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A semi urban city traffic management using wireless technology

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Abstract—handling semi urban and urban traffic is one of the main challenges addressed by today's traffic management systems. There are many traffic managements systems such as conventional, automatic, intelligent using image processing technique which have its own limitation for its practical implementation especially for countries like India. A customized traffic management system using embedded system and wireless technology is designed which operates in three different modes to manage the semi urban road traffic. The proposed system assists the traffic police in handling uneven road traffic across many traffic junctions without requirement of an additional manpower.

Keywords—Traffic controller; GSM; Embedded system;

I. INTRODUCTION

Traffic light signals are signaling devices positioned at road intersection, pedestrian crossing and other locations to control competing flow of road traffic. It requires control and coordination mechanism to ensure that traffic moves as effectively as possible. As the population of the modern cities is increasing, the vehicular travel is also increasing leading to blocking on roads. The average number of vehicles in India is growing at the rate of 10.16% per annum over the last few years [1]. Spending hours in traffic jam has become part and parcel of semi urban and urban life style, leading to health and environmental hazards. Handling traffic congestion on city road is one of the main challenges addressed by today's traffic management systems. Traffic on city roads many times leads to delay in emergency services (i.e. Ambulance, Firefighter, Police, etc). A variety of different control systems are used to accomplish this, ranging from simple clockwork mechanisms to computerized control systems that self-adjust to minimize delay to people using the road. Intelligent traffic management systems (ITMS) can reduce the negative impact of blocking, though cannot solve it altogether.

ITMS in India cannot be a mere replication of deployed ITMS in the developed countries rather it needs to be adapted to the Indian scenario. In this paper, we present a brief review of available traffic management systems and its deployment. We also present a prototype model to provide a solution using GSM technology to the problem faced by the traffic police of a semi urban city where the traffic signal lights are controlled by a simple independent control unit.

II. RELATED WORKS

In real world there are many traffic management schemes established already. These schemes are described in the following sections.

A. Conventional traffic management Scheme

In conventional traffic management scheme, a police officer stands in middle of the road monitors and controls flow of traffic. At the time of road blocking or emergencies congestion office in charge can decide the lane which requires more priority and gives signals to the vehicle driver whether to drive or stop. This scheme is most proficient than any other technique. But as it includes human as a part of system this scheme is inadequate. Efficiency of system depends on experience and capability of the person.

B. Automatic Traffic Management Scheme

Here fixed traffic poles with green, yellow and orange colors bulb / LEDs (light emitting diode) are used at the traffic junctions that display the traffic signals. In this case, the control system is programmed to display traffic signal lights in predefined sequence [2]. In some circumstances, it is not feasible for drivers to view from different angles of the road if they are behind a heavy motor vehicle or being unmindful of the traffic light. This can lead to various problems like delay in traffic flow and un-mindful jumping of traffic. Generally for each lane green light is on for 60 to 120 seconds which permits for traffic flow. Before green light, yellow light flashes for 20 second, signifying to start the vehicle and be ready to go. When traffic clearance is given at a particular lane, red light is on for the remaining lane, ordering each vehicle to stop. This system cannot identify emergency vehicle and therefore there are chances of delay in emergency services. In absence of police, drivers are tempted to disobeying signal rules causing serious accidents. Therefore CCTV (Charge coupled Television) cameras are placed at these junctions to monitor the smooth traffic flow and levied fine against offenders.

The modern traffic controllers typically contains a power panel, a detector interface panel, to connect to loop detectors and other detectors; detector amplifiers; the controller itself; a conflict monitor unit; flash transfer relays; a police panel, to allow the police to disable the signal; and other

components.[3]. A lot of advancements have been made in the traffic light control systems such as set-ups function according to the 'time-of-day' principle. Further research and knowledge of the applications of modern traffic controllers state that the vehicle-actuated controllers operate with an improved workability [4.5].

C. Intelligent Traffic Management Scheme based on Image Processing

This scheme contains cameras, which are meant to measure length of traffic in the system. Cameras are mounted on a high pole so that they can cover long distance. Video footage covered by camera is analyzed by a computer chip in order to detect object (i.e. car, truck, etc.) on road by using different object detection techniques. Cameras are also useful in detection of violation of traffic laws. An intelligent traffic controller using real time image processing is discussed in [6] where the image sequences from a camera are analyzed using various edge detection and object counting methods to obtain the most proficient technique. Subsequently, the number of vehicles at the intersection is evaluated and traffic is efficiently managed. The author also proposes to implement a real-time emergency vehicle detection system where the lane is given priority over all the others in case an emergency vehicle is detected in any particular lane.

Today, vehicle-actuated controllers are gaining more popularity as they hold a supreme capability of managing traffic flow on real-time basis [7]. An intelligent traffic light controller utilizing the fuzzy logic technology and image processing technique is found in [8]. A fuzzy logic control has been implemented to provide the attribute of intelligence to the system. For real-time image acquisition, the process is further linked to the fuzzy logic controller which generates a unique output for each input pattern. Here image processing and fuzzy logic tool boxes of MATLAB are used where the final output is sent to microcontroller to drive the traffic signals in the desired manner. The results obtained show an improvement of 26% in the overall outcome of traffic management as compared to the conventional traffic controller, marking great feasibility and practicality of the current model.

A new approach for controlling the traffic light by image processing is found in [9]. The system will detect vehicles through images instead of using electronic sensors embedded in the roadway. A camera will be installed alongside the traffic light. It will capture image sequences. The image sequence will then be analyzed using digital image processing for vehicle detection, and according to traffic conditions on the road traffic light can be controlled.

D. Intelligent traffic management scheme using Wireless Technologies

In this scheme, emergency / VIP (very important vehicle) vehicle and traffic signal are equipped with wireless antennas and receiver. As emergency vehicle come near to traffic junction, it transmit a signal, to notify traffic signal about its presence. As soon as traffic control unit receives signal from emergency vehicle, it gives green light to that particular lane, in which emergency vehicle is coming. An intelligent traffic signal control system using IR sensors, AVR32 microcontroller with and built in 8 -channels ADC has been designed [10]. Infra red (IR) sensor is programmed to detect emergency vehicle and microcontroller is designed in such a way to give red signal to all other lane but one with emergency vehicle. The major concern here is to protect IR sensors from various climatic conditions present in India. Battery backup and protection case requires additional cost for its practical implementation. An effective scheme for control/ management of traffic blocking using active RFID (Radio Frequency Identification) and GSM technology is designed by [11] which have a provision of detection of traffic congestion and management.

Automation combined with the increasing market penetration of on-line communication, navigation, and advanced driver assistance systems will ultimately result in intelligent vehicle highway systems (IVHS) that distribute intelligence between roadside infrastructure and vehicles. This is one the most promising solutions to the traffic congestion problem. The various traffic management architectures for IVHS such as PATH, Dolphin, Auto21 CDS, etc. are compared and presented in [12] along with an idea of adopting existing traffic control methodologies to an IVHS based traffic control set-up. Currently the use of wireless sensor and embedded technology has proved to be very beneficial in designing Traffic Light controller (TLC) which could dynamically be operated to minimize waiting time of vehicle and to manage traffic load. Here traffic clearance will be intelligently decided based on the total traffic on all adjacent roads. Thus optimization of traffic light switching increases road capacity, traffic flow and can prevent traffic congestions.

All the traffic managements systems that are discussed have its own advantages and limitations for its practical implementation in developing and highly populated country like India. Most of the advanced approach may not suit semi urban or urban traffic of India. In addition, advanced traffic management is costlier when compared to the conventional systems which require less budget allocation. Indian government has its own limitations in adopting high end traffic management system for semi urban or urban traffic control even though it is under road map. We have come across an urgent requirement from Karnataka police department for handling urban traffic signals remotely without much modification for the existing systems. This is required for them to alter the predefined sequence of traffic signals remotely whenever there is an uneven traffic flows across the traffic junction and during emergency.

III. Proposed Traffic Management Scheme

The proposed system controls the traffic light controller remotely by using wireless technology. The system has the option of automatic and wireless control of altering traffic signal sequence. The wireless mode can accept the command sent from GSM mobile in the form of SMS (short message sequence) for changing the order of sequence of clearing traffic. This will assist the traffic police to take control of traffic signal and alter it as per existing traffic state. The block diagram of the proposed traffic management system is shown in figure 1.It consists of four sets traffic signal lights at each junction having of 3 color LEDs (Light Emitting Diode) for each lane. Traffic signal lights in each junction are controlled by the control unit interfaced with GSM modem having a specific identification number and the rest of the operation of the traffic signal light mounted on the pole similar to the conventional traffic light system. In the normal situation, the system is programmed such that the green light corresponding to a particular lane will be turned "ON" and other lane signals will display "RED" and repeated in a cyclic order with a specified fixed delay ranging from 60 to 180 seconds. In case of emergency or sudden rise in the density of vehicles in a particular lane with respect to other lanes, the situation may warrant the traffic police to clear the density of vehicles to ease out the rush. The traffic police officer who is situated near the junction will send a command to the control unit to interrupt the normal sequence of operation and to alter the sequence or delay time or to increase the ON time of the specific lane through his mobile handset. The execution of embedded system program sequence is explained in flow chart as shown in figure 2.

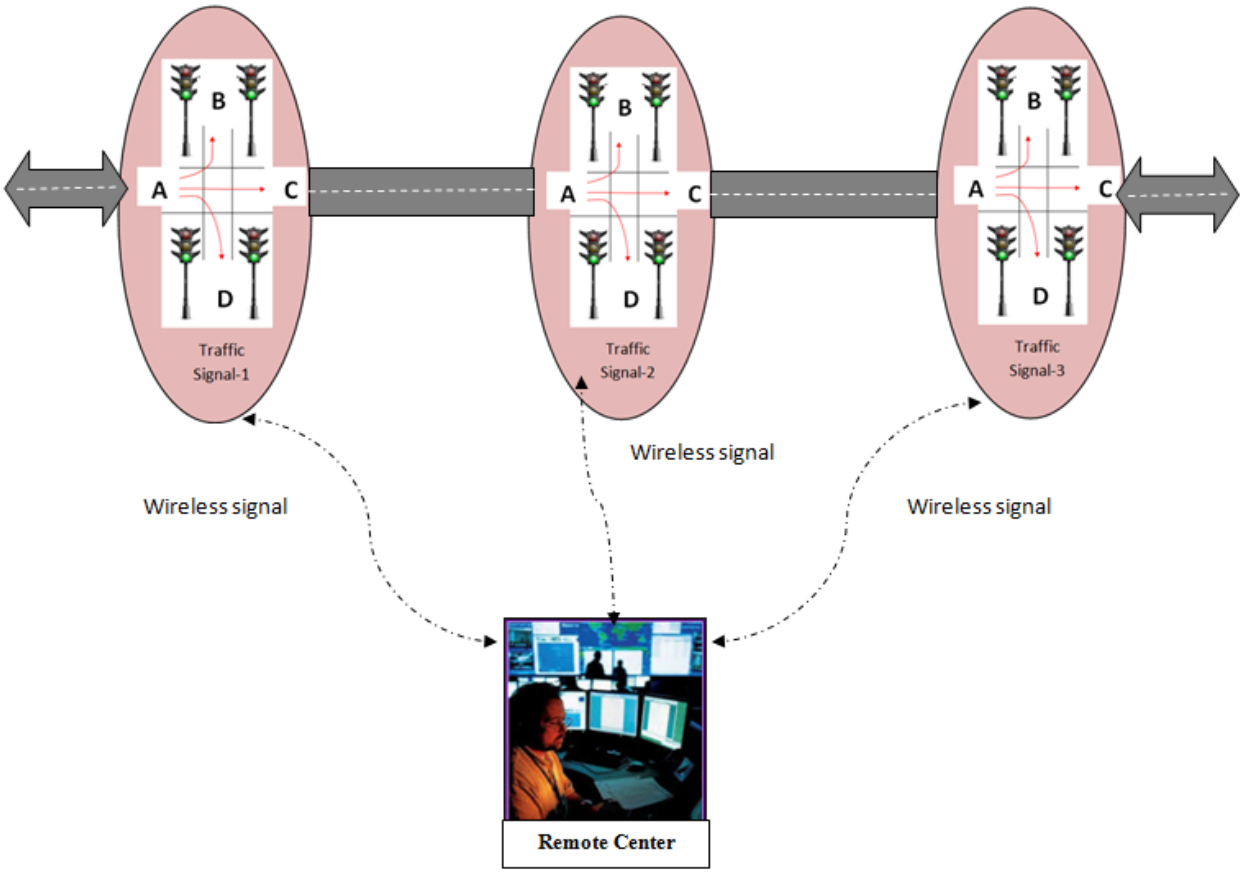

Fig. 1. Block diagram of Traffic Management System

We have considered the practical case of road traffic management in one of the semi urban cities of India. The proposed traffic management system works in three modes which are discussed in the following sections.

A. *Traffic management system operating in Mode-1*

The traffic signal light control unit is programmed for predefined delay where the traffic lights in each lane will turned ON /OFF for the specific period of time irrespective of traffic capacity. This mode of operation is not suitable to handle the uneven flow of traffic as the effective waiting time across the signal would increase in spite of less traffic across the particular lane.

B. *Traffic management system operating in Mode-2*

In this mode, traffic signal light control unit operates in two modes viz, automatic and wireless mode. The automatic mode of operation is similar to the mode-1 discussed earlier.

In wireless mode the traffic light signal control unit interfaced with GSM modem receives control command by the mobile hand set and changes the traffic light signal delay as per the requirement of the police officer who is in charge of the junction. Here traffic police officer can alter the sequence of traffic signal as soon as he notices an uneven flow of traffic across any lane. Since the mobile phone operation does not require line of sight, the traffic in charge can control the traffic from any point across the road junction.

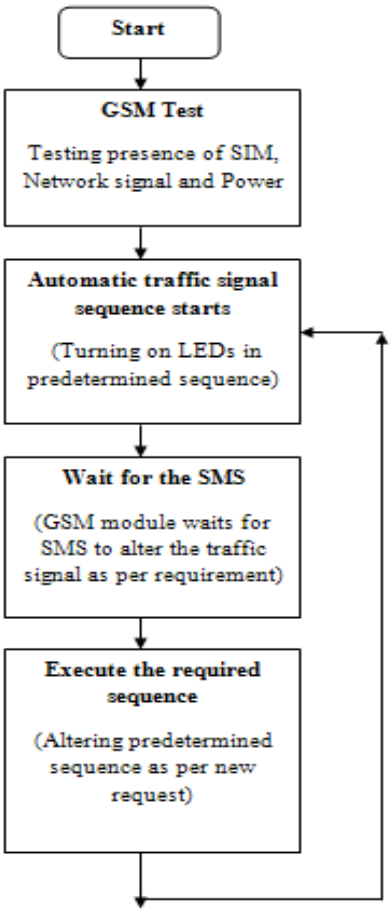

Fig.2 Flowchart of overall system working

C. Traffic management system operating in Mode-3

The major limitation of mode-2 operation is there is a lack of synchronization of traffic signal lights on the same road at various junction points which results in huge rush at a particular junction and poses a problem to the traffic police. In these situations clearing of uneven traffic at one junction could lead to congestion at another traffic junction unless they are controlled synchronously. This concern is taken care in mode-3 operation. Here all the traffic junctions are installed with CCTV cameras and monitored from remote control room. The person sitting at control room can visualize the live traffic captured from CCTV cameras and can control the traffic signals across many junctions through mobile phone. The traffic light signal controller with GSM modem located in each traffic junction receives the command sent from control room through Mobile handset controls the traffic signal lights according to the situation. In this way, traffic in charge will get complete control over many traffic junctions and therefore more effective in controlling uneven traffic flow.

IV. CONCLUSIONS

We have discussed an overview of traffic management system and its applicability for Indian scenario. Though there are advanced traffic controller designs available in literature, the current requirement of handling traffic lights by police is not met in cost effective manner. Our prototype design of remote traffic management using wireless technology is being appreciated by the traffic police department and is planning to incorporate to adapt the existing system as we proposed. The proposed design is simple, cost effective and easy to operate.

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