

Computer Vision Based E-Toll Collection System

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Abstract-

Many highway toll collection systems have already been developed and are widely used in India. Some of these include Manual toll collection, RF tags, Barcodes, Number plate recognition. All these systems have disadvantages that lead to some errors in the corresponding system.

This paper presents a brief review of toll collection systems present in India, their advantages and disadvantages and also aims to design and develop a new efficient toll collection system which will be a good low cost alternative among all other systems. The system is based on Computer Vision vehicle detection using Open CV library in Embedded Linux platform.

The system is designed using Embedded Linux development kit (Raspberry pi). In this system, a camera captures images of vehicles passing through toll booth thus a vehicle is detected through camera. Depending on the area occupied by the vehicle, classification of vehicles as light and heavy is done.

Further this information is passed to the Raspberry pi which is having web server set up on it. When raspberry pi comes to know the vehicle, then it access the web server information and according to the type of the vehicle, appropriate toll is charged. This system can also made to count moving vehicles from pre-recorded videos or stored videos by using the same algorithm and procedure that we follow in this paper.

The proposed system aims to design and develop a new efficient toll collection system which will be a good low cost alternative among all other systems. Computer Vision based techniques are more suitable because these systems do not disturb traffic while installation and they are easy to modify. The proposed system is portable and Computer Vision based system for moving vehicle detection and counting. A camera captures images of vehicles passing through toll booth thus a vehicle is detected through camera. Depending on the area occupied by the vehicle, classification of vehicles as light and heavy is done. Further this information is passed to the Raspberry pi which is having web server set up on it. When raspberry pi comes to know the vehicle, then it access the web server information and according to the type of the vehicle, appropriate toll is charged.

Index terms – Toll Collection System; Vehicle Detection; Open CV

I. INTRODUCTION

India is a country where we get to observe most extensive National highways. Government plans various phases to complete the projects under construction. The government signs agreement with the private companies who build the infrastructure like road, port and other stuff for a particular span of time generally in years. The invested amount is charged from the vehicles passing on that newly built highway. This charged amount is called as toll tax. People have no choice to pay for toll tax for using the infrastructure. The private agency involved in the manufacturing of the infrastructure is free to charge citizens. Computer vision is an important field of artificial intelligence where decision about real world scene having high dimensional data is taken. The general steps used in this process are acquiring, processing and analyzing the image and convert it into numerical or symbolic form. It is used to understand the scene electronically and the process is equivalent to the ability of human vision.

The numerical or symbolic information of a scene is decided based on the appropriate model constructed with the support of object geometry, physics, statistic, and learning theory. The scene under consideration is converted into the image(s) or the video(s), comprising of many images, using camera(s) focused from different locations on a scene. The various vision related areas such as scene reconstruction, event detection, video tracking, object recognition, object pose estimation and image restoration are considered as subareas of computer vision. Similarly, various other fields such as image processing, image analysis and machine vision are also closely related to computer vision. The techniques and applications of various above said areas overlap with each other. Moreover, the techniques used in all these areas are more or less identical. The difference in names only lies on the applications where the techniques are applied.

Image processing and image analysis both deals with 2D images. In image processing an image is transformed into another by applying some operations such as contrast enhancement, edge detection, noise removal and geometrical transformations. The image contents are not interpreted in image processing whereas in computer vision the interpretation of images is made based on the properties of the contents they contain. Computer vision may include analysis of 3D images from 2D.

This paper is organized in five sections. After this introduction, in Section II, Related work discussed of the paper, Section III about problem statement of previous method and Section IV the proposed method explained, as well as the novel feature of the proposed method. Finally, Sections V and VI provide the Experimental results and the conclusions, respectively.

II. RELATED WORK

Dhanya et al [2] developed a computer vision system for detecting and tracking the moving vehicle at day time and night time. First the videos are converted into frames and background and foreground of the image are detected. The headlight and the taillight of the vehicle is used for detecting and identifying the vehicle, after that image segmentation and pattern analysis techniques are applied. A fast bright object is identified and classified spatial clustering.

Mishra et al [3] develop an algorithm for detection and classification of vehicle in heterogeneous traffic. The entire process is divided into four steps i.e. camera calibration, vehicle detection, speed estimation, and classification. Vehicle detection is carried using background subtraction and blob tracking methods. Speed of the vehicle is estimated by using start and stop lane marker and calibration parameter. Classification of vehicles depends upon the various features of the detected vehicles. These features give the input to SVM for classification. A non-linear kernel is used as the classifier.

Chaoyang et al [4] recognizes logos in video stream in real-time. A new technique is developed that combines both coarse template matching approach and pair wise learning method together. The logo recognition becomes effective and efficient by eliminating the false alarms and further refines the recognition results. Image alignment for template matching improves the stability of the coarse stage. Experimental results show that this approach outperform the DOT matching approach and traditional multiple classifiers combination.

Daigavane et al [5] developed an application based on neural network for vehicle detection and classification. This system identifies and classifies the vehicles with their success rate 90%. Vehicle are tracked by using blob tracking method and neural networks classify these vehicles on the basis of length and height There have been cases where the system is unable to do the classification correctly. When multiple vehicles move together, with approximately the same velocity, they tend to get grouped together as one vehicle. Also, the presence of shadows can cause the system to classify vehicles incorrectly.

III. PROBLEM OF STATEMENT

This is not appropriate method for toll collection as it very time consuming. This method causes relatively long amount of waiting time at toll booth. Vehicles have to stop until their turn comes. It requires toll collector for working.

Collector classifies vehicles, generates receipts with printer and then gives that receipt to vehicle owner. In all this process takes significant amount of time as there is a lot of human intervention included.

IV. PROPOSED SYSTEM

A. Block Diagram

Proposed system is based on vehicle detection Uses Open CV libraries with embedded Linux platform for execution. Response time is quick and it is less expensive, more practical, and more efficient than any other system. And with this implementation it is also possible to count number of vehicles passing through toll booth. Depending on the area occupied by the vehicle, classification of vehicles as Light and heavy is done.

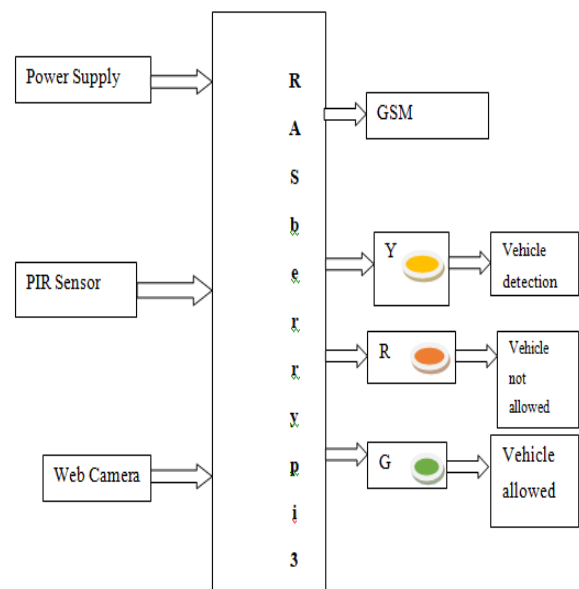


Figure 1: Proposed Block Diagram

. Further this information is passed to the Raspberry pi which is having web server set up on it. When raspberry pi comes to know the vehicle, then it access the web server information and according to the type of the vehicle, appropriate toll is charged.

B. Hardware Components Description

- **Raspberry Pi 3 Microcontroller**



Figure 2: Raspberry Pi 3 Microcontroller

Raspberry Pi is the Visa measured adaptable PC is fit for the essential number of the things that's purchaser desktop accommodating PC will, like spreadsheets, word-getting ready and beguilements. The Raspberry Pi has a Broadcom BCM2837 framework on a chip, which wires an ARM1176JZF-S 700MHz processor, video focus IV GPU, and was at first passed on with 256 megabytes of RAM, later refreshed (Model B and Model B+) to 512 MB. It avoids an undeniable hard plate or strong state drive; regardless it utilizes a SD card for booting and chose gathering, with the Model B+ utilizing a Micro SD.

- **GSM**

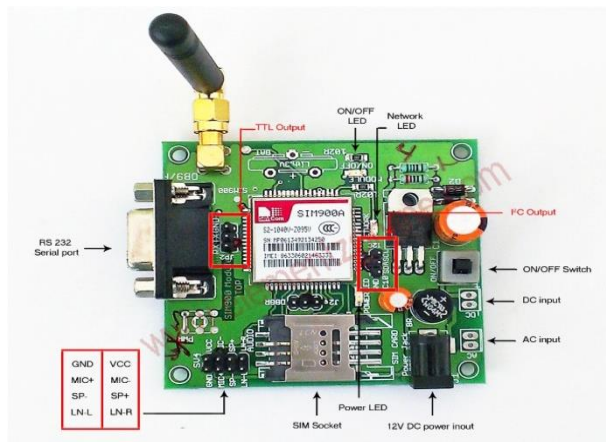


Figure 3: GSM

GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services. GSM supports voice calls and data transfer speeds of up to 9.6 kbps, together with the transmission of SMS (Short Message Service). GSM operates in the 900MHz and 1.8GHz bands in Europe and the 1.9GHz and 850MHz bands in the US.

GSM (Global System for Mobile Communications) [12], is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe protocols for second-generation (2G) digital cellular networks used by mobile phones. The GSM module is interfaced with the PIC for sending warning messages at time of intruder attack. The port number 25, which is TX port of PIC, is interfaced to GSM module via RX port of GSM and the GND port of GSM is grounded.

- **Web camera**



Figure 4: Web Camera

A webcam is a video camera that feeds or streams its image in real time to or through a computer to a computer network. When "captured" by the computer, the video stream may be saved, viewed or sent on to other networks via systems such as the internet, and emailed as an attachment. When sent to a remote location, the video stream may be saved, viewed or on sent there. Unlike an IP camera (which connects using Ethernet or Wi-Fi), a webcam is generally connected by a USB cable, or similar cable, or built into computer hardware, such as laptops.

- **PIR sensor**

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors.

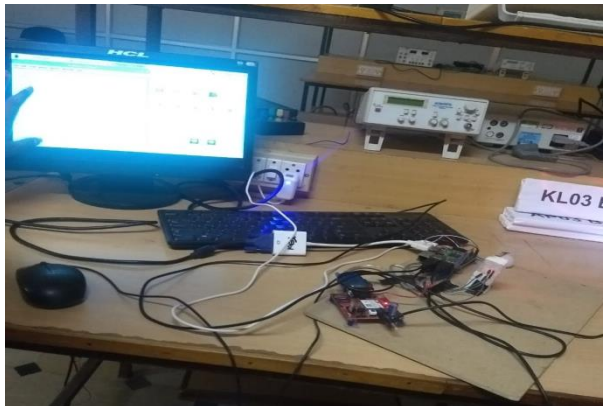


Figure 5: PIR sensor

PIR sensor detects a human being moving around within approximately 10m from the sensor. This is an average value, as the actual detection range is between 5m and 12m. PIR are fundamentally made of a pyro electric sensor, which can detect levels of infrared radiation. For numerous essential projects or items that need to discover when an individual has left or entered the area. PIR sensors are incredible, they are flat control and minimal effort, have a wide lens range, and are simple to interface with.

V. EXPERIMENTAL RESULTS

The below figure shows that hardware setup and results displayed on monitor.



VI. CONCLUSION

The technique which is used for implementation is very efficient and more feasible than any other methods for toll estimation. As for development Embedded Linux system is used, processing speed will be fast. And response time is less which is the special parameter about the system. On the other hand, Open CV plays very crucial role for vehicle detection. It has got libraries which can be used for vehicle detection and further one can extend its use according to requirements. At the toll collection booth, major task of toll collection will be done with less human efforts. This idea gives very less expensive toll collection system concept. Also the system is transparent to appropriate toll collection and provides reliability that it can work in adverse climatic conditions also.

Future Work

This technology will be used efficiently on different toll booth. The major problems like congestion of traffic, amount of time at toll plaza will be reduced significantly. The more work should be done on time of execution of presented system.

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