Ambulance Detection and Traffic Control System

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Abstract - *Emerging issue of traffic congestion is an inescapable condition in large and growing cities across the world. Rise in population has increased the number of automobiles leading to a sheer growth in traffic. Life, as we know it, is precious. It is second to none and once lost cannot be brought back. During calamities, the response time taken by the emergency services play a crucial role whether it be medical services, Fire engines or police forces. The major obstacle they face is the traffic congestion. In order to overcome that, there is a need for smart traffic control system which dynamically adapts to the changing conditions. The main concept behind this paper is to detect the ambulance en route to the destination and control the traffic system to provide the effective services. This paper proposes a system which uses a GPS module to transmit the location of the ambulance to the cloud using a Wi-Fi module, which is then transmitted to the smart traffic system which in turn changes the traffic signal cycle dynamically. This proposed low-cost system can be implemented throughout the city thereby reducing the delay and avoiding the casualties due to congested traffic situations.*

***Key Words*: Emergency services, Traffic congestion, GPS module, Wi-Fi module, low cost system, smart traffic control.**

1. INTRODUCTION

The vehicle traffic congestion in cities has been exponentially raised due to a large number of vehicles plying on the road. Due to this large traffic, often traffic jams occur on roads because of which the emergency medical vehicles like ambulance and fire engines get stuck in traffic congestion which may be the cause for losing human lives. Current traffic control systems are a static case wherein vehicles have to wait for a predefined amount of time until the microcontroller switches the green light for that lane. If the ambulance is stuck near to the traffic signal, then the traffic police can give priority to the ambulance by giving necessary symbol or signs to the vehicles so that the ambulance can get out of the traffic as quickly as possible. Moreover, if the emergency vehicles are stuck in a lane far from the traffic signal, the siren of the ambulance is unable to reach the traffic police, in which case the emergency vehicles have to wait until the traffic gets cleared or we have to depend on other vehicles to move aside which is not an easy task in traffic situations.

The use of IoT (Internet of Things) technology has been implemented in the proposed system. This system uses a SIM-28 GPS [Global Positioning System] module that has the receiver with antenna which sends the real time location in the form of latitudinal and longitudinal information about where the ambulance is precisely located. Therefore in this system, a GPS tracker module is acquired to implement the in-vehicle device. Along with the GPS module integrated is the ESP8266 IoT Wi-Fi module that gives any microcontroller access to the Wi-Fi network. The 8266 Wi-Fi module is used to transmit the location data to the base station by the Wi-Fi 802.11b and finally to the AWS [Amazon Web Service] EC2 cloud instance. Two predefined reference points are selected for all the traffic signals in the city before and after the traffic signal points. One such reference point is selected at a certain distance before the traffic signal control system, to check whether the emergency vehicle is in the vicinity of that particular traffic signal while the other reference point is selected after the traffic control system so that the traffic signal is made to toggle back to its normal sequential cycle flow after the emergency vehicle passes it. The traffic signals are integrated with Raspberry Pi 3B+. The traffic signals are programmed to change dynamically as the emergency vehicle passes the reference point.

2. LITERATURE REVIEW

In the paper Accident Detection & Ambulance Rescue System Using Wireless Technology[3], they presented a system to detect accident automatically using vibration sensor, and ambulance unit send the vital parameter of patient to the hospital. This will help to save the life of accident victim.

In the paper Ambulance Assistance for Emergency Services Using GPS Navigation[4], they proposed a system which is used by the hospitals to track down their ambulances. The main aim of the project is to reduce the deaths of critical victims by

making sure that they reach hospital in time for proper treatment. GPS technology is used so that the hospital can take quick action which might reduce the extremity. This system is more appropriate and the main advantage is that there is significant reduce in time consumption.

In the paper Accident Detection and Ambulance Rescue using Raspberry Pi[5], they proposed a system which finds the quickest path by controlling traffic light signals in favor of emergency medical vehicle. By this new system, the time delay is reduced by applying the RF technology that controls the traffic signals. The preference of service to the emergency medical vehicle follows the queuing technology through server communication. This makes sure of the reduced time delay between the accident spot and hospital.

In the paper Smart ambulance guidance system[6], they propose a system that uses a central server to control the traffic controllers. The traffic signal controller is implemented using Arduino UNO. The ambulance driver uses a web application to request the traffic controller to make the signal green in which the ambulance is present. A low-cost system which can be implemented throughout the city thereby reducing the number of deaths due to traffic situations has been aimed at.

In the paper ESP8266 based Implementation of Wireless Sensor Network with Linux Based Web-Server[8], they proposed a concept where the occurrence of a Wi-Fi based Sensor Network management exploitation using Linux board Raspberry pi and IoT technology using ESP8266 Wi-Fi module.

3. COMPONENTS USED

SIM28 GPS Module - This device is able to receive data from GPS satellites and then compute the device's geographical location. Using appropriate software tools, the device is able to showcase the latitude and longitudinal location on a map, and it will offer geographic directions.

Fig.1 SIM28 GPS Module with antenna

ESP8266 Node MCU Wi-Fi module – A cost efficient Wi-Fi chip with full TCP/IP capabilities and embedded with a MCU(Multipoint Control Unit) which provides the functionality to control I/O digital pins through simple and almost pseudo code similar to programming language. This module is an extremely cost efficient board with huge and ever-growing community.

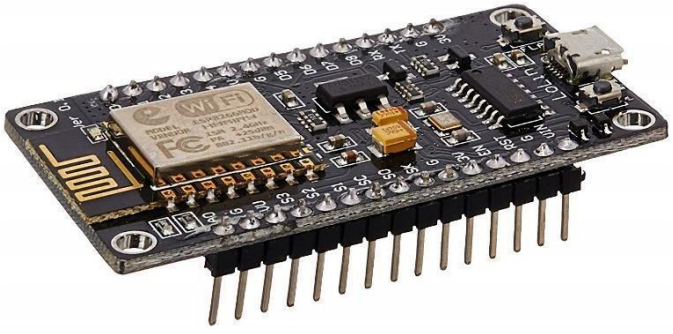

Fig.2 ESP8266 Wi-Fi Module

AWS EC2 instance - Amazon Elastic Compute Cloud (EC2) is the base of Amazon cloud computing, Amazon Web Services (AWS). It provides users with the service of renting the virtual computers for their specific uses. Furthermore, it supports the user in the deployment of applications by providing a bootable Amazon Machine Image (AMI).

Arduino IDE - a cross-platform application which is programmed in JAVA. Advantages of this IDE are to code and upload programs to the Arduino board.

Raspberry pi 3B+ - It is a sequential small single-board computers designed in the UK by the Raspberry Pi Foundation to increase the Computer Science education in schools and in developing countries. The Raspberry Pi 3 Model B+ has a faster 1.4 GHz processor and a three times faster gigabit Ethernet.

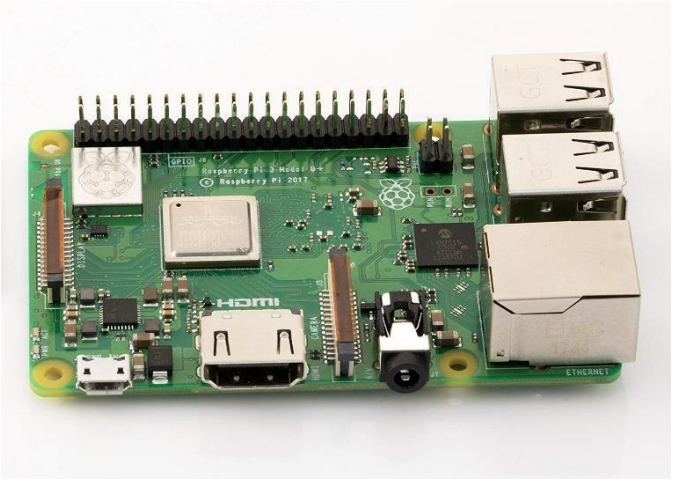

Fig.3 Raspberry Pi 3B+

IDLE (Python) –It is designed for python, which is bundled with the implementation of the language.

4. PROPOSED SYSTEM

Our project focuses on swift commutation of the ambulance right from the dispatch to the accident zone and to the hospital. There needs to be an effective strategy to reduce the congestion from the dispatch of the ambulance to the hospital.

4.1 Real time location tracking

The project is based on the retrieval of the GPS location of the emergency medical service vehicle which is provided by the location tracker. Hence the ambulance is equipped with an in vehicle tracking device. This device consists of a SIM 28 GPS module with antenna and a Wi-Fi module ESP8266. The GPS module, powered by the ambulance battery is programmed to send the live location of the ambulance every second to the cloud using the Wi-Fi provided by the ESP8266 Node MCU module.

4.2 Transmission of the Real time location

The Node MCU ESP8266 Wi-Fi module is paired with two smartphones, where one smartphone is used to connect to the ESP8266 Wi-Fi module while the other smart phone is used to provide the mobile [cellular] data to the module by the Hotspot. The smartphone that is connected to the Wi-Fi module is in turn connected to the hotspot of the other smartphone. As a result, the GPS device is able to transmit the location of the ambulance every second to the cloud. The protocol used for sending the location of the GPS data is the MQTT [Message Queuing Telemetry Transport] protocol. The GPS data from the device is published using the MQTT publish command. The cloud is registered in order to receive the data, this is done by the MQTT subscribe command.

4.3 Storage of location coordinates in the AWS Cloud

The AWS EC2 instance is used for cloud computing. It is a model that allows expansive pool of resources such as storage, network, computing power and software to be allocated on-demand. The resources are extracted and delivered as a service over the Internet anywhere, anytime. Thus, the GPS location data forwarded from the GPS device by the Wi-Fi module is stored in the cloud infrastructure.

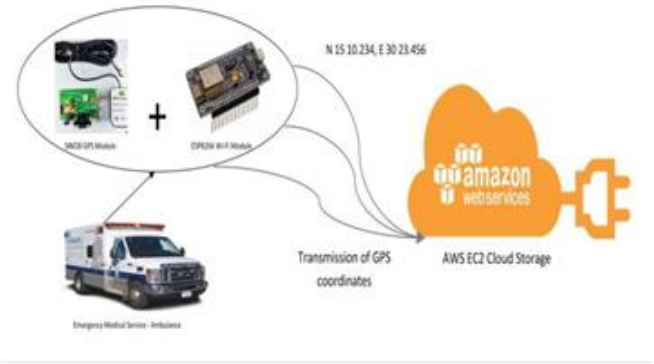

Fig.4 Transmission of location coordinates to AWS

4.4 Computing the distance function

The smart traffic signal posts consist of the Raspberry Pi 3B+ which is used to control the traffic signal cycle. At first, the exact GPS coordinates of the traffic signal post is estimated.

For example, say the current traffic signal post coordinates are at the positions N 12°17'54.0024", E 76°39'59.238", when converted to decimal degree results in the following Latitude : 12.298334, Longitude : 76.666455. Now, to fix the first reference point, a distance of 300 meters should be subtracted from the current location coordinates which is done by changing both of the x-axis and y-axis coordinates.

The formulae to change the axis coordinates are:

double x1 = long – (180/Math.PI)*(dist./637813)/cos(lat0)
double y1 = lat – (180/Math.PI)*(dist./637813)

When calculated by substituting the distance of 300 meters, we get the new first reference point coordinates as below. Latitude: 12.298188, Longitude : 76.669229. So once the live coordinates of the ambulance crosses these location points, the cloud sends a message to the raspberry Pi integrated in the traffic light system to change the current traffic light to signal green. Similarly, to fix the second reference point after the traffic light post, the new coordinates are calculated by adding the distance of 50 meters to the same mentioned formula above. This results in the new second reference point coordinates as below. Latitude - 12.29868, Longitude -
76.666275.

As the ambulance now surpasses the second reference location coordinates, another message is passed to the smart traffic control system about changing the current traffic light back to the normal sequential flow.

Fig.5 Raspberry Pi integrated with three traffic LEDs

4.4 Operation of the traffic lights

Raspberry pi of any model with GPO will work for controlling the traffic lights. We use a set of three LED s which serve as the substitute for the traffic lights and a HDMI display to show the output from the Pi. Here, the three traffic lights being red, amber and green LEDs are connected to the Pi using four pins. One of these needs to be grounded; the other three being actual GPIO pins are used to control each of the individual LEDs.

After the raspberry Pi 3B+ is installed with the raspbian pi Operating system, the traffic lights are programmed to work via Python programming language. Once the ambulance crosses the first predefined reference point which is situated 300 meters before the traffic signal system, a message programs the green LED light to turn on, so as to clear the traffic by making way to the emergency vehicle and at the same time red light is displayed at all the remaining directions of the traffic point to make sure that there is proper signaling for the automobiles entering the traffic section. Once the emergency ambulance vehicle crosses the second reference point which is situated after a certain distance of another 50 meters post the traffic signal system, the traffic lights are programmed to return to the default traffic signal cycle thereby efficiently controlling the traffic system.

Fig.6 Smart Traffic controller to manage traffic congestion

5. CONCLUSION

The proposed system can be used by the Adaptive Traffic Control System [ATCS] to effectively manage the motion of Emergency Medical Services [EMS] such as ambulance during high traffic congestion. The main attempt of this paper is to minimize the deaths of critical patients by making sure that the ambulance reaches the emergency location and the hospital in time for treatment. GPS, IoT and Raspberry Pi technologies are used so that the traffic controller system can take immediate action ensuring the reduction in time delay between the emergency destination spot and the hospital and thereby reducing the severity of critical situation.

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BIOGRAPHIES

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