International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-3, September 2019

Advanced Traffic Signal Control System for Emergency Vehicles

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Abstract*: This paper introduces the novel approach to handle the situation for emergency vehicles like ambulance and fire trucks to avoid traffic to reach the destination in time in order to save the lives. This system architecture is based on Internet-of-Things (IoT) using cloud at its center. The proposed system uses real-time GPS to track the location of the vehicle and update the same to cloud , smart traffic signals which are in present in route of the vehicle are notified the same. system maintains the details on the emergency vehicles to pass through the traffic with no or minimum waiting time, thus reducing the number of deaths during the travel to hospital and conditions to reduce the loss of property in case of fire emergency.

***Keywords* : Cloud, Internet-of-things, GPS, Android APP.**

I. INTRODUCTION

In the growing technical era the traffic in every city has been increases at a greater extent, sometimes it is even uncontrollable. This condition has a definite effect over the daily life and other activities of the society. When it is the matter of safety over the roads and the emergency situations like fire and health, high traffic causes a danger to the people [1]. It is even difficult to allot a special lane for emergency vehicles [2]. The existing solutions face many problems. To ease the moments of these vehicles we have come up with the solution of "Advanced Traffic Signal Control System".

The reason behind this work is to provide smooth and fast flow for emergency vehicles to reach the destination in time, thus by decreasing the number of causalities. The cloud helps the driver of the emergency vehicle reach the destination in time by providing proper route with synchronous traffic lights at every signal in the way.in this paper we consider ambulance as our emergency vehicle.

A survey said that 90% of heart patient can be treated if they reach in time, without any traffic congestion. It is one of the major problems of current growing world where people always prefer a comfort way of transportation buying a car or bike thus increasing the congestion it may even get worse in the future.

Manuscript published on 30 September 2019
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Existing solutions requires the attention of the people where they should coordinate and help emergency vehicles pass through, this paper proposes the system that is necessary to implement to avoid such disasters. The situation today has led to many deaths and losses due to increased population the increased number of vehicles. The image processing method for vehicle tracking works good during free flow of the traffic but they have difficulties with congestion, shadows and lighting transitions [2].

Therefore, we developed a system in order to improve the conditions for those vehicles so that they can reach the hospital soon or in case of fire brigade to reach the affected area as fast as possible. This could result in minimizing the deaths due to traffic and loss of properties in emergency situations.

A. RELATED WORK

The work done in [3] used health monitoring system in ambulance, parameters like ECG, Heart Rate and Body Temperature are monitored For ECG measurement, a 2 -lead Electrode Electrocardiogram technique is used Heart Rate measurement is done using photo plethysmography method. LM-35 is used to measure the patient's body temperature. Then pc in ambulance is used to send the data to hospital and to control the traffic signal.

A system consists of an android application which helps in registering the ambulance to the network is proposed in [4]. The android application sends an emergency instruction to traffic server and the direction which it travels with GPS when the ambulance has stopped due to traffic. The nearest is identified based upon GPS. If it nears then signal is made green so that it passes through, then original flow is restored.

The authors proposed a system where it is implemented by using ARDUINO, RFID reader for detecting RFID tag which is placed in ambulance [5]. The system updates to traffic system through RF transmitter and receiver if reader detects the emergency vehicle. Then traffic system controls the traffic lights accordingly. IR sensors are placed which helps in estimating the congestion, the same information is provided to emergency vehicle driver using GSM.

The work done in [6] proposed an approach where it measures distance between ambulance and intersection by some visual sensing methods. Emergency vehicle counting and time alert the traffic network. The distance measured is calculated for comparison using Euclidean distance, Manhattan distance and other techniques, And Arduino to control the traffic lights. In [7] a system is proposed where it detects the accident and reports the location of accident to the nearest ambulance, so that there are no or minimum causalities.

In this system ambulance driver has power to control the traffic, when the ambulance is carrying injured or critical patient's driver can make the traffic green. The same direction is provided by GSM technology which intern uses the internet to get latitude and longitude. The authors in [8] proposed a system which determines the optimal path by readings provided by sensors, it is done by modulating it into two parts data center and ambulance. The data center collects the data like current location of patient and hospital. As well as the location of ambulance. Crowd sensors readings are fixed on roads.
All this helps finding the optimal path where patient can be safely brought to the hospitals.

B. CONTRIBUTIONS

With the aim of improving the traffic situations and the making an easy way for the emergency vehicles, a system is developed using IoT and cloud. An easy authentication for the staff of the emergency vehicles is proposed. The details of the situation and the destination are recorded. This helps to provide non-stop or minimal travel path to the nearest safety point. For every minute, the GPS co-ordinates to track the vehicle are recorded. These details are shared to the drivers when they requested. This provides a faster way to clear the traffic jams in some of the junctions.

II. PROPOSED WORK

A. SYSTEM OVERVIEW

The model developed as shown in the Figure 1 is a combination of various applications of the technologies like machine learning, cloud service, android app and the IoT devices and the sensors. The model is not portable as the IoT devices are set near the traffic signals and the android application is provided to the emergency vehicle drivers.

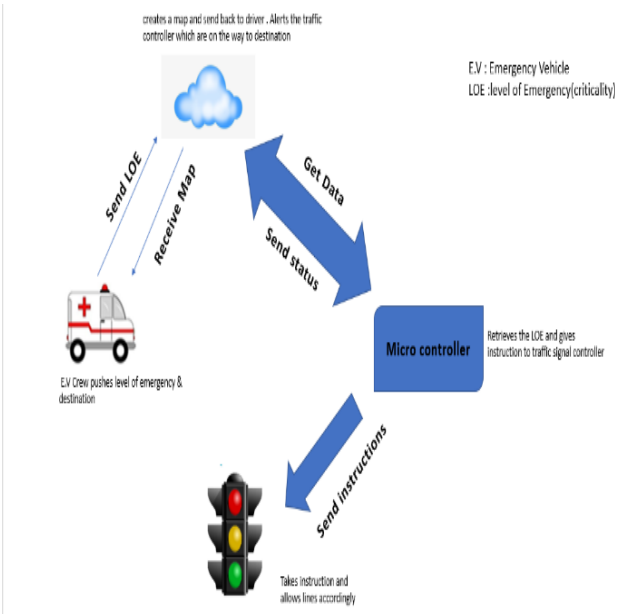

FIGURE 1: System Overview of the model.

The driver will provide the details of the situation once he reaches the accident spot or the fire spot. The details will be recorded to the google cloud service (firebase). The application is developed with the GPS service to track the staffs of the emergency vehicle. The staffs are provided with a username and the password by the service agencies. The repetition of the authentication will result in unsuccessful way of accessing the route map from the cloud service. Once the data has been stored in the cloud storage, it will be analyzed by the machine learning algorithms to decide the level of emergency and the situation.

The system is included with various sensors, Wi-Fi modules and other systems to know clearly about the situation and the way need to be cleared and the required time. Hence the traffic is maintained. The cloud system will return a shortest and less traffic map to the driver of the emergency vehicle through the android app integration. Once driver receives the map for the nearest hospital or the fire control center he starts travelling. The route map shows the traffic signals to clear and the internal integration helps the driver to move the vehicles without stopping and to reach the destination at faster rate with less time.

B. SYSTEM ARCHITECTURE

The Figure 2 shows the system architecture is shown with the components of the system.

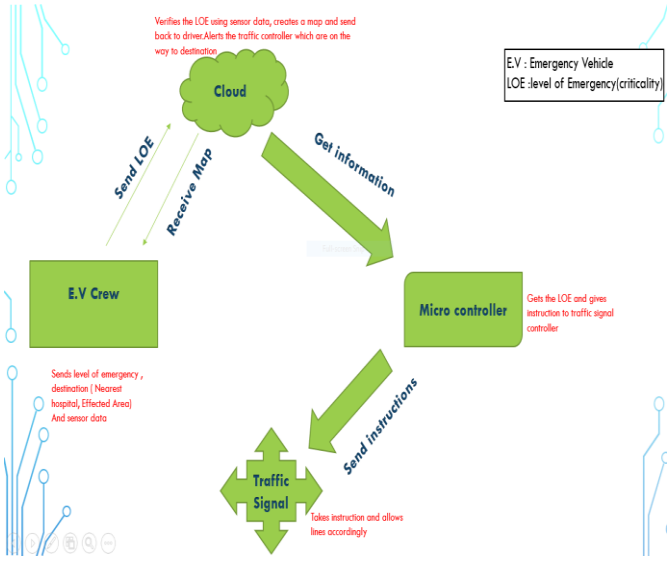

FIGURE 2: System Architecture.

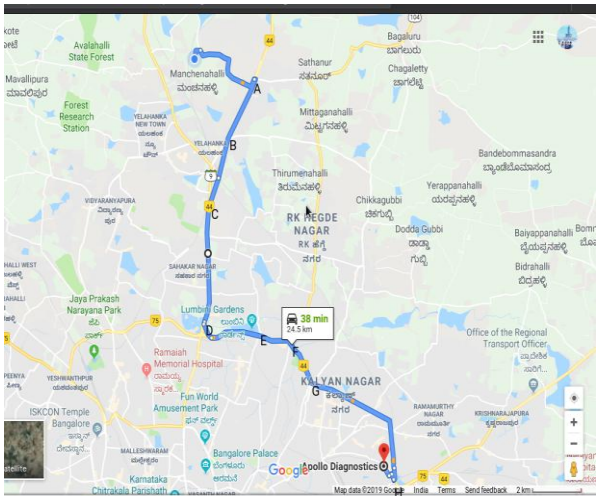

FIGURE 4: An example of the route

- **Emergency Vehicle Crew and App:** Staff of Emergency vehicle must decide the level of Emergency based on the condition of patient or the situation, Driver must know the working of application provided to him, he must also be aware of local routes. Crew members must be able treat the patients with first aid. The app updates the GPS coordinates for every interval of a minute, making it easier to track the location of Emergency vehicle.
- **Cloud:** It acts as the center of this architecture. It receives destination, Level of emergency and GPS coordinates from the Driver app for every interval of a minute. Then decides to send the instructions to all the microcontrollers which resides in the route to destination.
- **Microcontroller:** It gets the instructions from cloud system. It handles the traffic when there are multiple Emergency vehicles waiting.

- **Traffic signal:** These are the traffic controlling units, which directs and instructs the vehicles to move or wait. They operate on instructions provided by micro controller

III. ALGORITHM

In this subsection, an algorithm (refer to Figure 3) is designed to describe the operation of the system is presented. On start of the system the driver will use the android app provided and updates the details to the Cloud system (firebase) and also provides the GPS co-ordinates at regular interval of time. This information is transferred to the Raspberry Pi installed to handle the traffic signal. On examining the details of the driver the traffic signals are given instructions to change or alter the signals at the junction. The crowd is cleared using speakers which are guided again by the Raspberry Pi. After this the Cloud system (firebase) will return a map to the android app based on the status provided by the microcontroller. There is loop between the app and the firebase. The Cloud system (firebase) acts like a bridge between the traffic handling system and application at the driver. This handles entry and use from multiple drivers

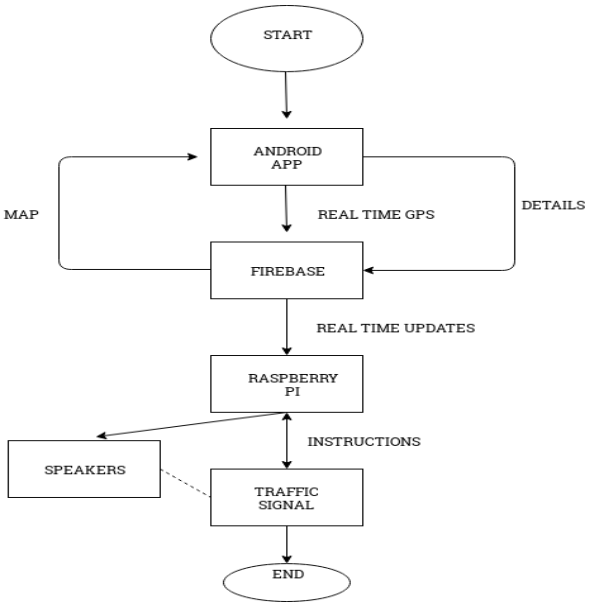

FIGURE 3: Operation of the system

IV. IMPLEMENTAION AND WORKING OF SYSTEM

This work focuses on reducing rather eliminating the waiting time of emergency vehicles near the traffic signal. The Figure 4 shows the example of route decided after analyzing the emergency by the system.

This system is fully automated and running always.

- Driver asked to enter the destination and level of criticality.
- Data is sent to cloud.
- Central cloud analyses the source to destination map and forwards the data to the signal controllers on the way it also verifies the level of criticality
- Signal controllers are raspberry pi which controls the traffic lights, they know the status of emergency vehicle beforehand. Thus, helping them pass the lane early.
- If there are multiple emergency vehicles coming in as shown in the Figure 5 lane then decision is made based on level of criticality
- **Level of criticality**:
  - There are the numbers in range of (1,10) which helps in describing the level of emergency of the situations
  - Sensors (heart rate, blood pressure, temperature) placed in the ambulance, this data can be used to verify the criticality In case of fire accidents the photos can be used to verify the criticality.

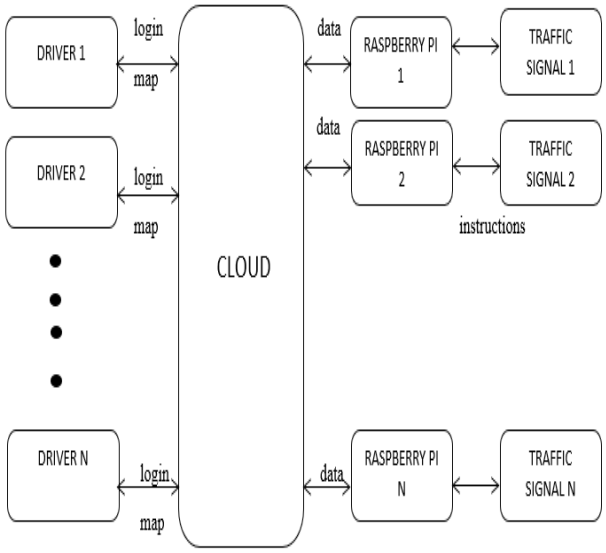

FIGURE 5: Multiple instances running at a time.

V. RESULT AND DISCUSSION

In this work, the results are shown for the hospital emergencies. The proposed system can also be used in other emergency agencies. The Figure 6 shows the hardware design of the traffic signal.

FIGURE 8: Hardware simulation of the traffic signal.

The representation of the data sent by the user through the android app is shown in Figure 7 in the database of the cloud service that is google firebase. First attribute shows the source and later comes other details with the attribute name like destination and level represents the level of emergency. 'Str' is the username of the driver of the vehicle.

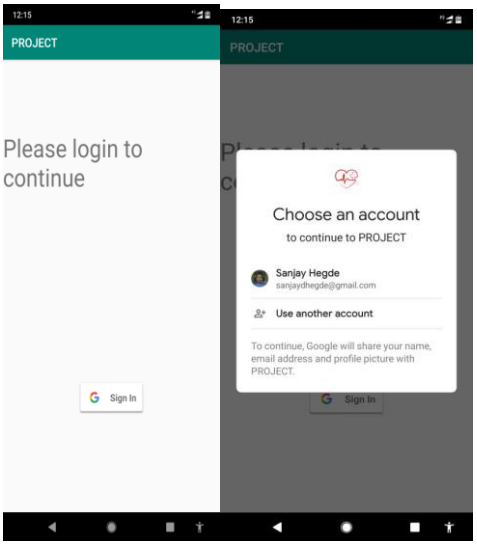

FIGURE 6: Login via android app

This is the android application provided by the hospital or the fire brigade for the vehicle drivers. In this work, the results are shown for the hospital (Figure 8). They will be given the username and the password to sign into the firebase. On pressing the login button the username will be entered in the firebase. If he/she tries to login again after successful login he/she will not be taken to next pages for detail entering.

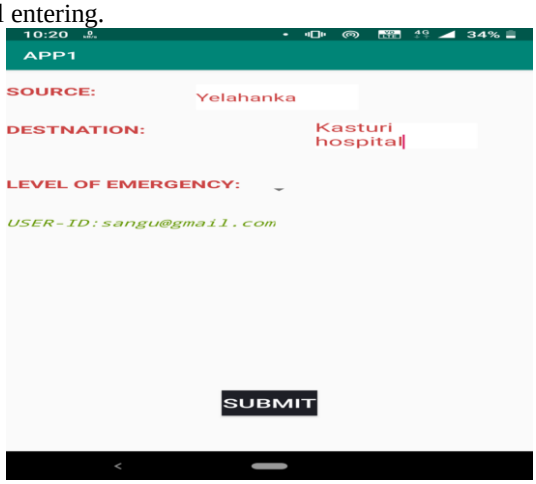

FIGURE 7: Details entering through the app by emergency vehicle driver

This is the page after the user successfully logged in. Here the driver has to enter the source from where the emergency vehicle is starting and the destination that is hospital or the fire spot. The level of emergency is been provided in the dropdown field. We can see the username in the page. On clicking the submit button he will get a popup message saying the destination added. He/She cannot leave any of the fields empty here.

VI. CONCLUSION

This paper has proposed a solution to existing solution by implementing center cloud which makes decision based on the real-time GPS coordinates and level of criticality of the situation.

Using smart micro-controller at traffic signals with vehicle status helps make a decision which can save lives

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