IoT- Based Traffic Signal Control for Ambulance

Reeta R., Kirithiga R., Kavitha V. Kumar, Jaishree M.

Abstract: ***In modern era, due to increase in traffic in the city, emergency vehicles take more time to reach the destination. The current, time-based traffic management system is not suitable and also not flexible for present day traffic, especially at the intersection where the traffic needs to be controlled for vehicles from all four directions. To solve this problem, we bring users a sound detector with automatic recording of various vehicle sounds and distinguishing the presence of ambulance in a particular lane by detecting the siren sound. The captured ambulance sound is processed using IOT and sent to the traffic pole to enhance the traffic clearance. This is carried out by placing the sensors in each lane and a sensor near the traffic pole to indicate that the ambulance has crossed the lane. In this method the traffic signal controller decides when the vehicle has to cross the road and also provide importance to the emergency vehicle.***

Keywords: ***sound sensors, IOT, Arduino UNO, traffic light, Ambulance***

I. INTRODUCTION

Internet of Things is a giant network with connected devices and sensors that gather and this is used to share data about how they are used and the environment in which they are operated. IOT is the collection of smart things which transmit and receive data in a much secured manner [8, 2]. Sensors are embedded in every physical device. These sensors continuously emit data of the working state of the devices. Sensors are functionally simple devices that convert physical variables into electrical signals. Smart sensors [8] are built as IOT components that change the existing variable that is being measured into a digital data stream for transmission from one gateway to another. Traffic is generally organized in many domains with marked lanes, junctions, intersections, traffic signals, or signs. The main problem is to regulate the movements at an intersection.

When properly timed and maintained, a traffic signal increases the traffic handling capacity of an intersection. In most cases, the intersections are the limit to maximum throughput of the roadway. That is, increasing the number of lanes or the speed limit will not have any effect on the overall capacity of the road. The only way to increase the number of vehicles that travels safely from one point to another is to increase the efficiency of the intersections. Sirens are used function of any traffic signal is to assign right way to allow emergency vehicles such as ambulances, police cars, and fire trucks. The traffic analysis in [1, 6, 11] is based on selection of vehicles by photoelectric sensors, radio frequency identification and GPS. Adaptive traffic signal control [4] method considers a number of factors on traffic to determine green light sequence and the optimal green light length. A siren is a warning device which makes a lengthy, loud sound, thus alerting the vehicles on the way. Sirens are integrated into a warning system such that it is linked with other warning media. Siren comprises of multiple tones in which each tone has its own meaning given to alert the residents of the impending danger. A siren sound in emergency vehicles indicates that the direction in which it is approaching. It is done using varying the pitch of the sound. An ambulance is an emergency vehicle [7] to provide emergency care to sick or injured people and to get them to hospital. Ambulance is mainly used to transport patients between hospitals. The siren sound of the ambulance has an alternative sequence of high frequency and a low frequency signal, the sequence of the frequency change is used to be the feature of the sound. They provide easy and quick access to health services, particularly out of hours. Thus it is very important for the ambulance to reach the destination at correct time. Traffic jams are common due to heavy traffic on road, as a result the emergency vehicles like ambulance and fire engines get stuck in traffic. Android mobile can be used to send message to the traffic controller using software installed in it [7]. The message is sent through the short message service available in phone to the GSM module. Image processing is a widely used method for identifying the lane in which the ambulance is approaching. The proposed method will be useful for the ambulance to pass through the traffic junctions without waiting, so that they can reach their destination quickly. GPS [3] does not help in recognizing and prioritizing emergency vehicles, its main function is to maintain the traffic system. The proposed method will be beneficial for the vehicles at emergency circumstances to pass through the traffic junctions without waiting so that they can reach their destination on time.

II. LITERATURE SURVEY

The author in [1] concentrates on providing a clear design of an integrated intelligent system for management and controlling traffic lights supported distributed in a lengthy range using Photoelectric Sensors in distances before and after the traffic lights by appropriate selection of vehicle. The main problem is to reduce the processing time and to enable message scheduling and sending in an optimal way. It is based on sending or receiving messages through any of the IOT devices.

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Delay-Aware Accident Detection and Response System provides an improvement by making efficient use of the benefits of sophisticated features of smart phones and fog computing to propose and develop a low-cost and delay-aware accident detection and response system, which we term Emergency Response and Disaster Management System (ERDMS) using GPS and android phone. The problem to detect the distance of the vehicles from a specific location, and signal is addressed. [3]

Adaptive traffic signal control method considers a number of factors on traffic to determine green light sequence and the optimal green light length. Green light sequence, using the traffic data real-time is determined using decision making method. The methods used involve vehicle detection, green light sequence determination and light length determination. The distance travelled by the green light is determined by the light length. [4]

The authors in [5] described that sensors can be used for measurement of traffic density. Traffic lights will manage data about the various traffic density based on the data collected particularly at junction, supported the density of the traffic which is measured using RFID technique. However, using this technique it is not possible to identify the density of the traffic beyond a particular distance and it is too expensive. Similar method is employed in adaptive traffic control [6].

IOT Based Traffic Signal Control Technique for Helping Emergency Vehicles [7] is proposed for the better management of the traffic of emergency vehicles through the use of internet of things (IOT). The proposed method enables the emergency vehicles to send message to the traffic signal controller placed at the traffic junction where two or more lanes meet regarding their arrival in order that the traffic can be regulated accordingly. In this method the user travelling in the ambulance carries the android phone with the software deployed in it. The SMS (Short Messaging Service) available in the mobile phone of the users , is used to send the messages to the GSM module.

The author in [9] proposed the process of synchronization and connected vehicle technology where each vehicle interacts with each other. This method displays the results comparing with the existing traffic control system. This technology comprises of connected vehicles, process synchronization, intelligent transportation system, real-time processing and intersection management.

This paper has introduced a new algorithm to avoid the traffic deadlock. It also depicts the singe intersection model for simulation, which represents the effective results and the flexibility for the development.

Traffic congestion is a serious problem in big cities where the population is more. In this paper [11] the traffic is controlled using GPS which is used to detect the position of the moving cars. IOT is installed in the moving car which is guided by GPS. The traffic analysis helps the car to take the best route without spending much time in traffic.

The transport network consists of heterogeneous stochastic agents such as intersection stochastic agents such as intersection controllers and road users. The task of adaptive Traffic Light Control is extremely challenging. In this paper [12] the author has analysed the complexity of Traffic Light Control on a single isolated intersection and used the concept of supervised learning. The bottle neck of this method is the data generation and annotation on the growing data in the intersection.

Iman Askerzade, Mustafa Mahmood introduced a system to control the extension time of traffic light. The extended time of traffic light is implemented in single junction based on Fuzzy Logic. This method also shows the simulation results obtained which also marks its better performance and is cost effective. The performance here is calculated by comparing the fuzzy logic with the fixed time controllers. Fuel, Air and Noise pollution are reduced by minimisation in the waiting time. This model can also be developed for better usage in future. [13]

Darwish T, Bakar K A have proposed a system on Traffic density estimation in vehicular ad hoc networks (VANETs) . The main reason for proposing this system is to safeguard traffic, distribution of data, and traffic management. Technologies related to wireless communication in vehicles are rapidly increasing and estimation on real-time infrastructure density free methods are growing day by day. Algorithms in this system is used in both infrastructure based and infrastructure free density method. [14]

III. ARCHITECTURE

The architecture diagram shows various modules involved in the project design:

This architecture diagram is a pictorial representation of our proposed system in which, two sound sensors, bread board and an Arduino UNO R3 kit is used. One sound sensor is placed at a distance of 120m from the traffic light and other placed near the traffic pole to sense the siren sound. Traffic light control is wired on the bread board.

The sound sensor is used to predict the distance of the the vehicles to and from it. In our system , one sound sensor is placed at a distance of 120 m from the traffic pole and the other is placed near the traffic pole. A sound sensor is used to detect the sound of an ambulance, which is transmitted to the traffic pole for light change. The traffic light control is wired on a bread board to make changes in the lights.

All these components are connected together using an Arduino UNO kit, that is an open source microcontroller board equipped with digital and analog input and output pins. The kit is programmable using Arduino IDE and can be powered using an USB cable or connecting it externally to a 9V battery.

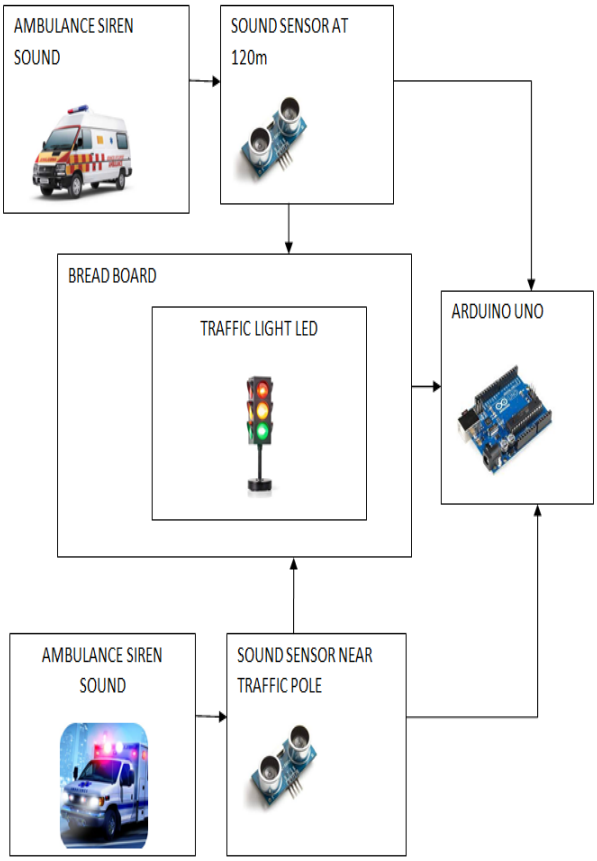

Fig 1. Model Architecture

IV. WORKING MODULES

Initial Detection of Ambulance Sound:

When the ambulance passes by the lane and is at a distance of 120m, the sound sensor detects the ambulance by recognising its sound level which is 120dB.

Transmitting signal:

The detected sound is then transmitted by the sound sensor to the traffic controller which is located at the intersection. This in turn enables them to change the signal at correct time.

Switching the lights at the time of ambulance crossing:

The traffic light at a particular lane in which the ambulance passes is changed to green and all other lanes are changed to red, thus allowing the uninterrupted passage of ambulance.

Detecting ambulance sound near traffic pole:

When the ambulance crosses the lane and reaches the traffic pole, the sound sensor detects the ambulance by recognising its frequency.

Directing signal after the ambulance crosses:

The detected sound is now transmitted by the sound sensor to the traffic controller again. This in turn enables them to change the signal. The traffic light at all the lanes meeting at the junction is changed back to normal form, thus allowing flow of vehicles in all the lanes.

Reverting back the changes made:

The traffic light is changed to normal form, thus allowing flow of vehicles in all the lanes.

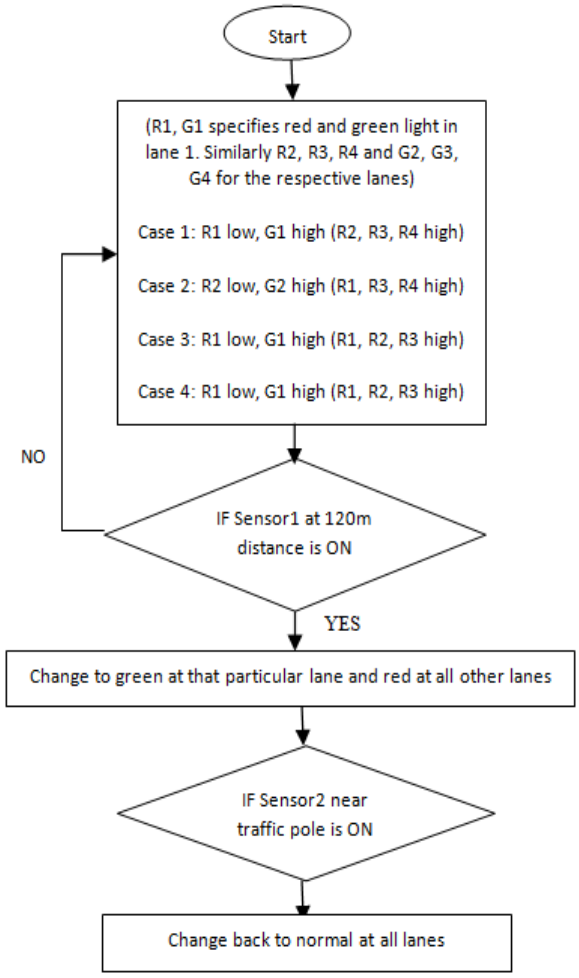

Fig 2: Workflow of IOT based traffic control system

V. RESULTS

The aim of this design is to obtain a highly accurate model for recognising the ambulance by detecting the siren sound at all the lanes. This is deployed by making use of sound sensor at a distance of 120m and the other sensor near the traffic pole. The sound sensor detects the ambulance sound passing the lane at 120m distance. This detected sound is sent to the traffic controller.

The traffic light at that particular lane is changed to green and all other lanes are changed to red using Arduino UNO. After the ambulance crosses the lane, the sensor placed near the traffic pole detects the ambulance sound, and concludes that the ambulance has passed and thus sends the message to the traffic controller to change the traffic light back to normal at all the lanes. The efficiency of using the sound sensor over other method of traffic clearance such as Image processing, Android, GPS are analysed. The given analysis on traffic signal control for ambulance, travelling a distance of 50Km using GPS, image processing, android software and IOT shows that, the average time taken to reach the destination using GPS is 30 minutes, image processing is 26 minutes, android software is 22 minutes and IOT is 20 minutes. Thus, IOT seems to be an efficient way to reduce the delay of ambulance.

METHODS	TIME TO REACH THE HOSPITAL IN MINUTES
GPS	30
IMAGE PROCESSING	26
ANDROID SOFTWARE	22
IOT	20

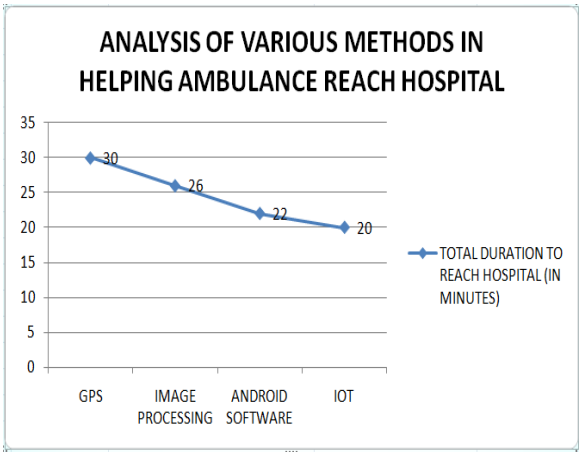

Fig 3: Analysis of various methods in helping reach hospital

VI. CONCLUSION

As human life is very valuable, people should be conscious and follow the security measures. In this paper, we have presented an efficient traffic signal system by which, we will manage the ambulance to succeed in the destination by avoiding much traffic. Our system is meant to realize lower vehicular waiting time than the prevailing ones. The most contribution of our proposed system is that, it is often used to select the simplest possible options for changing the green light and control the traffic system, such that the waiting time is minimized. Moreover, the implementation cost is reduced, because it does not involve any complex hardware installation. The plan was developed to regulate two or four way traffic junction. Additionally, our plan can be extended to handle various lanes and assigning priority to the ambulance if the ambulances are approaching at different lanes simultaneously. This IOT and sensor based system was developed to provide automated environment and save human lives.

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