International Journal of Research in Engineering, Science and Management
Volume-1, Issue-10, October-2018
www.ijresm.com | ISSN (Online): 2581-5782

An Efficient Traffic Signal Management System for Ambulance Services

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***Abstract*—Due to the increase in population and the use of automobiles in metropolitan cities, traffic congestion or traffic load is becoming one of the most frequent problems faced by emergency vehicles such as ambulances, fire trucks and police cars. In this project, we propose an efficient system which can potentially reduce traffic load and help get ambulance(or any emergency vehicles) faster to its destination by providing optimal path and changing the traffic lights appropriately. A GPS (Global Positioning System) and GSM module is used to send information to the server. Intel GalileoGen2 board, which is used as a server, calculates shortest path and sends to the ambulance Arduino, a microcontroller, fitted in the traffic signal changes the light to green when the ambulance approaches the signal. This is an optimal and efficient way of managing traffic signals for ambulance services.**

***Index Terms*— GPS, GSM, Arduino, microcontroller**

I. Introduction

Traffic is dense and crowded in places like India. Traffic congestion has been one of the major issues that most metropolises are facing, in spite of measures being taken to mitigate and reduce it. Emergency vehicles, such as, ambulances get stuck in traffic. Even if everyone wishes to give way, they are unable to do so because of traffic congestion. This may lead to the increase of time for the ambulance to reach the patient and the patient to reach the hospital. These minutes could very well cost a person, his or her life.

This proposed project has the potential to effectively manage traffic load for faster ambulance service, thereby, having effect on saving a person's life.

The ambulance has the modules, GPS module and GSM module. The GPS or Global Positioning System is a navigation device which is used to calculate the devices geographical position. The GSM, Global System for Mobile Communication helps in giving exact location distance between the source & destination which mainly helps in controlling false pricing & immediate emergency assistance.

The information from the ambulance is sent to the server and the shortest path available is sent to the ambulance. The best way to find the shortest path is by using Dijkstra algorithm. It is almost used in every road network and it is the simplest and very effective method. For a given source node in the graph, the algorithm tracks for the shortest path between that node and every other node. It can be used for finding the shortest paths from a single node to a single destination node by stopping the algorithm once the shortest path to the destination node has been determined. The server has all the details about the coordinates of the traffic junction in the way of the ambulance.

When the emergency vehicle, in this case, the ambulance nears the traffic signal the signal light is changed accordingly. The difference between the ambulance and the traffic junction is calculated. When it is approximately 300 meters, the data is transmitted to the traffic junction. The traffic junction is fitted with Arduino UNO-R3.At the traffic junction, the micro controller receives the data using the GPRS signal and it changes the traffic light. We use ZIGBEE S2 Modules to interconnect the Arduino UNO-R3 micro controller and Intel GalileoGen2 board. ZIGBEE S2 Modules is used for wireless communication.

II. Existing Systems and Related Works

[1] In this proposed system an android app that interlinks both the ambulance and the signal station using cloud network. In here, they make use of RFID (radio frequency identification) technology to excel the intelligent traffic signal control.An mobile application is used to send signals to the cloud which will in-turn send the the information to the traffic signal and the light turns green.

[2] This system proposes that once vehicles enter into the region that is allocated for traffic signal area, the vehicles send their posture to the located fog node on traffic signal and accordingly traffic signal is monitored. The major idea is to cut down the waiting time of ambulance, Fire Brigades and Police Vans using Fog Computing.

[3] The following system is the combination of the length of the distance between the emergency vehicle and a signal by using visual sensors, density of the traffic and sensitivity of the transmission of alert message within the sensor network. The length between the emergency vehicle and the signal is calculated to compare using Euclidean distance, Manhattan distance and Canberra distance techniques.

[4] In This proposed system, vehicle is enveloped with Radio Frequency Identification (RFID) tag, placed such that it can't be destroy. They use RFID reader, system-on-chip to note the RFID tags that is equipped to the vehicle and Raspberry-pi. It

takes the count of number of vehicles that pass by through the path during the noted duration. It monitors the network, and hence the green light duration for that path. IR sensors helps in detection of the density of the traffic, RFID technology is used to clear the traffic by indicating the green light.

[5] This system showcases a real time monitoring system in an ambulance and an efficient traffic system so that the life of a person can be saved. This concept consists of three divisions: dealing with patient physical states data transmission through communication system relies on Zig-bee technology, and hospital monitoring control centre and an RF based traffic control system. Since a patient or a person who injured in an accident enters inside an ambulance, the patient physical states data acquisition and communication system monitors the main physical parameters and movement status continuously.

III. Methodology

A. GPS

The basis of GPS is a constellation of satellites that are continuously orbiting around the earth. These equipped with atomic clocks & radio signals that contain their exact location, time and other information. The radio signals which are transmitted from the satellites are monitored & corrected by control stations which are sent back to satellites using ground antenna. The radio signals from satellites are picked up by the GPS receiver. A GPS receiver needs only 3 satellites to plot a rough, 2D position, which will not be very accurate. Ideally, 4 or more satellites are needed to plot 3D positions, which is more accurate than 2D.

B. Dijkstra Algorithm

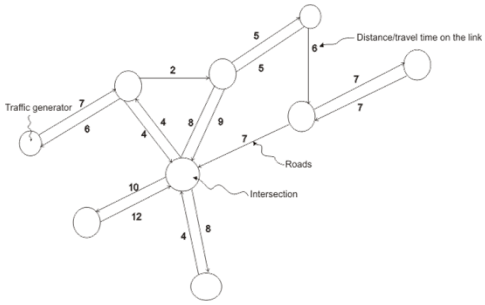

Fig. 1. Dijkstra algorithm

Dijkstra algorithm is a shortest path algorithm to find the shortest path between two nodes in a network. This algorithm is often used in routing. Dijkstra's Algorithm is used for finding the shortest path with minimum cost [6].

In the case of transportation networks, the nodes may represent locations from which traffic is produced or to which traffic is attracted. The nodes also represent intersections or traffic lights. The links represents roads or movements. The above description of a transportation network is a very simplistic viewpoint.

Formula:

$O|V|^2$ Where |V| is the number of nodes

(Or)

O (|E|+|V| log |V|) where |E| is number of edges

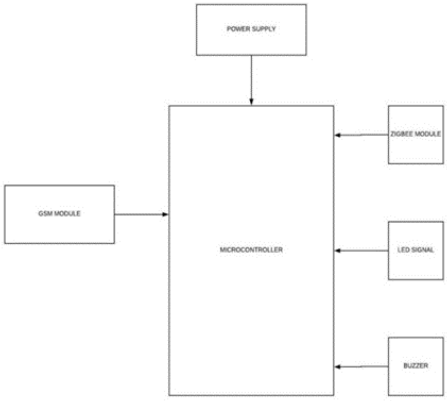

Fig. 2. Block diagram

IV. System Architecture

Here, the micro-controller finds the shortest path from the accident/incident spot till hospital by using the Dijkstra algorithm, then the shortest path is communicated to the ambulance where the driver gets the shortest path to the nearby hospital. Also using this information the traffic signals are controlled by the controller so that the path for the ambulance is set free for the ambulance to reach the hospital on time without any disturbance.

Scenario 1: When the ambulance is at the distance of about 300meters and the traffic light reads red then it turns green letting the vehicles clear so that the ambulance can have a smooth flow. This is done by the controller transmitting the signals to the traffic signal through zigbee module, where Zigbee modules help in high level protol communication between the signal and ambulance.

Scenario 2: When the ambulance is at the distance of about 300 meters and traffic signal reads green but is going to turn red before the ambulance crosses the signal, for this the controller transmits the signal to the traffic lights to stay green so that ambulance can cross the traffic light without getting stuck in the traffic signal.

V. Module Description

This module description can be divided into four sectors

A. Tracking unit
B. Main server
C. Node circuit

A. Tracking Unit

Tracking unit consist of the GPS module to indicate the shortest path to the hospital.

- *GPS Module:* GPS is a device that is capable of receiving information from GPS satellites and then to calculate the device's geographical position. This is used as the tracking unit since the exact geographical location and other

information is tracked by the GPS with the use of satellite.

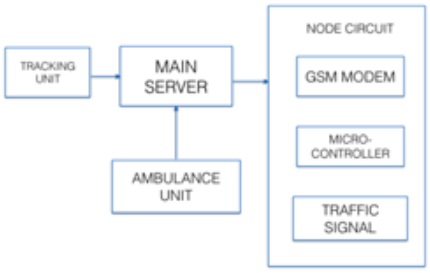

Fig. 3. Module description

B. *Main server*

The main server consists of microcontroller the heart of the project used as the communication. In here we use Intel GalileoGen2 board as the microcontroller.

- Intel GalileoGen2 board- is used as the server in this system. The Intel Galileo Gen2 has on-board regulator and a built-in Ethernet. This server calculates shortest path and sends the information to the ambulance.

C. *Node Circuit*

This consists of microcontroller which is the arduino board, GSM module and the traffic signal

- *Arduino board:* Arduino consists of both a physical programmable circuit board or a micro controller and a piece of software, or Integrated Development Environment that runs on your computer, used to write and upload computer code to the physical board. This board is fitted in the traffic signal.
- *GSM Module:* GSM stands for Global System for Mobile Communication .This channel is used in both uplink and downlink after mobile has established connection with GSM cell.

VI. Future Scope

We are in idea of extending the project in future by adding the privilege of selecting the desired hospital and the choosing the hospital from the given list, this list is sorted out by the nearest to the farthest. All this can be implemented in a mobile application that can be accessed through the medical assistant in the ambulance.

VII. Conclusion

The paper is mainly focused on the clearing the traffic congestion when the emergency vehicles like ambulance has to pass by without any disturbance; this also involves the life of the person in the ambulance. When this is implemented in real time especially in metropolitan cities in India can save many lives. The cost of the implementation is cost efficient and friendly.

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