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Automated Vehicle Verification System

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ABSTRACT

Objective: ***To Automate the system of vehicle verification on roads and to take punitive measures without human intervention.***

Providing the police and the government a powerful tool to keep a track of registered vehicles, their drivers and validity has been a daunting task. Manned police checkpoints are placed to establish the validity of a vehicles registration, and driver's license. This process is repetitive and ineffective, as it does not provide many countermeasures against counterfeit of registration documents and corruption in government services. Hence, this process can be automated. This paper proposes a very simple, yet effective way to tackle this issue, taking into account the on-going Unique Identification (UID) Project in India.

KEYWORDS

Automation; [5]Vehicle Verification; [1]Unique Identification; Vehicle Database; [2]Global Positioning System; [3]Radio Frequency Communication; [8]Secure Network;

1. INTRODUCTION

The number of vehicles on road today is more than ever. This situation is especially true in India due to the increased purchasing power of consumers. To add to this, the number of traffic management and traffic control personnel (traffic police) is not proportional. This puts extra load on traffic police who have to also monitor the validity of vehicles on the road. Moreover, the instances where commuters bribe the police personnel in exchange for permission to pass even when their vehicles or their licenses are invalid are quite prevalent. Not just this, due to excessive traffic, the verification process is quite long often resulting in inconvenience to the commuters in terms of traffic jams, etc. The implementation of an automated vehicle verification system solves all these problems: It reduces the work load on the police so that they may function more efficiently, it reduces or eliminates human interaction so that chances of bribery are reduced greatly thereby generating more revenue and, it makes the process of verification instantaneous thereby causing no inconvenience to the commuters. In fact, the commuter doesn't even have to know that his/her vehicle is being checked for validity.

The basic Principle behind this system comes from [3]Radio Frequency Identification (RFID). The system may be split into three important parts:

1. Vehicle Mounted Subsystem.
2. Checkpoint Mounted Subsystem.
3. [7]Central Online Database.

The vehicle mounted subsystem is basically a transmission-only setup. On the other hand, the checkpoint mounted subsystem and the central online database is a reception and transmission setup. Let us now go through the various parts of this system in more detail.

2. VEHICLE MOUNTED SUBSYSTEM MODULE

A basic implementation and interfacing of the different components inside the vehicle mounted subsystem module is shown in *figure 1*. Such a system would occupy negligible space in a vehicle and can be mounted on say, the dashboard of a car.

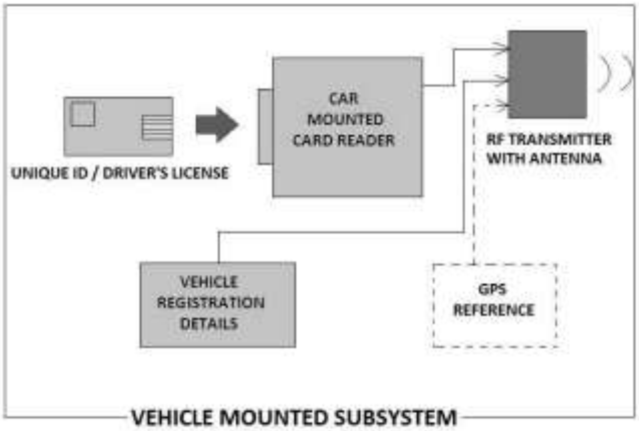
UNIQUE ID / DRIVER'S LICENSE
CAR MOUNTED CARD READER
RF TRANSMITTER WITH ANTENNA
VEHICLE REGISTRATION DETAILS
GPS REFERENCE
VEHICLE MOUNTED SUBSYSTEM

Figure 1

As can be seen in *figure 1*, this subsystem module contains 4 essential parts:

1. [3]Unique Electronic ID / Driver's License
2. Card Reader
3. Memory containing vehicle registration details.
4. [3]Radio Frequency Transmitter.

Another component also has the possibility of being interfaced to assist in tracking of invalid vehicles and their interception. This is a [4]GPS Device, whose reference can also be sent to the Central Online Database end so that the vehicle can be tracked remotely.

3. UNIQUE ELECTRONIC ID AND CARD READER

The Unique Identification (UID) Project is a huge undertaking with the objective of providing every citizen a unique electronic ID card which would be made universally acceptable. Our situation assumes that a person's driver's

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license would be integrated into the UID card so that just by analyzing the data in the card, it can be found out if the person is licensed by the government to operate a vehicle or not. Even in the current situation, many major cities are issuing electronic smart driver's licenses, which have a chip containing all the relevant details. Therefore, our system can very easily and efficiently be adapted to read such cards.

Moreover, the system can also be used without the need of electronic IDs if all the driver details are stored on the central online database and only a reference number is required to be read by the card reader. These details may also include the driver's bank account details, so that after notifying the driver, the applicable fine can automatically be deducted by the authorities. This can greatly reduce the inconvenience caused to the driver. The reference number can be in the coded form of a tamper-proof bar code. Therefore, whenever a vehicle passes a verification point, it transmits just this reference code to the central database, which then retrieves the data and verifies it. Therefore, in this case, the vehicle-mounted card reader need only be a simple bar-code reader. This is one of the reasons why this system, if implemented, can be quite affordable at the user end.

4. TRANSMISSION OF VEHICLE DETAILS

Apart from the driver details, the vehicle details are needed to be verified by the system. This calls for a very small memory device which has in it, stored, all the necessary details. But it should be noted that the only essential vehicle detail that needs to be transmitted is the vehicle's license plate number. When a vehicle passes through a verification point, it transmits just the vehicle's license plate number. The online database will already contain all the details of registered vehicles. Thus, it can use the license plate number as a reference to check the details of the vehicle. This would include its insurance details, and its RC details. Of course, for this to work, the central online database must be continuously updated with a vehicle's insurance details. This calls for all renewed insurances to be brought to the notice of the authorities so that they can update the central database. Also, in case the driver is himself not the owner of the vehicle, the system should send the fine notice to the owner and not the driver. Such a situation is common when people hire drivers. As can be seen, since the physical transfer of money has been removed, chances of bribery are next to zero.

Another advantage of using this system is for emergency vehicles. Today many cities have centrally controlled traffic signals (eg. B-TRAC in Bangalore). Emergency vehicles like ambulances, fire trucks and police cars need to get to their destination in a hurry and getting stuck behind traffic waiting at a traffic signal is not an option. Here, the automated vehicle verification system can be of use. Let us assume that a verification checkpoint has been setup right before a signal junction. Now, apart from the remaining vehicle details, an emergency code can also be transmitted by the vehicle when it is on an emergency call. When the receiver module encounters this signal, it can immediately notify the traffic signal management and they (automatically) can turn the signal green until the time the emergency vehicle has passed through. Also, in case the vehicle is not on an emergency call and has its siren and emergency lights off, the transmitter can also shut down the emergency code broadcast so that the automated vehicle management system treats it like an ordinary vehicle.

If a GPS devise is included in the system, the vehicle details will also need to carry the reference number of the GPS tracker inside the vehicle. This will facilitate real time tracking of the vehicle. This concept is especially useful in case of tracking stolen vehicles.

5. RADIO FREQUENCY TRASMITTER

This is the link between the vehicle mounted subsystem module and the central online database via the checkpoint mounted subsystem module. All the relevant data required to be transmitted are fed to the RF transmitter, which includes a modulator and encoder. The encoded signal is then transmitted to the checkpoint mounted module. The checkpoint would be less than 10m away from the vehicle when it passes it and therefore a low power RF link would suffice. Popular links like Bluetooth^{TM} and Wi-fi^{TM} may be used effectively in this situation. So, when the vehicle passes a verification point, these continuously transmitted signals are picked up and decoded by the checkpoint mounted subsystem module. Note that the vehicle module doesn't have the capability to receive any signal, so the signal traffic is one way only.

6. CHECKPOINT MOUNTED SUBSYSTEM MODULE

This module can be mounted on any roadside mount and it is not required for the vehicle to be stationary to be detected by this system. *Figure 2* illustrates the placement of such a module.

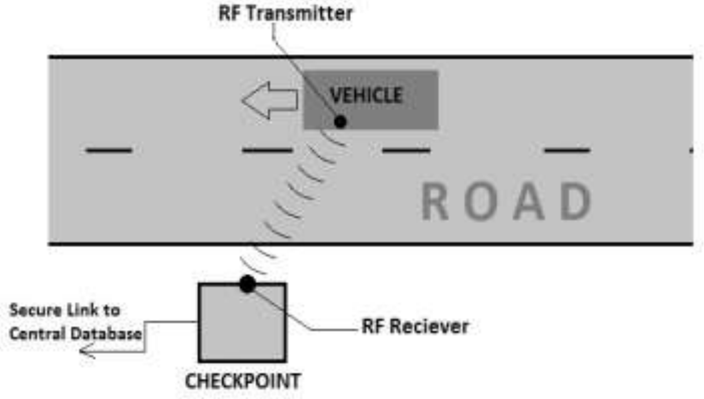

Figure 2

As can be seen from this diagram, the checkpoint need not be on the road itself in any obstructive position. Rather, it can be on the side of a road in a discrete location, provided that it maintains [3]line of sight. As mentioned earlier, the reception and verification of the vehicle can be done in a few seconds at most.

Figure 3 illustrates the internal interface of all the components in the checkpoint mounted subsystem module. As can be seen from the figure, the internal network contains 2 main components:

1. [3]Radio Frequency Receiver.
2. [8]Modem to transfer and receive data via Secure Network.

Note that the RF Receiver is meant to include the decoder within.

When the vehicle passes next to this module, its RF signals are picked up by the RF receiver. The receiver decodes the information and transmits it via a [8]secure network to the central online database. Once the information is transmitter, the records are checked at the database and the validity is established. Depending on the situation, a notification is sent to the nearest traffic police station if immediate interception of the vehicle is required. In case the offence only invites a fine, a notice is sent to the vehicle owner or the driver. Also, as mentioned earlier, the fine may be withdrawn from his bank account in case of UID implementation.

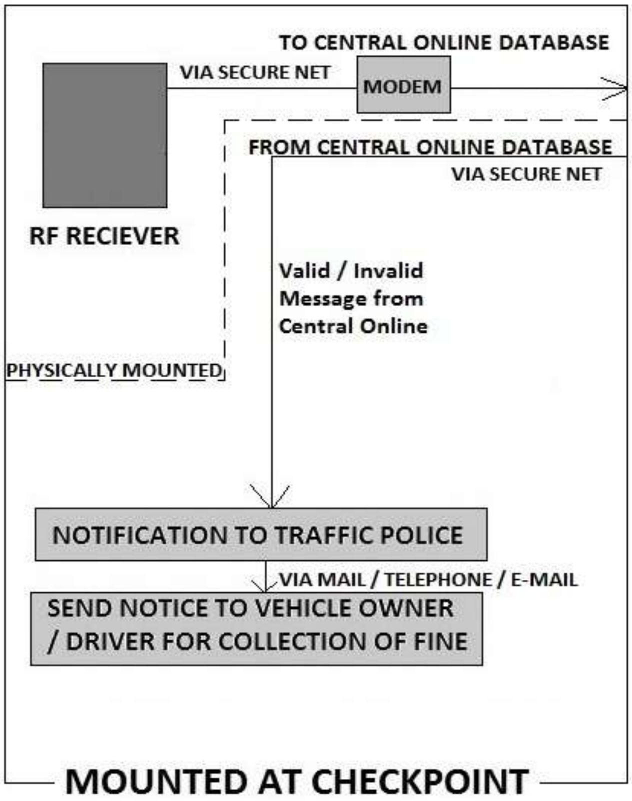
TO CENTRAL ONLINE DATABASE
VIA SECURE NET
MODEM
FROM CENTRAL ONLINE DATABASE
VIA SECURE NET
RF RECIEVER
Valid / Invalid
Message from
Central Online
PHYSICALLY MOUNTED
NOTIFICATION TO TRAFFIC POLICE
VIA MAIL / TELEPHONE / E-MAIL
SEND NOTICE TO VEHICLE OWNER
/ DRIVER FOR COLLECTION OF FINE
MOUNTED AT CHECKPOINT

Figure 3

Note that the only physical component that is actually necessary to be mounted at the roadside checkpoint is the RF receiver and the secure network modem. This is because the decoded signal from the RF receiver is fed to the modem and then to the central online database via the secure network. From there, the police is also notified via the same network (if available) or by other internal means. The police then notifies the owner/driver via regular mail or telephone etc. Thus, the roadside checkpoint for this basic implementation can be very cheap and very small.

The secure network mentioned here can either be an exclusive network meant only for this system to communicate with the central database and further to the police, or it can be a message sent over the regular secure communication link of used by the police.

6. CENTRAL ONLINE DATABASE

The implementation of the central online database would include server setups to actually host the database. At least for a state model, such database is readily available as information of all vehicles registered with their respective Regional Transport Offices would be stored in a centralized database. It is required that the automated vehicle verification system be made compatible with this database. The complete database should also include the vehicle insurance and other details.

7. ADDITIONAL FEATURES

An intrinsic flaw of this whole system explained till now is that if a fake transmitter transmits a code that is accepted by the receiver, it could cause fining a vehicle which did not actually commit any offence. This situation can be dealt with by the following improvements to the system.

We discuss two additional features that may be added to the automated vehicle verification system. The first addition deals with conformation of the fact that the vehicle has actually passed the checkpoint. The second addition gives the checkpoint a feature to monitor the speed of passing vehicles and thus act against over speeding vehicles.

1. The system we discussed till now can work perfectly well if there is no threat of an error in the RF signals sent by the vehicle module or of any miscreants using a fake RF transmitter in the same frequency band. This problem can be solved by introduction of a camera unit at the checkpoint. This camera needs to be a high speed and high resolution camera as it would need to be able to read the lisence plate of the passing vehicles, possibly over speeding. By use of [9]image processing software, it is possible to automate this reading process as well. It is also possible to obtain a legible image of the driver’s face[2]. The obvious advantage of this addition is to confirm the data received by the RF receiver. Another use of this feature would be that the image captured can be used as proof against the vehicle owner/driver.
2. The second addition would be that of a [6]Doppler radar gun at the checkpoint. Current Doppler radar guns used by police are handheld and require the police personnel to physically wait for a vehicle to pass. This makes it an easy process to automate. The speed captured by the Doppler gun can be sent to the central database where it can be compared against the maximum speed limit of that area and thus, the driver can be appropriately fined.

It should be noted that the addition of a high resolution image to the data to be transmitted would result in higher bandwidth requirement and/or reduced speed of transfer. Therefore, it is necessary that the image processing operation be carried out at the checkpoint itself. Also, the image should be transmitted over the network only if traffic offense has been committed. That is, after the photo is acquired, it should be locally processed to read the license plate so that its RF code can be checked against the lisence plate number. After this, it should wait for response from the Central Database. If it is decided that the vehicle/driver has committed an offense, then the image should be sent to the central database where it could be analyzed further and stored as proof.

Figure 4 illustrates the addition of these new components.

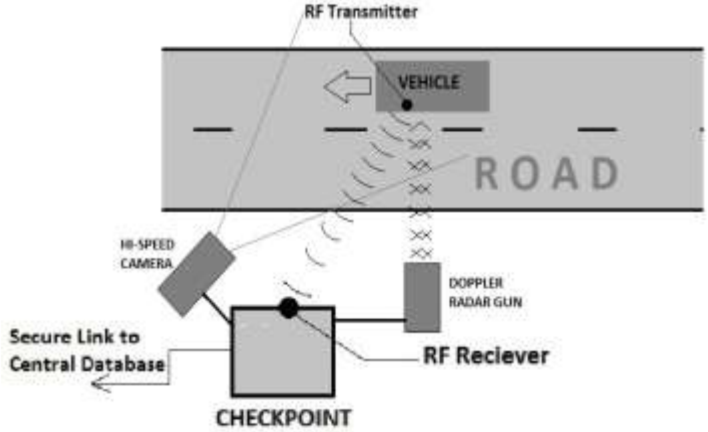

Figure 4

Note that with higher resolution cameras and better software, it is possible to obtain accurate speed reading from multiple camera images, thus eliminating the need for a Doppler radar gun. Therefore, the budget available should be considered while choosing between the two additions.

8. CONCLUSION

This paper presents the concept of an Automated Vehicle Verification System which intends to automate the process of vehicle verification on roads without any kind of human intervention. This paper started with the introduction of the concept and explains the requirement of such a system. It explains how such a system could be integrated with current system under implementation like the UID. Then follows a detailed overview of the technology used with the scheme of interfacing components and its brief working. Explanation is given about the different subsystems and how they are interfaced. The paper further explains what additions could be made to the system to give it more functions and make to more secure. The paper ends with a look at its future scope.

9. FUTURE SCOPE

The future for such a system is bright. Already, electronic driver's licenses are being issued, and soon the UID project will be completed, thus completing all the requirements for making such a system mandatory. Speed cameras and Doppler radars are currently being used by traffic police and even unmanned units are in service. Moreover, today more and more cars are being equipped with [4]Global Positioning System (GPS) for navigation. If this GPS device is standardized and implemented along with this system, then in case of a situation requiring immediate police action, GPS coordinates can assist greatly in the interception.

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