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GPS Tracking Traffic Management System using Priority Based Algorithm

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Abstract. In recent years, there is an extreme increase in road vehicle usage which in turn a challenge to manage the traffic system. The current traffic system is not based on the vehicle density level and a pre-established time is distributed to the traffic lights for every lane crossing which had an issue like traffic congestion & wastage of time and this condition turns out to be worse in the peak hours, and it also increases the emission of CO₂ in the environment. In this paper, real-time dynamic traffic management system based on density level of each junction with the help of approximate geo-density information is developed. The density level on each junction is then updated to the real-time database. Then, this real-time data is computed with an exclusive priority-based algorithm where the crossing with high density is prioritized over the other (emergency vehicles are given the maximum priority) while maintaining the congestion around the junction under control. The prototype of GPS based real-time traffic management system is implemented and tested.

Keywords: GPS, priority based algorithm, traffic system.

1 Introduction

In our day-to-day life, people are living in an environment with full of pollution. The inhaled air is not free of dust or the drinking water is not free of impurities. Most of the reasons for this pollution is no other than the massive increase in our population. Due to this, the usage of vehicles is also increased which later made problems like traffic congestion, emission of CO₂ and also there is so much time is wasted while waiting in the queue for crossing the lane. The common working of a traffic light needs more than a little control and cooperation to assure that traffic and pedestrians move without difficulty and also safely. There is a series of different control systems used to conquer this problem, started at a normal time-based structure to computerized control and coordinating ways that self-adapt to reduce the time whoever using the junction.

2 Related Works

Various traffic management system was implemented for traffic congestion. A traffic light is usually monitored by a device installed inside the cabinet. Till now the Electro-mechanical controllers [1] are used in India. In this traffic system, for every lane in the junction, there's a time allotted constantly and it works in that case. Since the controller will monitor the signal timing in a pre-assigned manner. Even though there is no vehicle in that particular lane, the other lane in that junction has to wait and there is so much time is wasted. Some other ways are like using image processing technique [2], in that they find the density of vehicles on that particular junction and estimate the count. They used to monitor or control the traffic signal using that data. The major tasks of the [3] are detection of stationary objects and their location, by identifying those mobile vehicles, and the data is transmitted to the monitoring or controlling process. It is very useful in real-time traffic information by monitor the architecture by using wireless communications IoT.

In general, Electro-mechanical signal controllers use timers that have constant time intersection plans. The cycle of signalized timers is found by small motors that are attached to the timers. Cycle motors that are normally had a range from 35 seconds to 120 seconds. If a motor/gear in a timer fails, another cycle gear is used for replacing the failed one. A dial timer can control one intersection at a time because it has only one intersection time plot. Another way of using the load cell, which produces an electric signal based on the mass on the cell [4]. This helps us in calculating the number of vehicles approximately on the specific road and thus finds the amount of time for the particular lane to give the green signal to clear the vehicles on that lane.

One of the methods makes use of VANET to develop an Intelligent traffic system [5,6] while another method makes use of the infrared signal to find vehicles and consider those rule breaches by any vehicle. Another method makes use of state-space equations to design a simulation of a domestic traffic network. In another system, to reduce the waiting time of the vehicle and to actively solve the traffic problem they use fuzzy logic [5,7]. This method is proposed using Photo-electric sensors which are fixed on one side of the lane to control the vehicles crossing through that lane. In a smart toll system, the LED shows red color when the IR sensor detects the vehicle, by placing that sensor at a specific place. Every vehicle must have an active RFID tag [8,9] installed which will store the vehicle registration no. as a digital code. Thus, the RFID readers can detect the vehicles. The number of vehicle counts will be stored in the database. This traffic light signaling is done by micro controllers. RFID has 16-bit information [10]. The information like vehicle number, driver's information, and the account details fed in RFID tag and the LCDs shows the data. The database matches the vehicle's details and the amount will deduct and then allows the vehicle to pass through. The method used in [11,12] will be image processing-based signal controlling. The signal crossing time will change as per the vehicle load in the specific lane.

A system based on a PIC microcontroller stimulates the vehicle density using IR sensors and achieves an active timing period with different levels. Likewise, to solve the problem of emergency vehicles stuck in the crowded junction, the portable controller device

is used. In [10,13], Arduino UNO will circularly check each road of the junction and if it detects any traffic on the road then it allows it to cross the junction by signaling a green light to it and vice versa, the road will be signaled as red light, if the junction detected has no traffic. Surveying the existing system related to traffic management system shows that they have used different technologies & sensor modules. Finally, they started with IoT [14] which is the emerging and promising one that requires for today's fast world. Each system gives its solutions for the problem of manual traffic management system where each technique and technology have its merits and demerits for process and system design. Every system has its drawbacks which can be overcome by other systems and hence the emerging technology for traffic management systems using IoT will give accurate and live information about the density of the traffic.

Table 1. Summarize of Literature Survey

Ref	Model	Description	Limitations
[1]	Electromechanical controllers	Using controllers, time slot is allotted for every lane	If no vehicle is in the lane, other vehicles have to wait to cross. Time consumption is a major problem.
[2]	Image processing technique	Using this technique, find the count of the vehicles.	Implementation is difficult.
[3]	RFID + Sensors	Transmit data through wireless communication.	Security of smart objects is a major problem and is limited to some situations.
[4]	Load cell	Based on the number of vehicles on the specific road, amount of time for a particular lane is calculated.	Slow process
[5]	IOT+Load Cell+RF Transmitter and Receiver	Through IOT and RFID, data are stored in the cloud and analyze the data. Based on traffic data and using load cell, calculate the required time to clear the traffic. For emergency vehicle, RF transmitters and receivers are used to clear the traffic on particular lane.	Security is a major problem
[6]	Fuzzy logic	Intelligent traffic system was implemented using Fuzzy control logic	Not effective solution
[7]	Image processing algorithms	Edge detection algorithms and object counting methods are used	It is very lengthy process. Implemented this system for cars only.
[8]	RFID	Using RFID tag in the	RFID range is very

		vehicle, RFID reader counts the number of vehicles in the database. According to number of vehicles, traffic signal can be changed.	limited
This work	GPS based real-time traffic system	Based on GPS , density of vehicles in particular location is identified	Effective and low cost solution

3 Proposed System

A GPS based real-time traffic management system is proposed to eliminate drawbacks from existing works. In this proposed system, all vehicles have GPS module.

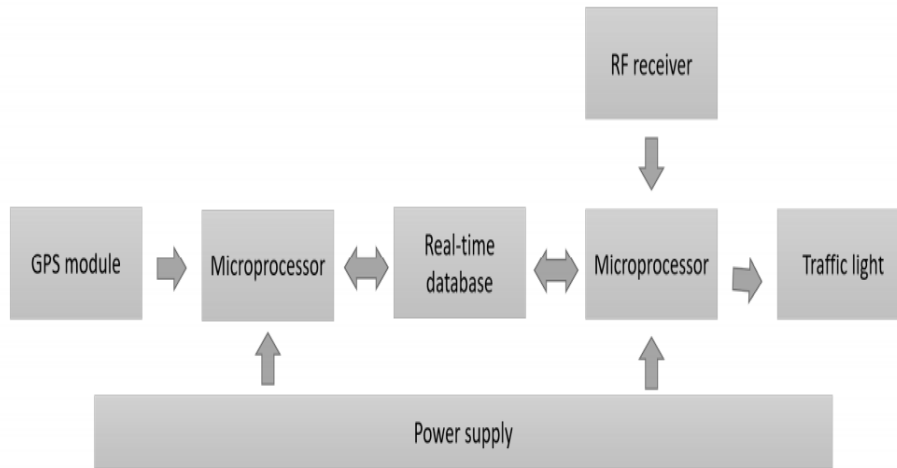


Fig.1. Block diagram of proposed system

The block diagram of the proposed system is shown in Fig.1. The proposed system consists of the sensing part and decision part. In this system, the traffic density is sensed by using the GPS in the geo-fenced location and fetch the values to the database and the values are processed, decision will depend on the priority-based algorithm. Ambulance's gps module is sensed in the geo-fenced location, instead of incrementing the density, it automatically flags the ambulance's entry to the database. With this algorithm, the emergency vehicles can be given separate priority.

2.1. Density Sensing

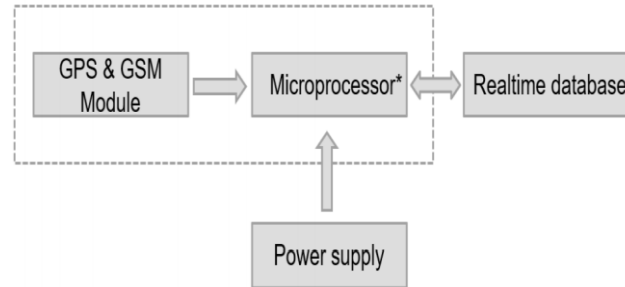


Fig.2. Block diagram of Sensing Part

The power supply for the microprocessor is directly fed from the vehicle's power source (Battery) as shown in Fig.2. The microprocessor tracks the geo-location regularly, but only updates its count only when it reaches the geo-fenced region *

The steps of density sensing part algorithm are as follows

Step 1 :Acquire GPS coordinates from the GPS module.

Step 2 :Process the collection of 4 geo-fence locations for each traffic junction of 4 crossings from JSON file.

Step 3 :Check if the GPS coordinates fall into any of the geo-fence locations extracted from the JSON file.

Step 4 :If true, Increment the user count in the real-time database and wait for 15 seconds, re-check for the existence of the vehicle in the same geo-fence location.

If it exists, no change is made to the database. If it doesn't exist, decrement the user count in the real-time database.

Step 5: Repeat the process from Step 1.

2.2. Decision Making

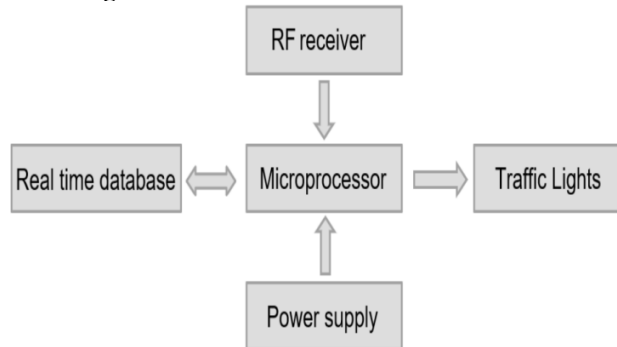


Fig.3. Block diagram of Decision Part

The density values from the real-time database are computed through the priority-based algorithm in the microprocessor. This algorithm grants a time span of 15 seconds for each prioritized crossing, with a priority of the crossing done every 10 seconds. RF receiver functionality only works to prioritize emergency vehicles.

The Algorithm used in Decision making part are as follows

Step 1: Acquire the data from the database.

Step 2: Find the maximum density count from the available crossing data.

Step 3: Check for any priority signal for emergency vehicle. If a priority signal exists, assign the signal priority to that crossing. If it doesn't exist, assign the signal priority to the crossing with maximum density.

Step 4: Wait for 15 seconds, • If the signal priority doesn't change, increment the time counter, • If the signal priority changes set the time counter to zero.

Step 5: If the time counter reaches four (4), reset the time counter, reassign signal priority to the next maximum density crossing.

Step 6: Repeat the process from Step-1(Fig. 3)

The proposed model is to sense the density of the traffic at each road crossing in real-time. For the sensing of the traffic density an embedded kit with a Global Positioning System (GPS) module is to be installed in the vehicle(s). This embedded kit is designed to track the movement of the vehicle locally and only updates it to the internet only when it is in the specified geo-fenced location. So, whenever the vehicle (GPS) enters the pre-mapped geo-fenced location at each side of the road crossing, it updates its count to the real time database (which in this case is Google firebase). The traffic density which is available on the internet (Real-time database) is then computed with a priority-based algorithm at each road crossing junction. With this algorithm (which is to be discussed in the next slide), the traffic is managed by regulating the congestion at the higher traffic density side. This algorithm is overridden when an emergency vehicle is to be detected by the use of RF communication between the emergency vehicle and traffic controller at the junction. The overridden algorithm automatically prioritizes the side at which the emergency vehicle is detected. Any glitch/abnormality in working of this methodology returns the traffic controller to a fail-safe mode where the controller works with a typical timer system.

3 Circuit Design

As declared, the GPS modules are set up like a u-blox NEO-6M GPS engine. The ROM version is ROM 7.0.3, the type number of NEO-6M is NEO-6M-0-001 and the PCN reference is UBX-TN-11047-1. The NEO-6M module, For serial communication, has one UART interface, but the common UART baud rate is 9,600. Because the GPS signal is RHCP and the model of the GPS antenna is varying from common whip antennas (used for polarized signals). The patch antenna is the most popular one compared to others. They are flat and are mounted on a metal plate, normally have a ceramic body. The patch antennas are usually cast in housing. Always know, the optimal execution of the GPS receiver depends on the position of the mounting of the antenna. The patch antenna always should be installed parallel to the geographic horizon. Make sure the antenna is not having a partial view, make it has a maximum view of the sky. Keep as same as for every antenna to have a narrow line with the many satellites.

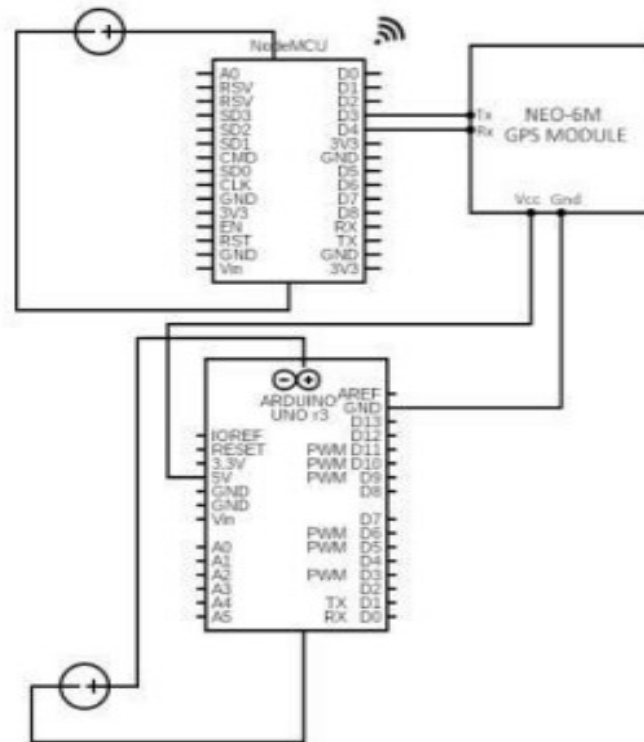


Fig.4. Circuit diagram of Sensing part

In the Raspberry Pi 3 range, the latest product is Raspberry Pi 3 Model B+, it's having a 64-bit quad-core processor running at 1.4GHz. Also, it has a dual-band which is 2.4GHz, Bluetooth 4.2/BLE. It also has faster Ethernet, 5GHz wireless LAN, and PoE capability via a separate PoE HAT. The dual-band wireless LAN has a separate consent certification, permitting the board to build it into final products with exceptionally decreased wireless LAN consent analyzing, increasing both cost and time. When compared to Raspberry Pi 2 Model B and Raspberry Pi 3 Model B, the Raspberry Pi 3 Model B+ will have the same mechanical footprint.

The Relay Module we use has 5V Dual Channel and it is used for low-level triggers only. In between the input terminal and GND, signal voltage will be there which refers to the low-level trigger and the trigger gets short-circuited away from the Channel connection by the GND -ve trigger.

In Fig. 6, Node MCU – ESP8266 board, GPS Module takes 5V 2A dc power as an input. The development board is enabled by internetworking through WiFi.

The U-bloxNeo-6m GPS module (Fig. 6) senses its location data from the GPS satellite. When the sensed GPS location is within the Geo-fenced location, the micro-controller gets instructed to upload the density count to the database.

compared to a mutual database. This Real-time Database API is designed to only permit actions that can be concluded rapidly. This qualifies you to develop a great real-time knowledge that can provide millions of users without gets uncomfortable on interest.

5. Experimental Results

In this, the description of the results obtained through the proposed model is discussed here. The hardware Decision Part Module is designed as shown in Fig.6.

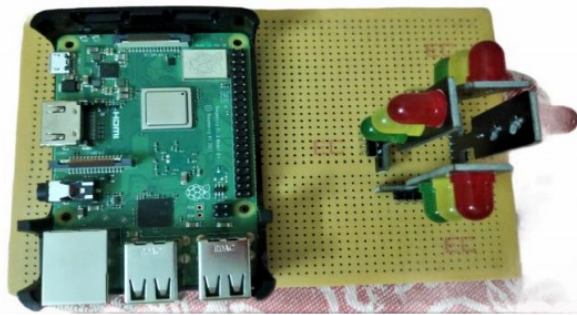


Fig.6. Decision making

The data from the real-time database is passed to Raspberry pi 3 b+ (Fig 6), then the data are compared and finds the highest priority lane, which gets a green signal then the other lane gets a red signal. The hardware module of Sensing Part as shown in Fig.7.

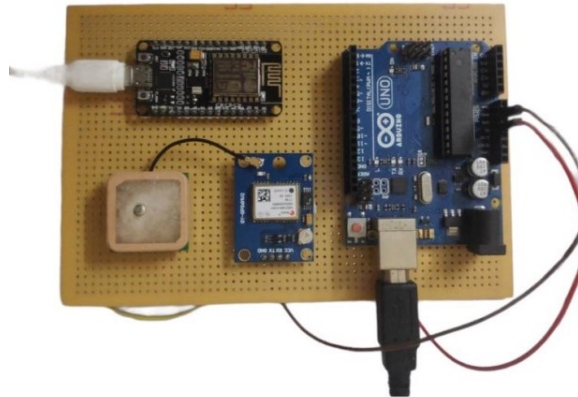


Fig.7. Density Sensing

In sensing part, the location of the vehicles detected using GPS module within the geo fenced location and the count of the vehicle is transferred to the database. The GPS tracking traffic system is successfully implemented as shown in Fig.8 and 9.

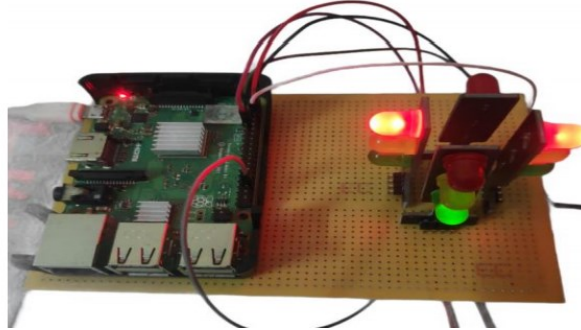


Fig.8. Working Model

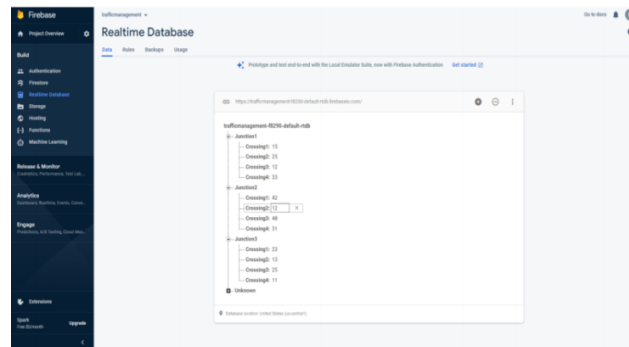


Fig.9. Real Time Database

6 Conclusion

The Real-time dynamic traffic management system based on density using GPS and Raspberry pi 3 b+ has been successfully implemented. The proposed model is easy to adopt and it is user-friendly, the main feature is to give a green signal to high priority based on the density level and giving way to the emergency vehicle. Hence this traffic system is dynamic waiting time, emission of CO₂, congestion can be reduced. The emergency vehicle has a higher priority and also gets a huge advantage in the implementation of this model.

The proposed traffic control system is the very basic step towards achieving automation in the field of the traffic control system. With various advancements taking place in today's world, people are in search of automated systems which not only saves their time but also a lot of energy in different forms. The saving of fuel (petrol, diesel, natural gas), reduction in time of operation of automobile engines, reduction in the emission of the harmful gases in the atmosphere. Thus, this system helps in reducing the number of accidents that take place just because of this inappropriate transport system and making way to a better traffic management system. The proposed system aims to save the number of manpower wasted at the signals and hence making effective utilization of time. Additional work can be done in this area and made

available to build a real-time dynamic traffic management system. Further research can be made to make this algorithm better optimized to deliver more precise results based on the past density data. As for the future implementation, the management controllers could be grouped to form a cluster based system, where the controllers would be able to communicate with others to provide an Artificial Intelligence-based management system.

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