An Automatic Traffic Light Management Using Vehicle Sensor and GSM Model

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Abstract— Recently, management of road traffic is fast becoming a matter of grave concern. The number of accidents on roads has increased greatly in vehicle traffic, so it is the necessity to build a safer and much more reliable system for traffic. In this paper, we are going to achieve this by using an Automatic Traffic Light Controller (ATLC) which co-ordinates the network of traffic lights of all signal junctions. In this controller, TC-QT50, a vehicle sensor is connected to the Embedded System (ES) which in turn is connected to the server through Global System for Mobile Communication (GSM) for sharing information regarding congestion. The server controls the TLC of all the Signal Junction (SJ) and manages the traffic efficiently. A GSM device is fitted in all the vehicles, so that they can reroute and the Emergency services can get green signal when it reaches a junction. This system efficiently avoids the congestion without any barrier.

Index Terms— Embedded System (ES), General Packet Radio Services (GPRS), Global System for Mobile Communication (GSM), Liquid Crystal Display(LCD), Mobile Intelligent Traffic Control System (MITCS), TC-QT50, Traffic Light Controller (TLC); *(keywords)*

1 INTRODUCTION

In most parts of the world, traffic congestion is a serious problem lights as traffic lights have a meagre setup using a microcontroller with fixed signal timing[1]. This leads to long queues at traffic lights causing congestion on roads and extreme discomfort to road users, which in turn leads to excessive disobedience of traffic signals and accidents. Traffic congestion also reduces the efficiency of transportation infrastructure and increases travel time, air pollution, and fuel consumption.

Intelligent traffic control system proposed in [1] is based on the spacing between the vehicles but this system is not 100% accurate. Design of intelligent traffic control system based on DSP and Nios II. Using Dual-CPU, Intelligent Traffic Control System combined with logic control in FPGA has been discussed in [2]. But this system is not cost effective.

For an intelligent traffic control system before implementing any control algorithm, it is necessary to monitor the traffic frequency first. There are various ways to monitor the traffic like, video image processing [3], vehicles counting through intersecting proximity/ touch sensors array.

Different countries have their own traffic control systems. A novel traffic control system framework, the Mobile Intelligent Traffic Control System (MITCS), designed for Taiwan is proposed in [4]. Similarly, an intelligent traffic control system is operational in Beijing by the name SCOOT [5].

In our proposed system we are going to use TC-QT50sensor wired to Embedded System with GSM technology. Therefore a complete Automated Traffic Light Controller is designed which manages the traffic efficiently and automatically without any human support. The sensor is very accurate and sense vehicles for larger distance in all temperature. GSM acts as a wireless network to send warning signals to server, Signal Junction (SJ), Congested Signal Junction (CSJ), Highly Congested Adjacent Signal Junction (HCASJ), Less Congested Adjacent Signal Junction (LCASJ) and vehicles including emergency services. The vehicles can reroute if possible and emergency services can get green signal if needed without any human interference.

A. Global System for Mobile Communication (GSM)

The GSM standard originally described a digital, circuit switched network optimized for full duplex voice telephony. The packet data transport is done via GPRS (General Packet Radio services) and it is increased via EDGE (Enhanced Data rates for GSM Evolution) referred as EGPRS.

B. TLC

A traffic signal is typically controlled by a Traffic Light Controller, placed inside a cabinet mounted on a concrete pad. Traffic controllers use the concept of phases, which are directions of movement grouped together.

C. TC-QT50-D

The TC-QT50-D is a radar-based sensor for detection of moving or stationary vehicles. Fully weatherized, this sensor can withstand extreme temperatures, wind, snow and ice. The TC-QT50-D offers flexible mounting options as it can be mounted up to 40 feet away from passing vehicles.

D. Embedded System

An embedded system is a special-purpose computer system designed to perform a dedicated function. Unlike a general-purpose computer, such as a personal computer, an embedded system performs one or a few pre-defined tasks.

2 EXISTING SYSTEM

In general, Intelligent Traffic control System is based on microprocessors and microcontrollers using inductive loop, or the sensors in which, the Traffic signal changes from lane to lane according to fixed time intervals so that even the empty lane used to get the green signal for fixed time. Even though the traffic is automated, there is still a need for Human Traffic controller to let the emergency services pass and to control the vehicles violating the law. The sensors used are not accurate and are used for shorter distance. Even though it is automated, it requires remote monitoring by wireless networks. Therefore, it takes more time to free the congested lane, which delays the waiting time of other lanes. Here the cost and fuel consumption is increased.

3 DESIGNING ATLC

A. Architecture of ATLC

A simplified ATLC is shown in Fig.1, where TC-QT50, a vehicle counter sensoris mounted on the TLC on each lane. An ES, which consists of Microcontroller and GSM will be placed on each SJ and is wired to each TC-QT50, so that the vehicle count from sensor will be given as input to the ES. Based on the count, the traffic signals are displayed in each SJ and the total count summed for each lane will be send to the server with its name via GSM. Finally, the server will send the warning signal about the congested lanes and SJ to the ASJ and vehicles using GSM technology.

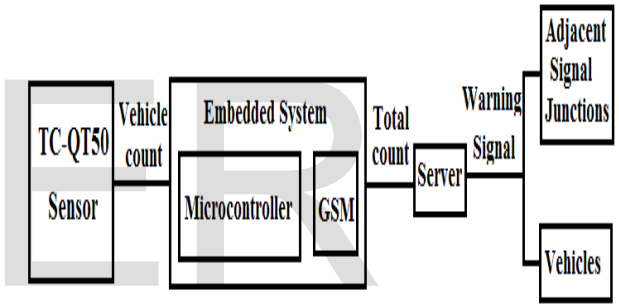

Fig. 1 Architecture of ATLC

From Fig.2 it is shown how the counts from sensor is amplified and converted into digital signal to be given as input to microcontroller and then to traffic light for making decision.

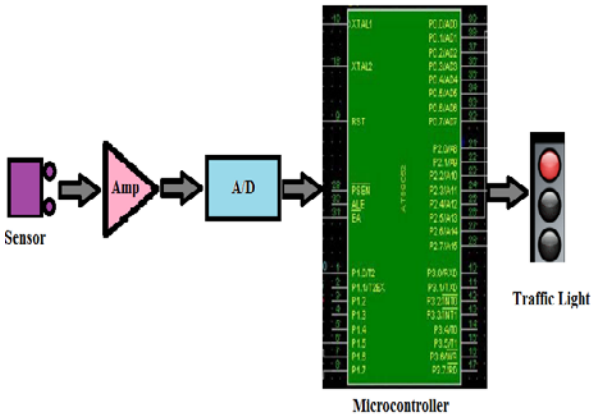

Fig.2 Architecture of Sensor

B. Signaling Management System

From Fig. 3, the Signaling Management system includes Time Management, Signal Management and Connection Management. These three modules further divided into corresponding sub modules. Time management system fix a waiting time as 2 minutes for every lane getting a green signal and pedestrian walk. Signal management includes signaling based on congestion, adjacent SJ and emergency services.

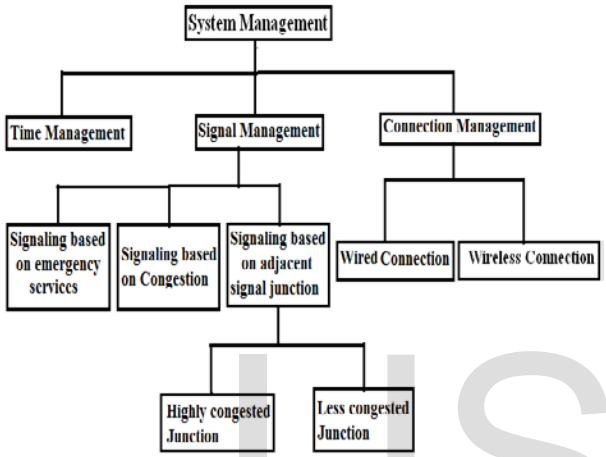

Fig.3 Signaling Management with its module and sub modules

Signaling based on congestion generates light signals for every lane according to the descending order of its congestion count sensed by the sensor. It is shown in Fig. 4.

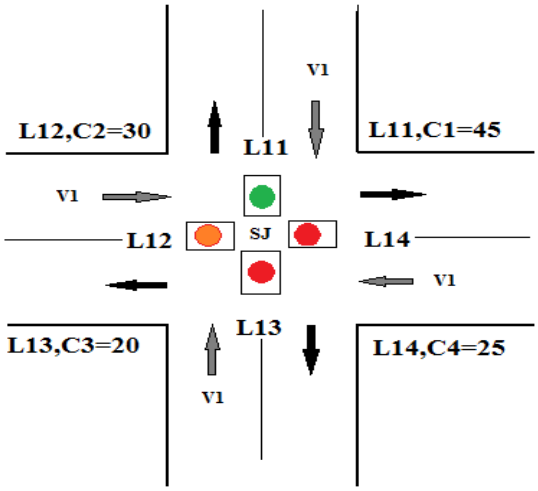

Fig. 4 Signaling based on congestion

Signaling based on ASJ is further divided into Highly Congested ASJ (HCASJ) and Less Congested ASJ (LCASJ). In HCASJ, the lane getting traffic from the congested SJ will get cleared first according to the counts as shown in Fig.5, which is followed by the normal algorithm for its own traffic count as shown in Fig.6.

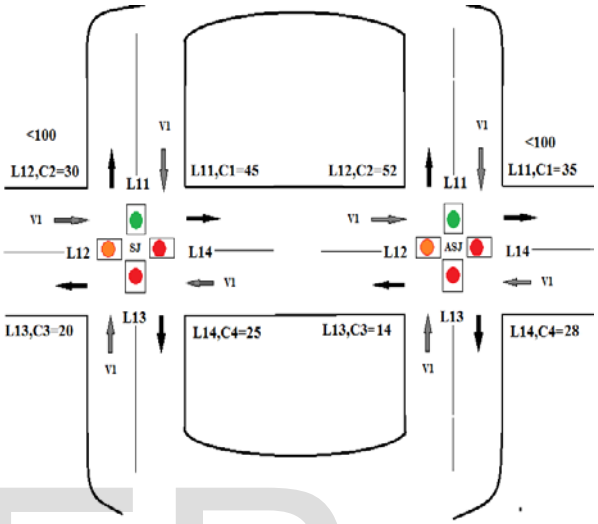

Fig. 5 Signaling on HCASJ based on lane's count of CSJ

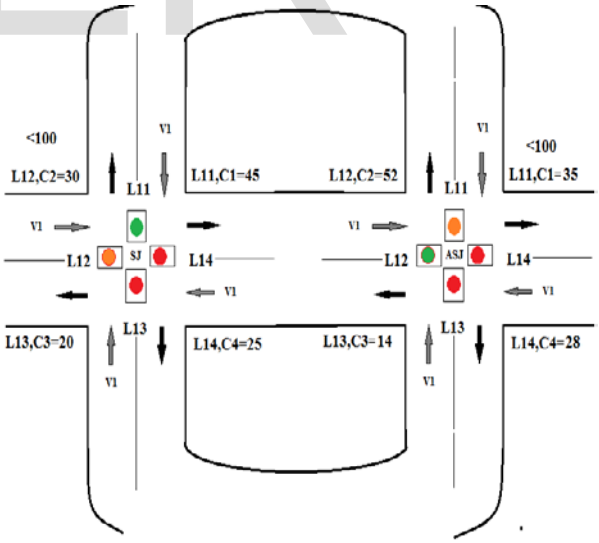

Fig. 6 Signaling on HCASJ based on its own lane's count

In LCASJ, the green signal will be given to two lanes opposite to each other for a round followed by normal count priority. It can be seen in Fig. 7.

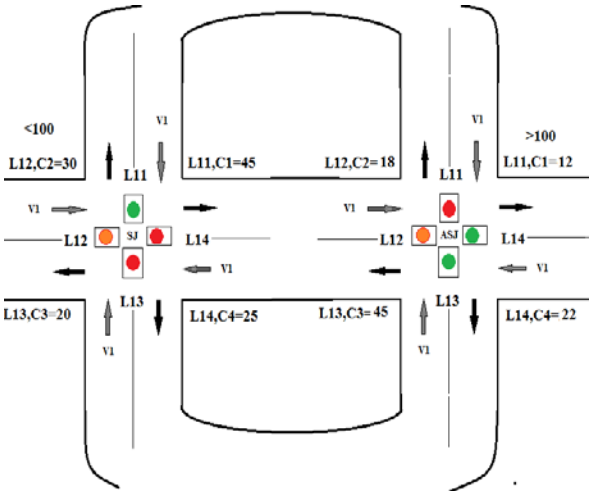

Fig. 7 Signaling based on LCASJ

Signaling based on emergency services gets green signal for the lane having emergency services that has given a warning signal and are followed by normal count operation. It can be seen inFig. 8

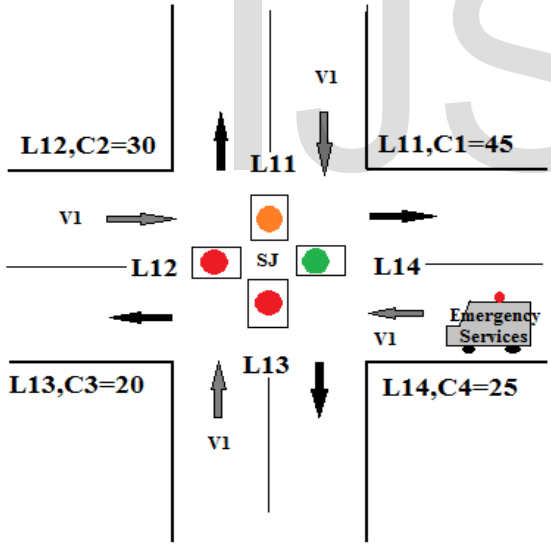

Fig. 8 Signaling based on Emergency Services

C. Connection Management System

Connection management includes wired and wireless connection. Wired connection is made between sensor and TLC to send the count and wireless is made through GSM between TLC to Server which in turn to vehicles, SJ's and ASJ's and emergency services to server for sending warning signals as shown in Fig. 9.

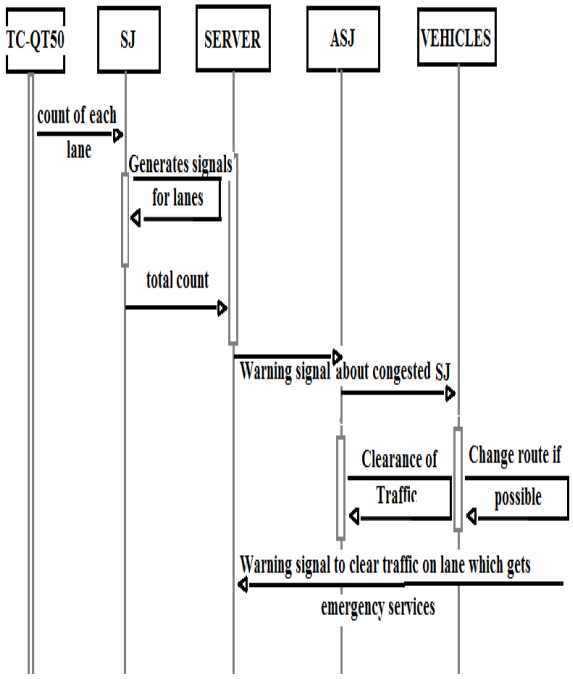

Fig. 9 Wired Sensor and Wireless GSM communication

4 Implementational and Operational Environment

In implementation, four TC-QT50 vehicle counter sensors are mounted on the TLCof every SJ and are pointed towards eachlanes, say (L1, L2, L3, L4). The sensorsare given a view, say (V1, V2) and distance, say (D=40m) to sense vehicles from that particular view up to the given distance. Then the sensor is wired to connect to the ES, which is placed on the TLC of each SJ, so that it can receive the count information say (C1, C2, C3, C4) for every lanes for every particular junction.

ES is composed with GSM and Microcontroller, so that the processed information from Microcontroller can be communicated via GSM to and fro the server. GSM interconnects all the SJ to the server. Therefore, after collecting the count information, system will compare and sort the count in descending order. Lane which have the highest count will get the Green signal first and the next highest, the Yellow signal, the next, Red signal and so on ending up with pedestrian walk. A time period say (T=2min) is maintained for each shift from one signal to another. Finally after a cycle, the system will be resumed and restarted.

Then the ES sum up the counts for every SJ with its SJ name say ((C=C1+C2+C3+C4),S1/S2/..) to the server via GSM. Server then record the data and if it detects that the count is high say(C>= 200) for S1, then it will senda warning signal say(S1) to its adjacent SJ'S and all vehicles.

In case, the ASJ is also highly congested one, then it will clear the lanes getting traffic from the warned of SJ first, followed by previous operation. In case of LCASJ, it generated two signals and clear traffic from two lanes opposite to each other. Vehicles that are warned can reroute themselves if possible. The emergency services also warns the server about the lane it gets to reach through when it is in 50m far from the SJ, so that it will get green signal when it reaches the SJ. This system reduces the waiting time, prevents tampering, reduced cost and easy to install. These sensors can withstand any harsh environments. It also manages the traffic efficiently before the junction gets congested.

5 PROPOSED SYSTEM

To make the TLC more efficient, we are using an adjustable field radar-based system, TC-QT50 series vehicle controller sensor, which sense the count of the stationary/moving vehicles, rejecting the humans for about 40 m and can be set in a specific view. GSM is used to send information about the congested signal junction to the server located in a remote location which in turn will inform the adjacent signal junction and also to all the drivers about the congestion so that they can re-route accordingly. Also, the vehicles of emergency services are fitted with GSM device to inform their arrival to get a green signal. Therefore, it efficiently manages the traffic automatically and economically. Installation is simpleand easier reducing the fuel consumption, accidents and pollution. It is more Time consuming and completely automated.

6 CONCLUSION

In this work of Automatic Traffic Control, the trafficcount is measured by the sensor for about 40 m in each lane and accordingly the traffic is managed in the respective junction and also in the adjacent junctions as they are notified about the congestion by the server through GSM technology. Even all the vehicles are informed about the congestion so that they can reroute. A device is fitted in all the emergency services. By using that the drivers can inform the server when they are about to cross a junction which in turn informs the corresponding junction to give green signal.The LCD in the sensor is used for recording so that we can easily trace any vehicle's route if needed.

7 FUTURE ENHANCEMENT

Apart from this the following things can be added in this project:

1) Auto shutdown with alarms when there is sensorfailure occurs.
2) Providing with a reroute map to all the vehicles when a particular junction gets congested.

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