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Enhancement of Vehicle Speed Detection System for Avoidance of Accident

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ABSTRACT

This paper presents an arrangement to detect reckless driving or over speeding on highways and by design send tickets to violators over email. In the past, many devices have been proposed but they require human effort. There are no means of control or monitor speed of the vehicles except the use of traffic policemen. Given the huge mileage of driveways, the number of traffic policemen is far from enough to observe and analyze most drivers. The proposed model is advantageous as there will not be any need of traffic policemen and will accurately detect speed rather than maintaining trust in the eye. This paper discusses the hardware as well as the software modules involved in the speed detection system. The system requires a microprocessor, a camera for input, and network capabilities to send data. It includes some reflections on the evolution of this methodology and different design decisions and their impact on the system.

Keywords: *Speed Detector, Camera, Traffic.*

1. INTRODUCTION

Rash driving is the cause of many accidents in India (45.12 per lakh in 2011). The existing systems either require human's intervention. There are a lot of areas to cover and it is not physically possible to cover all of them. This problem is even more enhanced at night when the authorities are off duty. Visibility is also lower which decreases the ability to identify the speed of a vehicle. The central idea surrounding this system is to identify the speed of a vehicle through the use of video processing. The system will then grab the license plate from the frame, and using image processing extract the license number and send it to a web server. The web server will then look up other details connected to the license plate and make certain decisions on whether to send a ticket or not to the registered citizen.

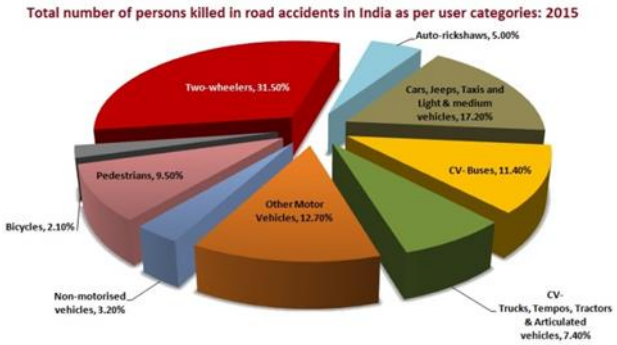

Fig 1: Statistical data on road accidents

A. Existing System

The systems that are currently employed require manual mediation from authorities. Traffic officers patrol the highways or set up a base near commonly speeding areas. They may employ devices which use Doppler Effect or other phenomena to detect the speed. These devices usually indicate a speeding vehicle by noising a buzzer or blinking lights. Another method which is employed, usually in closed tourist areas or hilly areas is by timing the vehicle." In this method it will compare in-time of the vehicle and out time of vehicle and by using it will calculate the speed of the vehicle by using the distance formula. This is currently being used in many hilly areas.

B. Issues in Existing System

There are various different flaws which can be exploited by both sides of the law for their personal benefits. This may create mistrust among the citizens and increase the probability of the citizen trying to evade the authorities. We need traffic authorities to cover the large area and give salary to those traffic authorities. It is not as cost-effective. The area covered to cost ratio is very low. There is a chance of bribery where the rash driver may not be punished in a proper manner. It also breaks down the law system we have. The system relies on the trust of traffic officials. Some times the speed of the vehicle cannot be computed accurately.

Traffic authorities cannot work the whole day and also in the night. At night, visibility is much lower, which makes it harder to check if a vehicle is speeding. It is difficult to read the license plate for humans as well.

Limitations on Equipment:

The current devices are not extremely inefficient as they alert the authorities after the speeding occurs. Because of this, the authorities are too late to indicate to the rash driver or to start chasing them. If the speeding vehicle is beyond a certain speed, traffic authorities won't be able to chase them and then lose their sight.

2. METHODOLOGY

A. System Requirements

Before starting to develop the system, a look at the requirements will help understand the problems which we are facing. These requirements may either be something that is directly targeting the problem, or it can enhance the system as a whole. We can classify these requirements as functional requirements and non-functional requirements.

Functional requirements are those which specify how a system or component should act, while non-functional requirements specify the traits of that system.

- Input video should be of a predefined easy to process format such as .avi
- The system should be able to provide a live feed of what the camera sees online.
- Able to detect the speed of the vehicle
- Define the limited speed for objects
- Removal of shadows
- Online as well as the offline mode in case of network loss.

Following are some of the non-functional requirements that may be needed in the project.

- The user interface must be convenient to use and interactive.
- The system should be easy to set up and portable.
- The system should be modular so that parts can be changed easily in case it is required.
- The system should be robust and have a certain anti-theft system.

B. Proposed System

This section intends to briefly introduce the readers to the proposed system. There are modules involved in this system which each target a certain problem. The hardware part will consist of various parts. A camera for getting the input, a microprocessor to make necessary computations and a network module to send the data to the centralised server. A storage device is also required to store certain data in case of loss of network. When the network comes back, the data can then be sent. Whenever an object crosses the speed limit, the system will try to compute the Vehicle Identification Number (VIN) of the vehicle and send it along with other data such as speed, time of the event to a centralized server. The server checks in its database for previous incidents and based on that makes the decision to send the owner of the vehicle a ticket or just a warning.

3. SYSTEM ARCHITECTURE AND DESCRIPTION

This part covers the architecture of the system. It consists of a hardware part and a software part.

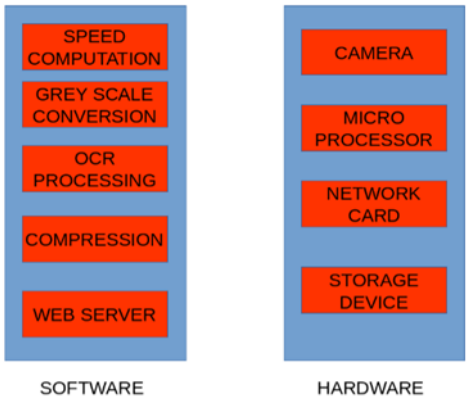

Fig 2: System Architecture Diagram

For the purpose of simplification, the architecture diagram is divided into two parts namely the software and the hardware part. Both the parts require frequent interaction with each other and amongst themselves. Apart from that, each of these parts is supposed to be modular i.e they should not depend on each other.

Hardware Modules:

1) Camera:

Fig 3: Camera supporting 720p at 60 frames per second (fps).

The camera need not be able to record high definition videos, but it should have a good framerate for getting better input. The quality of the camera should be good enough to compute the VIN through OCR. It should also be able to adapt to night time as there won't be any natural light. For that, a camera having more sensors such as thermal, infrared is required. The camera should also be robust.

2) Microprocessor:

Fig 4: Raspberry Pi: A Single board computer used for purpose of experimentation for this project

For the purpose of experimentation, we have used a full-fledged single board computer called raspberry pi. This board uses an ARM-based microprocessor and it has a controller which can perform complicated tasks. For real systems, other stripped microprocessors can be used which will reduce the cost of the device. They will also lower the complications of the system. The microprocessor should have a controller capable of managing network card and the input from the camera.

3) Storage:

The storage requirements depend on various factors. If the device is online, not much needs to be stored as most of the data will be transmitted.

But in case of network is lost the data needs to be stored for later retrieval or transmission. The amount of storage depends on the authorities and their predicted rate of response. If the rate of response is expected to be slow, then the storage should be high. But if the rate is expected to be quick, not much storage is required. No special kind of storage is required except that it should be robust. The data can be compressed to save space but this requires more processing power. If the video feed also needs to be stored, the most cost-effective option would be to use magnetic tapes. They are very useful for cold storage where access is not much required. The disadvantages of using a tape are that it is not good for random access look up. The data cannot be deleted from the middle. And a given tape can only be accessed by one process at a time.

Software Modules:

1) Speed Computation:

Fig 5: An image illustrating the two reference lines for calculation of speed.

The first thing that needs to be done for a given object is the calculation of speed. This is done by creating two imaginary reference points whose distance is known. One of the lines can be said as the entry line and the other exit line. Based on the time taken between the entry line and the exit line, speed can easily be calculated using the distance formula.

$$\text{SPEED} = \frac{\text{DISTANCE}}{\text{TIME}}$$

The speed is then compared against the speed limit of the particular way. If the speed is lesser than the speed limit, all the data stored is removed from the system. But if the speed is greater than the speed limit, then the images are sent to the next modules for further processing. This part can be done locally in vito or all the data can be sent to a centralized server for processing. Sending all the data requires a good network with high bandwidth as the amount of data can be quite high. But processing in place requires more processing power on individual devices which has a greater cost although the data that needs to be sent will be very low.

2) Conversion to grey scale:

For OCR processing the image needs to be converted to grey scale. There are various reasons for doing this and they are as follows:

a. Reduction of noise to signal ratio

For processes such as extracting text, color is not a useful property. We only need to identify the edges. Since we don't need color, it can be considered as noise.

b. Complexity of code

Finding edges based on chrominance and luminance is additional work which need not be done for something such as text processing as the information on color is just not useful.

c. Speed

Bringing color into the equation adds another level of computation that is not required for a task such as OCR processing. As extracting numbers from license plate requires the only distinction between the edges, we don't need to handle color as that will consume unnecessary CPU cycles.

3) Optical Character Recognition (OCR):

Fig 6: An image illustrating the use of OCR to find out the VIN of a vehicle.

Once a vehicle is found to be over speeding the VIN of the vehicle needs to be determined. The input is in the form of an image and that itself cannot be used directly. The data needs to be converted into a more usable form such as text format. Since the image is already converted to grey scale, this module only needs to extract the VIN from the image. A set of images can also be provided whose output can be compared against each other for better error verification. Once the VIN is identified it can be sent with other data as the speed, the time of the infraction, even the image of the vehicle can be sent.

4) Compression

The data that needs to be stored or send over network need can be compressed for efficiency. Compression itself is a CPU intensive process so it is a trade-off between CPU time vs storage.

There are two types of compression, lossy and lossless compression. Lossy compression strips down parts which are not required and lossless compression exploits statistical redundancy to represent data without losing any information, which means that the process is reversible.

5) Web Server

A web server will be required for the camera to be accessed remotely. This system proposes to have two types of servers. A centralized server where in all the data is sent for further processing. The other server will be on the remote devices. Each of them will have a specific ip address which can be used to access it. The access can be used to check for the status of the device, get logs, some stored data. It can also be used for changing its parameters such as the speed limit, based on the time of the day.

The system can also function without a web server. A web server is not required to send data but only to receive data or requests to be more accurate. But this will make it configuring the devices extremely inconvenient. If the speed limit needs to be changed, an engineer has to go and do it manually.

4. CONCLUSION AND FUTURE ENHANCEMENTS

In today's world, more things are being automated. The setup costs and running costs for electronic systems are very low in comparison to manual labor. Similar to how during industrial revolution the output to labor ratio increased exponentially, the upcoming age of automation will also see a similar output.

This system is highly configurable, robust and works like a clockwork throughout the day. The electricity and network cost is very low. If manufactured properly, the lifetime of the system can be very high and the rate of maintenance can be low.

The system can be enhanced to limit the amount of input being consumed. Currently, all the data, when a vehicle is inside the reference line is stored. But if the predicted speed of a vehicle is already lesser than the limit, it need not be processed any further.

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