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Development of Front end Communication System for Traffic Congestion Monitoring System

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ABSTRACT: The paper provides the design and implementation strategy for the fully automated front end communication infrastructure for detection of traffic congestion in a junction and convey the message to the vehicle likely to pass that junction. Poles are placed along the roadside in which communication modules are installed. Similarly communication modules are installed in all vehicles as well. Pole modules will read the vehicle Identification number from the vehicle and transfer this data to a database in a Central server. The central server utilizes these data to determine the traffic congestion status of the road network by following a specific algorithm and convey the congestion status to the vehicle through the pole. The mode of communication realized in the system is wireless and wired.

KEYWORDS: ANPR, RFID, GSM, GPS.

I. INTRODUCTION

Transport system is considered as the life line of any nation. Road Infrastructure, because of its easy accessibility, flexibility in operation, door to door service and reliability occupies a dominant position in the transportation system. It is vital for unleashing economic growth and is a critical component of all inclusive growth. In the last few decades, road transport in India has registered tremendous growth and has become the most preferred mode of transport. The share of road transport in carrying the passengers and goods is more than 80% and 60% of the total passenger and freight movement respectively. According to these circumstances, the Intelligent Transport System (ITS) came into existence. Intelligent transportation system (ITS) is a term used for applying information technology to improve the performance of the existing transportation system. Information technology has been applied to transportation systems for various purposes. The primary aim of all of these applications is enhancing the safety and efficiency of the transportation system available.

The goal of this work is to design and implement a reliable and intelligent full-fledged front end communication system for traffic congestion monitoring system. It also aims to work as a better infrastructure for the following applications.

- Traffic jam detection
- Toll collection
- Speed limit enforcement

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- To check vehicle and driver's license
- To provide traveller aiding information
- Traffic modelling
- To suggest routes for drivers.
- To detect stolen vehicles
- Traffic rule violation detection
- To improve traffic management(such as traffic signal coordination)
- In accident cases for tracking the vehicle who did the crime as well as for detecting the vehicle which became a prey.

A. *Traffic congestion monitoring system*

"Traffic Congestion Monitoring System" alerts the driver about the traffic congestion condition of the nearby junction. It can be implemented in lanes and junctions which carry heavy traffic. The RF transceiver module is used for transmitting and receiving messages. When congestion is reported at nearby junction corresponding alert message has been sent to the vehicles that are likely to pass through that junction. This facilitates the rider in taking an alternate congestion free route, avoiding being stuck in the traffic jam (congestion). This helps in diverting the traffic and hence reducing congestion.

The traffic congestion in a particular junction can be detected from the data updated in a database. The front end communication system helps to update the database at the control centre by loading the vehicle identification number which is received from the vehicles in junctions or lanes. If a set of data updated by a part of this front end communication infrastructure installed in a junction is same for a particular interval of time, then there is a chance for traffic congestion. This algorithm is running in the database at the control centre. The resulting alert message from this algorithm regarding the congestion status at that particular junction is conveyed to other vehicles through the front end communication system, so that those vehicles can choose alternate congestion free path.

II. TRAFFIC RELATED TECHNOLOGIES

Various technologies have been used to enhance the existing infrastructure of transportation systems. The following are just an example of these technologies.

A Doppler radar is specialized radar that makes use of the Doppler Effect to produce velocity data about objects at a distance. Doppler radars are used in aviation, sounding satellites, meteorology, police speed guns and radiology. By measuring the deviation in frequency of the reflected signal the speed of the vehicle is being calculated.

Sensor systems may be subsurface (e.g., loop detectors), roadside (e.g., laser profilers), or overhead (e.g., infrared beams). Their primary uses are in detecting the presence of a vehicle, counting the number of axles, helping in classifying vehicles, and counting the number of vehicles crossing a point. They also serve as gatekeepers by triggering other vehicle identification systems. Two consecutive sensors on the road is used to detect the vehicle speed[1]. Magnetometers and Inductive loops are examples.

Automatic number plate recognition (ANPR) is a mass surveillance method that uses optical character recognition on images to read vehicle registration plates. Systems commonly use infrared lighting to allow the camera to take the picture at any time of the day. ANPR technology tends to be region-specific, owing to plate variation from place to place[2].

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Transponders are becoming a common form of vehicle identification. In this technology, an RFID chip is embedded in a unit or sticker, called an electronic tag, which is mounted on the windshield near the rearview mirror of the vehicle. As the communication module in the vehicle passes near a gantry with a mounted radio transmitter, it responds to the radio signals. One drawback is masking of the signal by metalized windshields. Laser and infrared signals have also been tested, but the radio spectrum provides the greatest level of accuracy [5]. The global positioning system (GPS) is the only fully functional global navigation satellite system, utilizing a constellation of at least 24 medium earth orbit satellites. As for the transportation field it is widely spread for navigation [6].

In cell phone technology, a cell phone device would be installed in a vehicle, and frequent communication between cellular towers and the device would determine the vehicle's location. This technology appears to be technically feasible. Installing a cell phone in a car will likely be less expensive. In addition, the infrastructure needed (cell phone towers and user/accounting systems) already exists. However, coverage in remote areas is still spotty [6].

III. SYSTEM ARCHITECTURE

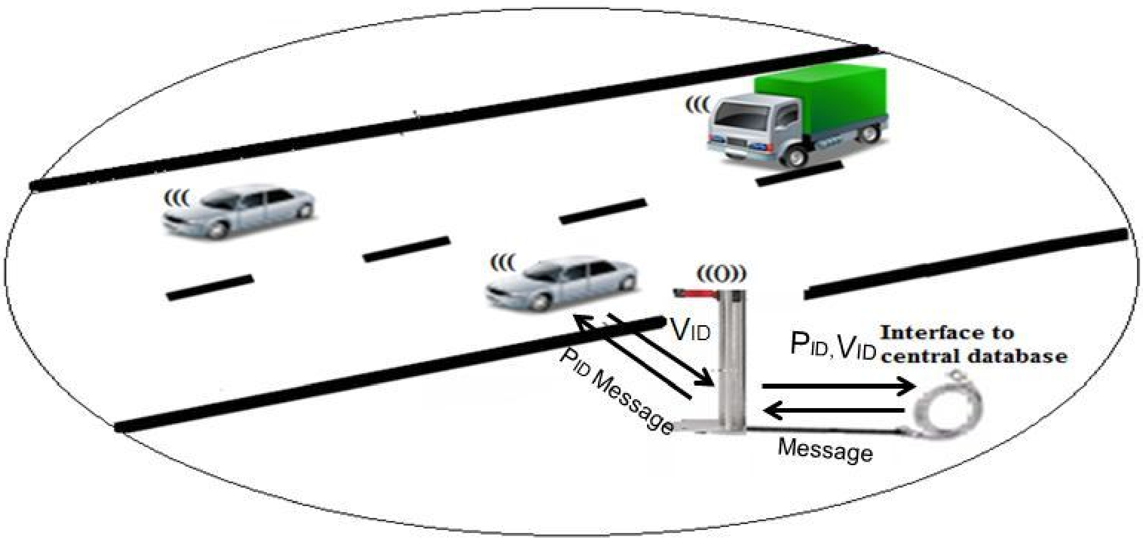

Fig.3.1 System overview

Fig.3.1 shows the system overview. This architecture of proposed data collection system is as follows. The system can be divided into three main Units. The subsystem installed in all vehicles, the subsystem installed in all roadside poles and Database at the traffic control centre. There should be two communication links between these three units. A communication link between the module in the vehicle and pole and another link between the module in the pole and the traffic control centre. Between two adjacent junctions, poles are placed about 1Km apart.

Each vehicle contains a communication module with its unique identification number embedded in it. Similarly each pole contains a communication module with unique pole ID. Communication module in the vehicles transmits its vehicle ID while receiving a request from the nearby pole module. When the module in the pole receives this vehicle

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ID, it will attach its own unique pole id with the received vehicle ID. This combined information (Vehicle ID and Pole ID) is then sent to the database through a network. Similarly data from all other poles including the junction pole will update the database. Based on these received details an algorithm running in the database will detect the presence traffic congestion at junctions. The message regarding the congestion at any junction will be sent to the poles in the neighbouring junctions. From those poles this message will be forwarded to the vehicles and will be displayed on the LCD screen in the vehicle, so that the driver can take an alternate path to escape from congestion. By rerouting vehicles in this way, the present prolonged congestion problem could be eliminated.

A. The subsystem installed in the vehicle

Fig.3.2 shows the block diagram of subsystem in the vehicle. The subsystem to be stationed in the vehicle has an RF transceiver module, a microcontroller unit, a display and necessary power supply units. Microcontroller is the controller of all other devices in this subsystem and takes decisions based upon the algorithm which have been created. The role of the subsystem in the vehicle is to send the unique vehicle identification number (VID) to the pole in response to its request and receive the message from control centre through the pole to inform the driver by displaying that particular message. The message can be any traveler aiding information. Here it is used to inform messages regarding the congestion status. The RF transceiver module sends data and receives message at arbitrary time intervals. The send packet contains vehicle identification number (VID). The packets may be received by roadside pole modules to update the database at control centre.

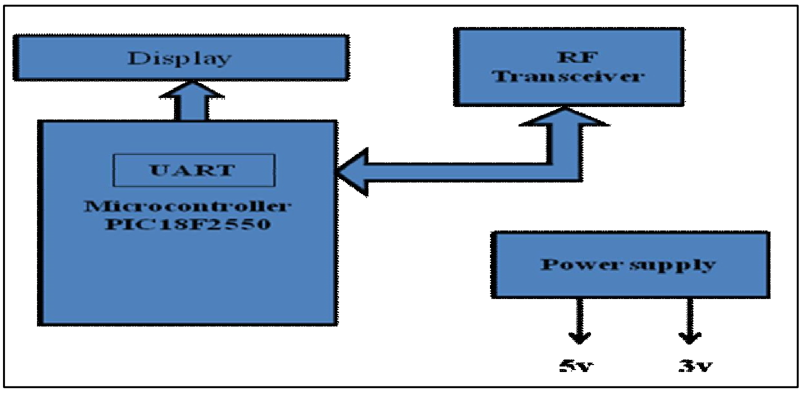

Fig.3.2 Block diagram of subsystem in the vehicle

B. Subsystem on the road

Fig..3.3 shows the block diagram of subsystem in the pole.The subsystem to be stationed in the roadside pole has an RF transceiver module, a microcontroller unit, and a network interfacing unit and necessary power supply units. Microcontroller is the controller of all other devices in this subsystem and takes decisions based upon the algorithm which have been created. The role of the subsystem in the pole is to broadcast request signal to vehicles, receive the VID from the responded vehicle, retransmit this VID after attaching its own pole id to the control centre for updating the database, receive traveller aiding information from control centre if any, and retransmit the received information to the vehicle to inform the driver.

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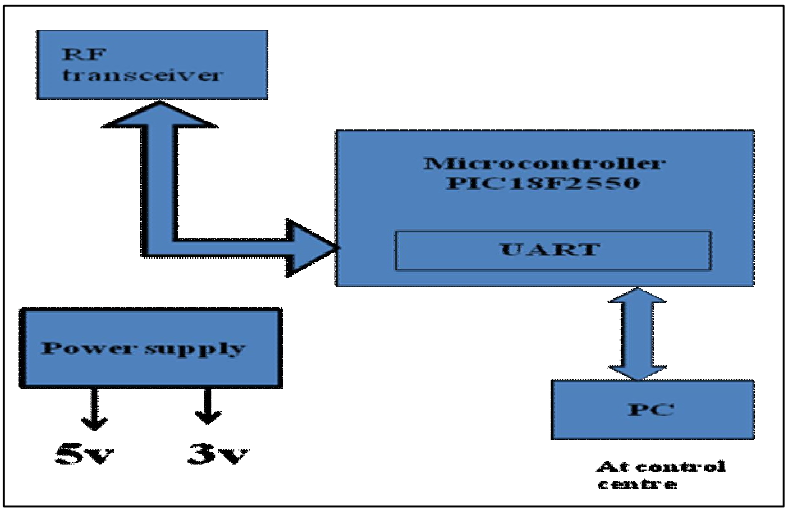

Fig.3.3 Block diagram of subsystem in the pole.

C. Vehicle – pole link

Vehicle – pole link uses two 1GHz FSK transceivers designed for ISM band operating in two-way communication mode. Two way communication has the following advantages. The communication module in the vehicle can only transmit in case of receiving a request from the communication module in the pole. The system may be used as a building block for other future applications which are easier to implement using two-way communication links.

D. Pole – traffic control centre link

The link between the pole and the traffic control centre is needed so that the control centre can be used to acquire data and send useful information to the driver after detecting traffic congestion at any junction poles. This link may use a wired connection. The existing infra-structure of power lines or telephone lines may be used. An alternative way is to use the computer network between each communication module in the pole and the control centre. In this case a dedicated single board network interfacing unit is needed to be designed.

E. Data packet format

It includes packet data in the format as shown below.

- Vehicle registration number

District code	*Sub-regional code*	*Series representation*	*Series representation*	*4-digit number*
1Byte	1 Byte	1Byte	1Byte	2Bytes

Fig.3.4 Vehicle Registration Number packets

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To represent a vehicle registration number registered in a state, it requires minimum of 6 bytes. District code specifies which district to which the vehicle is registered. For 14 districts it needs about 1 byte field. Sub regional code specifies which RT(Road Transport) area the vehicle is registered to. Series representation indicates the number series. First 1 byte is used for future expansion. Whenever second 1 byte field reaches Z series, only then first 1 byte is used. The remaining 4-digit number indicates the registration number of the vehicle. It should need about 2 bytes for representing all possible combinations.

- Pole identification number

District code	Sub-region code	Pole identification number
1 Byte	1 Byte	1 Byte

Fig.3.5 Vehicle Registration Number packets

District code and Sub regional code specifies the same pattern as in vehicle registration number. Pole identification number should need 1byte to represent about 255 poles.

IV. SYSTEM OPERATION DESCRIPTION

The primary application of our data collection system will be traffic congestion detection. For such applications multiple pole modules should be located on streets, on highways and on junctions. Each of these communication modules in the poles should be having a unique identification number and a coverage area of about 1Km^2, in such a way that the coverage areas of adjacent poles should not be overlapped. Sufficient gap should be provided between these adjacent coverage areas so that at a time a vehicle will be in communication with only one pole. When a vehicle passes through the coverage area of a certain pole, the communication module in the pole will request the ID of the vehicle. The vehicle will reply by its Identification number. All poles including junction poles will attach their own unique Pole ID to the received Vehicle ID and send to the central server. By running an algorithm, the server will detect and inform the driver about the presence or absence of traffic congestion at nearby junction.

If there is a group of vehicles passing through the coverage area of a certain pole, they will respond to the request simultaneously and it will increase the chances of data collision. For avoiding data collision we want to encourage the spontaneous response of only one vehicular module by preventing the response of other vehicular modules. For this purpose, the responding vehicle will first broadcast an ant-transmit signal (ATR) to other vehicles as well as to the pole module. Thus only the module in the vehicle that responds to the request first will be in the transmission mode and all other transceivers in other vehicles, those received the anti transmit signal will be in receive mode. Vehicles will not respond to any other sort of signals other than from a pole. The module in the pole will receive the 'anti-transmit' (ATR) signal as an acknowledgement to its request and send back a 'Receive Ready'(RR) signal. While receiving this RR the vehicle will send it's vehicle ID to the pole along with end of transmit signal (EOT).

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V. CONCLUSION

This paper proposes a design for 'a front end communication system for traffic congestion monitoring system' Due to the implementation of data collision avoidance algorithm, we can ensure the correctness of data. Both vehicle and pole modules are having a low cost implementation and the cost of vehicle module is affordable by a vehicle user. The system is very reliable because the pole modules communicating with vehicle modules are installing along the roadside poles, so that for most of the time a vehicle will be under the coverage of any one of the adjacent poles.

The main attraction of the system is that both pole-vehicle link and pole-server link are in duplex mode, and hence it can act as a better infrastructure for many other traffic related applications.

As future expansion we can appropriately configure this infrastructure for toll collection, vehicle tracking, low enforcement applications etc. The requirement of a dedicated single board network interfacing unit can lead to the design and development of the same.

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