toll road and load Cell used for finding the weight of the vehicle. Also update the total number of vehicle and toll rate on network database daily, weekly and monthly.**

Keywords— **Canny Edge detection, Load Cell ,Hough transforms, Image Processing, MATLAB, Network Database, Toll Collection, Weather Sensor,**

I. INTRODUCTION

This is the new method of electronic toll system presented by this concept analyses the vehicle axle count based on image processing and approximate the total load on toll road. The toll road maintenance cost can be calculated automatically and be updated toll rate on network database on daily, weekly ,monthly or yearly basis. This work is totally done by image process system in MATLAB. It has low complexity and the processing time has reduced largely. This system also gives the average rainfall on the toll road by use weather sensor. The charge of the toll depends upon varied vehicle sorts, weight or variety of axles as a result of toll rate is proportional to the quantity of axles to own a vehicle. This system gives the better performance in traffic management.

This research gives the smart toll rate determination in real time system. This is often simply done by MATLAB. It also gives the total working details of toll plaza and system analyses the vehicle axle count based on image processing and thus approximates the total load on toll road, and thus the maintenance cost of the toll road, which can be calculated automatically, and thus facilitating automated calculation & updating of toll rates on daily, weekly & monthly or yearly basis. This work done by 2 methodology initial one is Hough transform method and second is canny edge method.

II. TOLL COLLECTION SYSTEM USING IMAGE PROCESSING

Normal method for detecting vehicle axle [1] by the use of sensor (called laying sensor) in the most important way of toll plaza. In this method as the vehicle passes through the sensors, axles are to be count by the generation of signal. Although in this method, maintenance is the main issue. It is a time consuming and a costly process. This method is highly unacceptable when the traffic flow is high. Therefore, another alternative method used via Image processing in which the setup is easy to maintain.

In this paper, we described an automatic system to count the number of axle of a vehicle in real-time for smart toll collection system. The Hough transform for circle [2] is used for detecting the presence of a wheel. Our experiments show that the Hough transform is suitable for such an application. Our system setup is simple and by using commodity components, its setup cost is also low. In case of circle detection, triplets of pixels will be randomly chosen from the image and mapped to a single point in the 3-D parameter space. As the points selected from the image is not exhaustive, therefore, the number of operations can be reduced

III. HARDWARE SETUP

The hardware part of the system covers the whole electrical system. A model toll-plaza was designed [3] by wooden

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frame, which gives a pictorial view of the proposed automated toll-plaza (Fig. 1).

Fig 1:-Pictorial view of the system

IV. WHEEL REORGANIZATION TECHNIQUES

When a vehicle passes through toll booth, the camera Captured wheel images [3]. Figure 2 shows the position of the camera relative to the road and a sample image captured by the camera is given in Figure 3.The front wheel and rear wheel of a cat taken about 2 second to pass through the camera and processing system completes the recognition process within the 2 second in time frame.

The image of wheel is slightly destructed due to the position of camera but it still resembles a circle. Hough transform used to [4] detect presence of the wheel and its major advantage is to capability to identify a wheel even it is only partially appearing in an image.

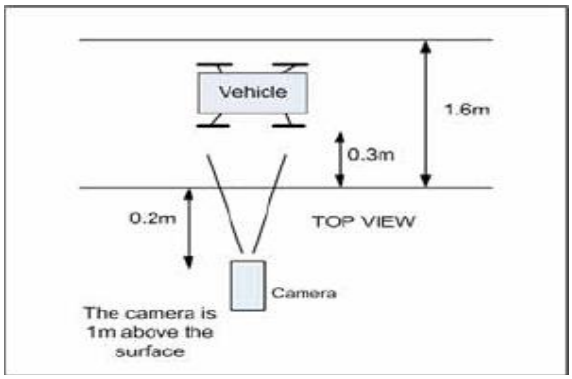

Figure 2: Camera set up for the wheel detection system

A. Hough Transform Method for circles

Hough transform, a feature extraction technique is used in image analysis, computer vision and digital image processing. This technique is used to find the imperfect instance of object within a certain class of shape by a voting procedure. When the numbers of points that fall on the perimeter are known as the parameter of circle can be determine using Hough transform [5]. It is also use to find the shape in an image.

So, the flow of events is something like this:

1. Load an image
2. Detect edges and generate a binary image
3. Detection of radii works for concentric circles as well.
4. For every 'edge' pixel, generate a circle in the space
5. For every point on the circle in the space, cast 'votes' in the accumulator cells
6. The cells with greater number of votes are the centers

B. Canny edge detection

A very powerful tool for detecting is in a noisy environment and being considered in our application is the canny edge detection [6]. It first smoothness the image to eliminate noise and it find the gradient to a highlight region. Two Threshold (T1, T2) with T1<T2 is used to reduce the image gradient. It is said to zero if the magnitude of an image pixel is below the first threshold (T1). It is made an edge if the magnitude is above the threshold (T2) unless there is a path from this pixel tool to a pixel with a gradient above T2, the magnitude between the two thresholds is said to zero. The result of applying canny edge detection to figure 2 is given in figure 4. On comparing figure 3 and 4 most of the unwanted edge point can be removed by canny edge detector and finally the circle can be detected with the help of Hough transform method.

In this paper we apply canny edge detection for reorganization the axle of vehicle.

Ex. BW = edge (I, 'canny') specifies the Canny method

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Fig 2: Simple image capture by the system

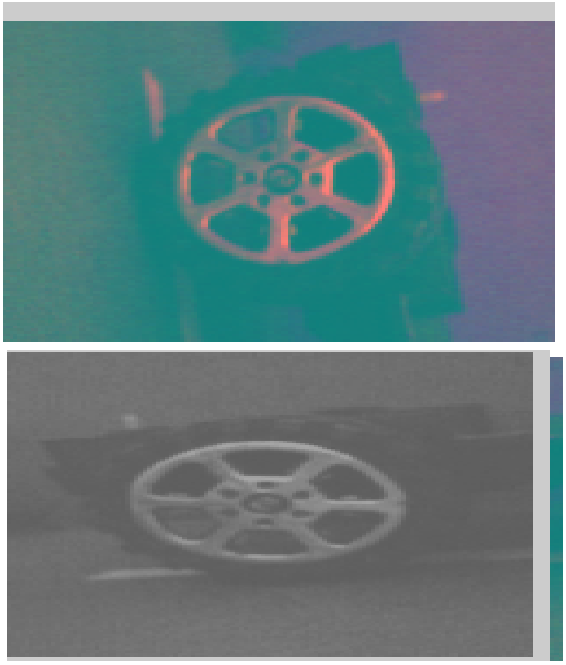

Figure 3: Sample image capture by the system after Image processing

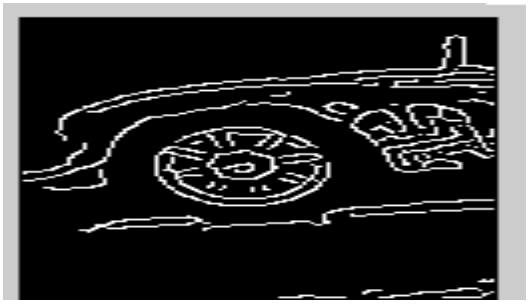

Figure 4: Result of Canny edge detection

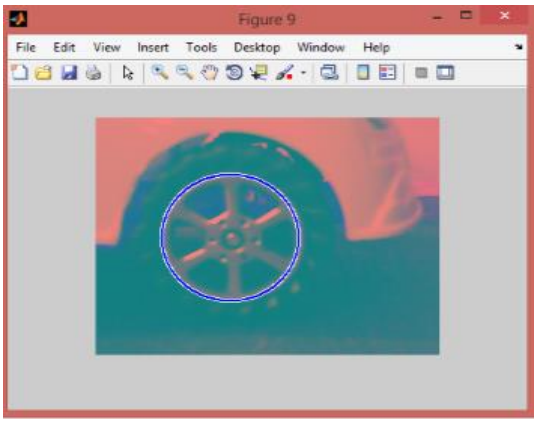

Figure 5: Edge detection of wheel

IV. CHALLENGES IN REAL TIME TOLL RATE DETERMINATION

A. Flow Chat of the system per vehicle

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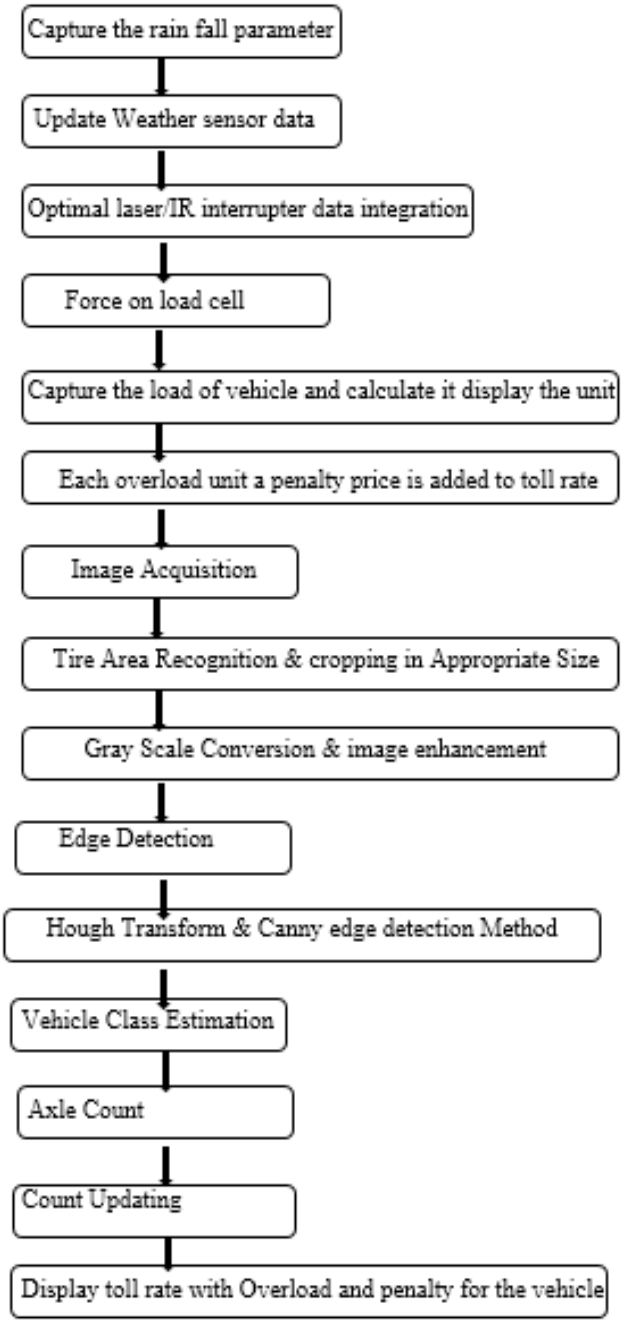
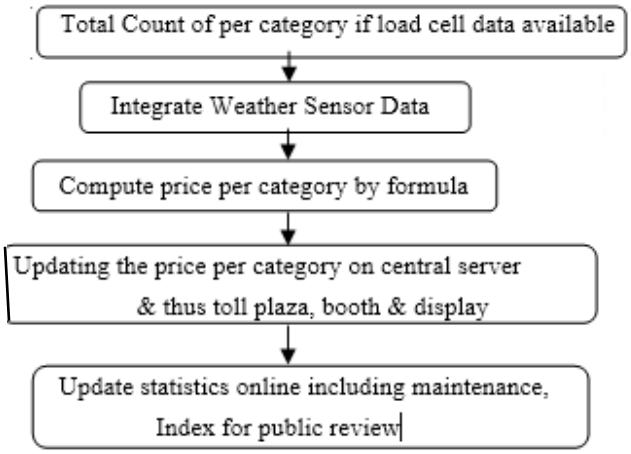


B. Flow Chat of the system per week



C. Vehicle Class Estimation

Vehicle class estimation is based on wheel of the vehicle. On above method canny edge detection and Hough transform is gives the appropriate size of the vehicle and MATLAB classify the vehicle.

According to this system there are four types of vehicle class:-

1. CAR
2. LCV
3. HCV
4. MAV

Vehicle class estimation based on radius of the wheel which defines by the user

D. Axles Count:

It takes about 1.5s time for processing 24 frame of sub-sampled image. It required 2s for processing. The frame 3 to 7 of the camera capture the view of the front wheel of the vehicle and load maximum emerges at frame 5.similarly; frame 15 to 17 captures the rear wheel of a vehicle. When the car leaves the toll booth area, therefore the total number of image frames covering the rear wheel is less than the front wheel. However, a local maximum is still available in frame 16. Based on such a phenomenon, we can easily determine the number of wheels captured by the camera by detecting the number of peak from the Hough transform.

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E. Count Updating

We can count the total number of vehicle pass thought the toll plaza on the basic of vehicle class estimation. It is also count the total number of CAR, LCV.HCV, and MAV and update the total no of vehicle on network database with the help of the total number of vehicle .we can use the formula for estimating the toll rate on this toll plaza.

Number of Vehicles passing from XYZ Route

CAR	LCV	HCV	MAV
20000	60000	40000	70000

F. Load of vehicle using load Cell

1. The limitation imposed by the vehicle's design and construction. You must not exceed the vehicle ratings specified by the vehicle manufacturer for the chassis, axles, tires and other components of the vehicle.

2. Limits to axle mass are imposed to protect the road infrastructure. This is because certain sections of roads are not built to the same strength specifications in all the road.

G. Rate calculation:-

Toll rate is proportional to number of vehicle on toll plaza. Toll tax is based on the cost of construction, repairs, maintenance, expenses on toll operation and interest on the outlay.

- Formula for Toll Rate Determination

Toll Rate = Base Rate + Annual increase Rate + (initial maintenance cost (fix) +Maintenance Rise)

$$MI = \frac{\text{Number of Vehicle per week} \times \text{Average load of Vehicle type} \times \text{Weather Factor}}{\text{Maintenance Price per Unit Load Per KM}} \times \text{Total KM}$$

Where, MI = Maintenance index

Weather Factor =Unity for normal Weather

= 1.1 to 1.3 for small Rain

=1.3 to 1.7 for moderate Rain

= 1.7 to 2.0 foe heavy Rain

$$\text{Maintenance rise} = \frac{\text{Maintenance Index}}{\text{Number of vehicle per week}} \div \text{Base Rate}$$

H. Online database updating

The toll rate can be calculated according to traffic volume on road by updating the number of vehicle passing thought the toll plaza. The information about toll collection like toll rate of CAR, LCV, HCV and MAV & number of total vehicle passes thought the toll plaza can be updated. It can be update the information weekly, monthly, yearly etc. So everyone can see the toll rate of that plaza on Network.

V. RESULT

An automatic system is described to count the number of axle of a vehicle in real time for toll collection purposed. For detecting the presence of wheel Hough transform method is used for circle. , we can process up to 24 images within 1.5s and it satisfies the timing constraint imposed upon the system. Our system setup is simple and by using commodity components, its setup cost is also low. It classify the vehicle (CAR, LCV, HCV, MAV) on the basic of circle detect by Hough transform method processed.

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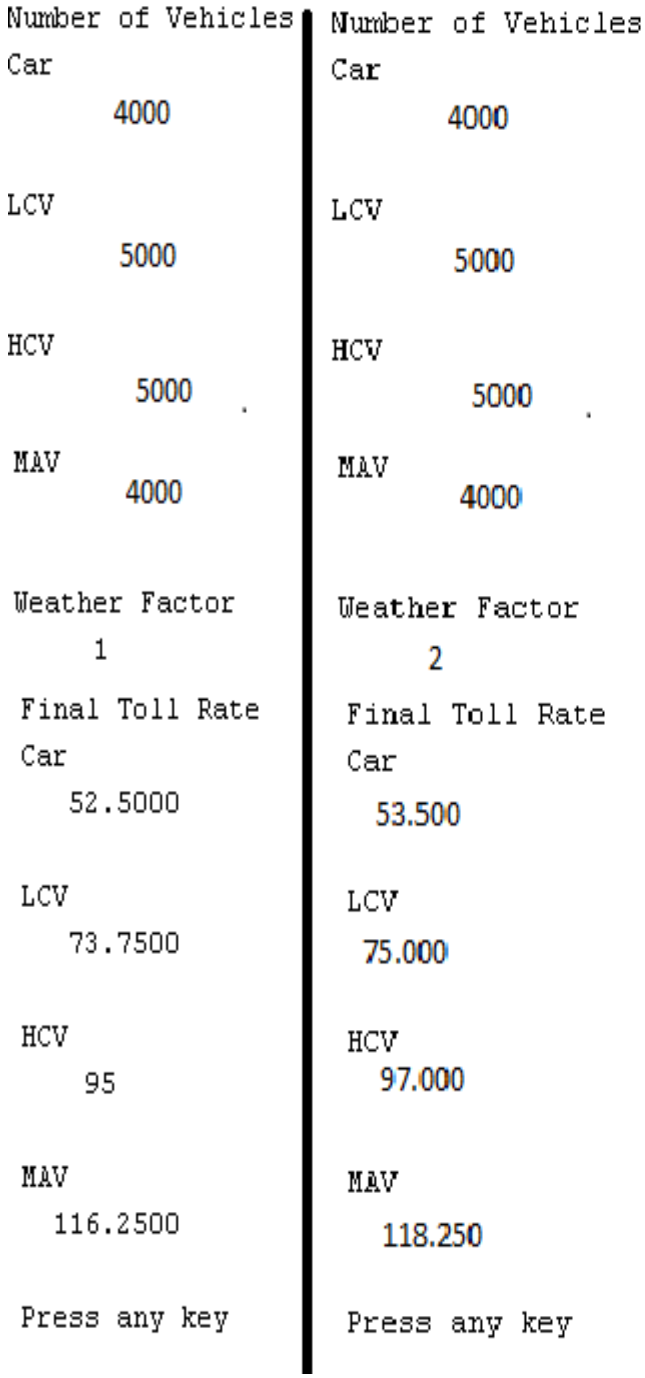
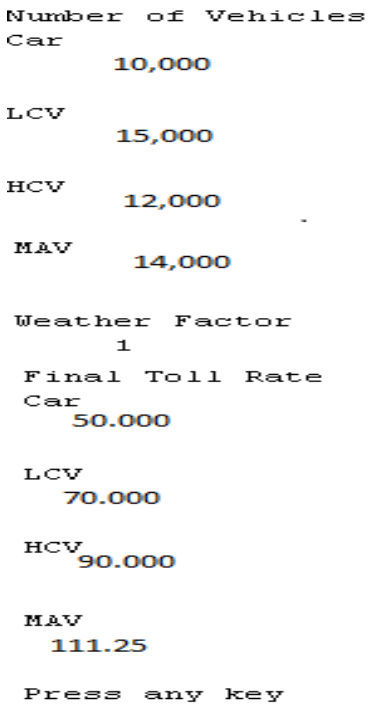


Figure 6: snapshot of result



VI. ONLINE UPDATE OF TOTAL NUMBER OF VEHICLE AND SPECIFIC TOLL RATE OF VEHICLE

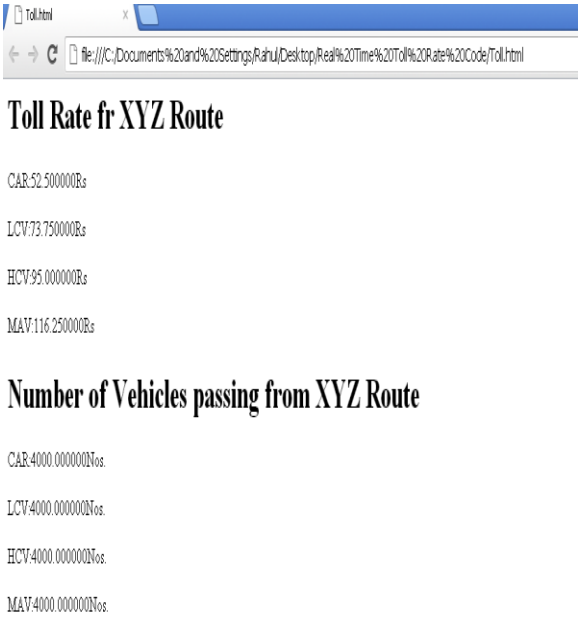


Figure 7: Network Database

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VII. OVERLOAD CASE (RESULTS)

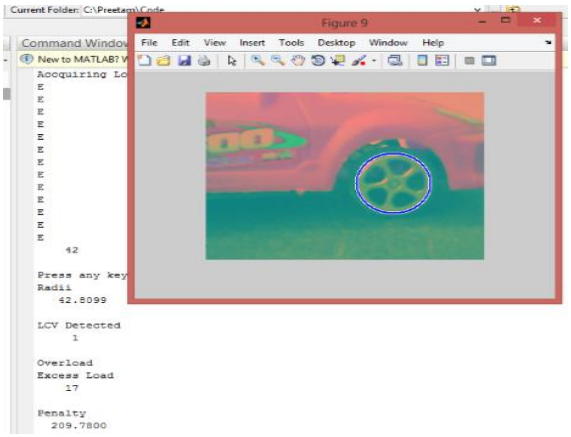


Fig 8:-Overload case for LCV

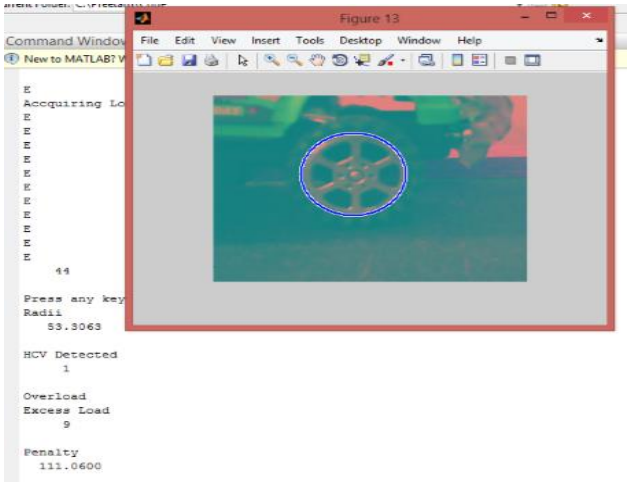


Fig 9:-Overload case for HCV

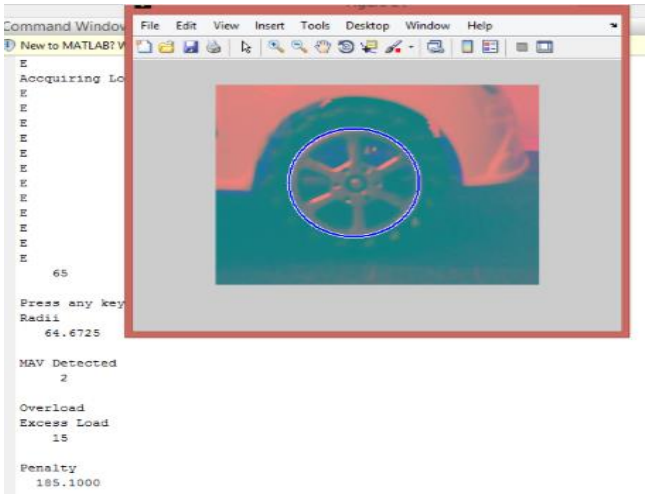
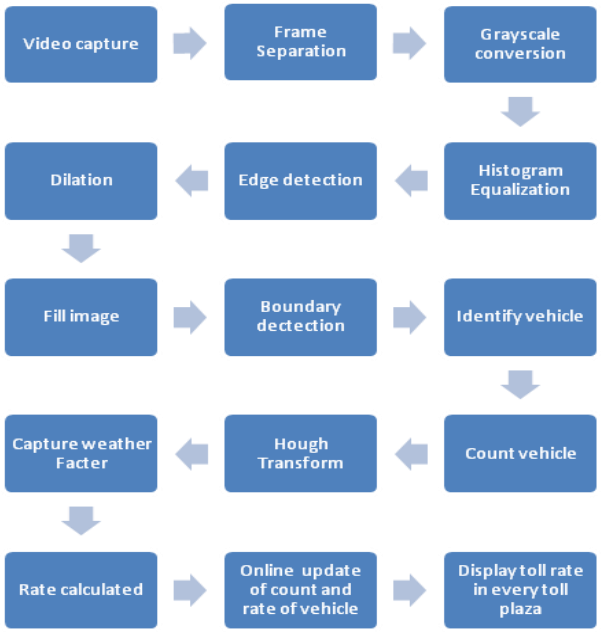


Fig 10:-Overload case for MAV

VIII. CONCLUSION

The techniques and methods discussed in above sections are based on the high resolution images. Most of the technique are used for circle detection [7] of wheel and count the total number of wheel or vehicle then calculate the toll rate of that toll plaza because the toll rate charged for the usage of facilities such as a tunnel or a bridge is usually proportional to the number of axles possessed by a vehicle.

IX. Block diagram of the system



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