

IoT Based Geographic Multicast Routing Protocol with DPA through WSN

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Abstract : The traffic blockage is the several problem in metropolitan areas which reduces the fuel efficiency of vehicles as well as time wastages due to traffic jam. In this paper the main approach is to design a system for reducing the traffic congestion at signal and rush areas. The proposed system uses a concept of Internet Of Things with geographic multicast routing protocol and dynamic priority assignment provided at traffic signal. In this paper the multicast routing protocol finds shortest path for ambulance or emergency vehicles in congested areas. This system is designed with component like ESP8266 Wi-Fi module, number of sensors. The ESP8266 is the main component which is used to control all so it acts like a controller. Density of the traffic will be decided with the help of number of sensors. The system is provided to all traffic signals in the city as well as to rush area and they are interconnected to each other through multicast routing protocol.

Keywords—IoT, WSN, DPA.

I. INTRODUCTION

The electric traffic light was developed in 1912. Traffic lights consist of three universal colour lights: the green light allows traffic to proceed in the indicated direction, the yellow light warns vehicles to prepare for short stop, and the red signal prohibits any traffic from proceeding. In Indian road traffic the problem like traffic congestion unpredictable travel time taking serious shape which is also disorganized and noisy. As effect of this the emergency vehicle like ambulance and fire brigades affects the farthest.

The vehicle corral is largely occurred at traffic signals and rush areas. In present scenario the traffic control is achieved by traffic police, traffic signals and marking. In existing traffic light signal system, traffic lights are sets on the different direction with fixed time delay, following a particular cycle while switching from one signal to other creating unwanted and wasteful congestion on one lane while the other lanes remain vacant and if the ambulance comes on this lane or in rush areas it's difficult to reach at destination. In order to overcome this problem we are visualizing to control the traffic blockage at traffic signals by using Dynamic Priority Assignment (DPA) and providing shortest path to the emergency vehicles like ambulance with the help of Internet of things, Wireless sensor network and multicast routing protocol. The Dynamic Priority Assignment (DPA) has number of priorities which are based on emergency vehicle detection like ambulance, major traffic and normal traffic density using WSN and the IoT provides detection of Controlling and monitoring action through internet and the multicast routing protocol helps to provide shortest path for ambulance in rush areas. As per the figure 1 the paper contains following things In section 3, we discussed Internet of Things with geographic multicast routing protocol with wireless sensor network (WSN). In section 4, we discussed Dynamic priority assignment. In section 5, we discussed Experimental setup.

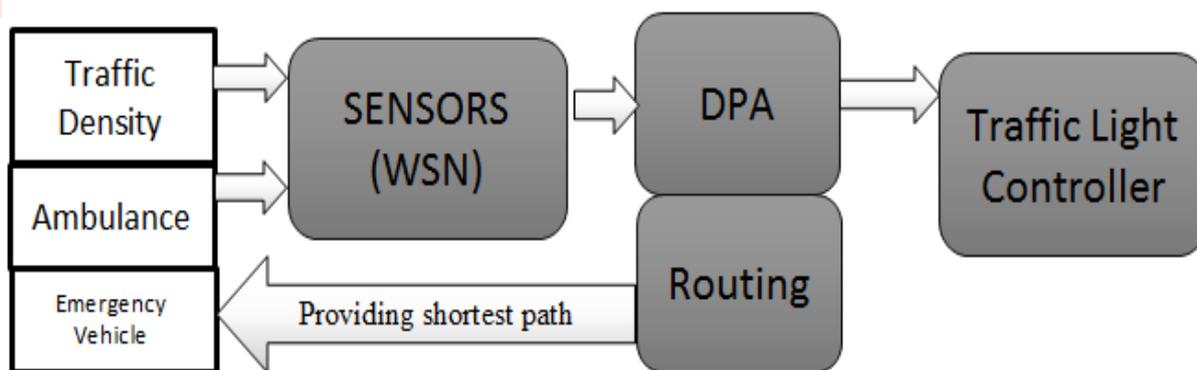


Fig. 1 conceptual block diagram of IoT based multicast routing with dynamic priority assignment (DPA) through WSN

A. Challenges

The challenges for reducing traffic congestions with the help of multicast routing and DPA are avoiding deadlocks, security, reliability, low-power, multicast latency.

1. At traffic signals if we providing multiple signals to the traffic lights it's essential to occurred deadlock in communication. So for avoiding this we have to provide these multiple signals with some priorities.
2. Communication security must be handled efficiently by the proposed solutions. Indeed, wireless nature of communications in WSN is more prone to security attacks than wired technologies. Wireless communication can be easily eavesdropped or denied through jamming. This constitutes a privileged target for hackers and terrorism with potentially high collateral damage. Moreover, motes may be deployed without physical protection or surveillance. This increases the risk of compromising the motes by intruders and get access to sensitive data or credentials to pursue attacks through privilege escalation [1].

3. Data reliability is of a high importance for urban traffic monitoring and management, but this becomes challenging when using WSN due to the low coverage and limited capacity of sensor nodes, added to the lossy nature of wireless communication channels. Therefore, ensuring reliable end-to-end communication must be taken into account by any proposed WSN architecture and communication protocols [1].
4. However, low-power communications also lead to lower link reliability. The end-to-end error rate increases with the number of hops, usually requiring error recovery mechanisms to keep it within acceptable bounds. Finding the right balance between energy efficiency and end-to-end reliability is one of the main tasks of the transport layer [4].
5. In [3], multicast routing algorithm was proposed based on the priority assignment rule which is an old method and the finding of routes will take much computational effort. Also, the trust level of the nodes is not considered.



Fig. 2 Traffic Congestion in Metropolitan Areas

II. LITERATURE SURVEY

Density, speed, and flow are the three critical parameters for road traffic analysis. High-performance road traffic management and control require real-time estimation of space mean speed and density as input for large spatial and temporal coverage of the roadway network. The system specifies the use of on board sensors in vehicle and standard wireless communication protocol Specified for vehicular applications. They implement various traffic Signal control Algorithms. For all this literature survey was conducted for the dissertation in all possible means through the medium of text, reference books, technical magazines, IEEE and of course the powerful media of internet.

In only vehicular sensor network (VSN) it's very easy and more suitable for the controlling traffic light signals. WSNs technology helps a lot in designing flexible because of its easy installation, extension and maintenance. But it's not help to provide shortest path to the emergency vehicles [1].

In network it distributed geographic multicast routing protocol which support to reduce the multicast latency. But does not supports the node mobility [3].

Traffic Congestion is a major issue. Because of this congestion problem, time taken for travelling will be increased. A design was developed using wireless technology with PIC microcontroller, IR sensor and XBEE. IR sensor was used to decided traffic density and timing for the traffic light. XBee was used to provide Green path for emergency vehicle. But this design was implemented only for automatic mode of operation [6]. An algorithm was also designed so that more number of vehicles are passed in signal. Priority number would be given to different category of vehicles. Emergency vehicles like ambulance, fire trucks etc. would have first priority. Next priority is given to VIP's. Next to ordinary Vehicles priority was also given depending upon vehicle density in one side of road in traffic junction. The road which had higher vehicle number would get highest priority [7].

RFID is mainly used to track the objects. RFID readers and tags are used in showrooms so that no one takes off any object or material without paying the bill. This RFID is also used to track the lost vehicles. When the unique ID of RFID tag of lost vehicle is detected then its location where it is found is obtained [8].

III. INTERNET OF THINGS WITH GEOGRAPHIC MULTICAST ROUTING PROTOCOL THROUGH WSN

The main objective of our project is multicast routing protocol. Here the multicasting of number of wireless sensors with internet cloud data from number of respective nodes are provide on the internet for monitoring the traffic. In this signals travels from single sender to multiple destination or towards group of the interested nodes. The internet cloud provides the updated data of particular node on respective channel its helpful data for providing the shortest path as well as monitoring traffic on road.

A Node MCU modules are provides a service of memory space by storing information of the destination cloud for sensors, which originally needs to be stored in sensors. Then the modules transmits the data received from sensors to corresponding nodes channels by internet cloud information with strong transmission power. Once a network begins to operate, sensors are transmit traffic data including their location and ID data to neighbor nodes. At the same time internet transmit stronger radio wave so that they can inform their locations to the node located farther.

The traffic congestions is mostly occurred at traffic signals. So at t traffic signals if we providing multiple signals to the traffic lights it's essential to occurred deadlock in communication. So for avoiding this we have to provide these multiple signals with some priorities. The another important thing of our project is to provide dynamic priority assignment (DPA) provide at traffic signal which has two basic priorities are only use for traffic lights and one highest priority is use only for ambulance with security. The DPA provides traffic density by using ultrasonic sensors which performs major role to preventing vehicle coral at traffic signal. IoT provides internet application to each node.

IV. DYNAMIC PRIORITY ASSIGNMENT (DPA)

Dynamic priority assignment (DPA) is very important scenario in this project which is gives number of priorities in the basis of density of vehicle as well as emergency vehicle is detected on road or path. At traffic light signal for providing priority to specific signal and specific time it's possible to occurred the deadlock situation, if there is similar density on road or if emergency vehicles are on two different paths. For avoiding this the DPA is major concept in this system.

The DPA mainly consist two things which has to be expressed: density of roads and delay of roads.

- Density of roads

The density of roads is classified into three different types that are high, medium and low. When the traffic is up to first sensor it consider low density, when the traffic is up to second sensor it consider medium density and when the traffic is up to third sensor it consider high density.

- Delay of roads

The delay of green signal to each road is chosen according to the density on road or if there is any emergency vehicle is on road. The delays are like if the emergency vehicle on path it gives delay on the basis of density on that path, for low density it gives 20 sec delay, for medium density it gives 40 sec delay and for high density it gives 60 sec delay.

V. EXPERIMENTAL SETUP

This project density based traffic light control and providing shortest path to the ambulance is an automated way of controlling signals in accordance to the density of traffic in the roads. IR sensors are placed in the entire intersecting road at fixed distances from the signal placed in the junction. The time delay in the traffic signal is set based on the density of vehicles on the roads with respect to dynamic priority assignment (DPA). The wireless sensors are used to sense the density of vehicles on the road. According to the IR count and the ambulance on road ESP8266 controller takes appropriate decisions as to which road is to be given the highest priority and the longest time delay for the corresponding traffic light.

As similar the next traffic light signals decision on the geographical path of ambulance is communicate with the each other through multicast routing protocol.

In this ESP8266 as a microcontroller which gets its four inputs from wireless sensor which are set so that they receive signals from vehicles coming towards the road. The sensor monitoring data are logged into the system memory for the first 10 seconds. After the initial 10 seconds, the readings are compared to set levels so that the output delay for LED is calculated. This happens for every of the four main control lines for the signal output.

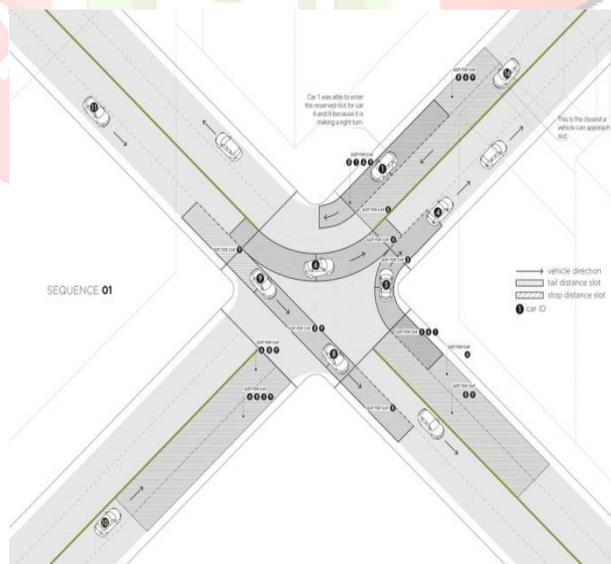


Fig. 3 Sample of traffic on four paths

A. Flowchart

The flowchart of proposed system is also divide in two parts that are shortest path flowchart of node MCU Wi-Fi module in figure 4 and traffic signal flowchart of Atmega328p which is shown in figure 5.

Flowchart For shortest path

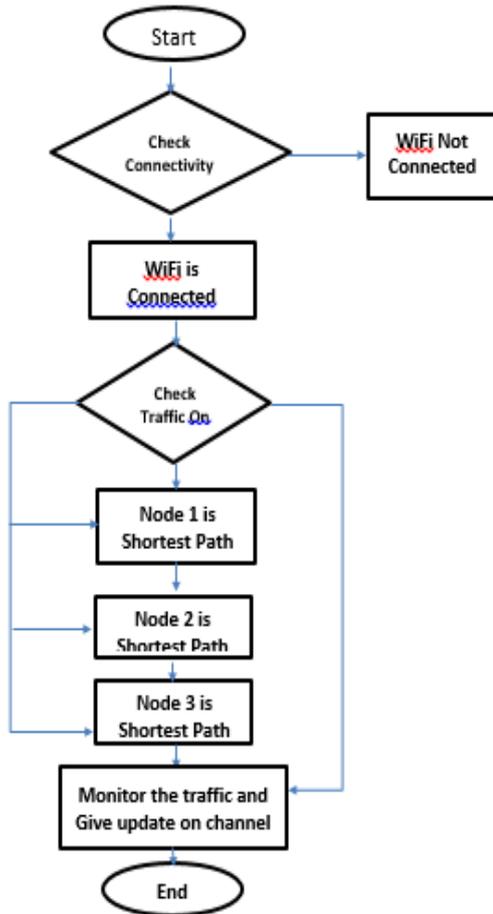


Fig. 4 flowchart for shortest path

Flowchart For Traffic Signal

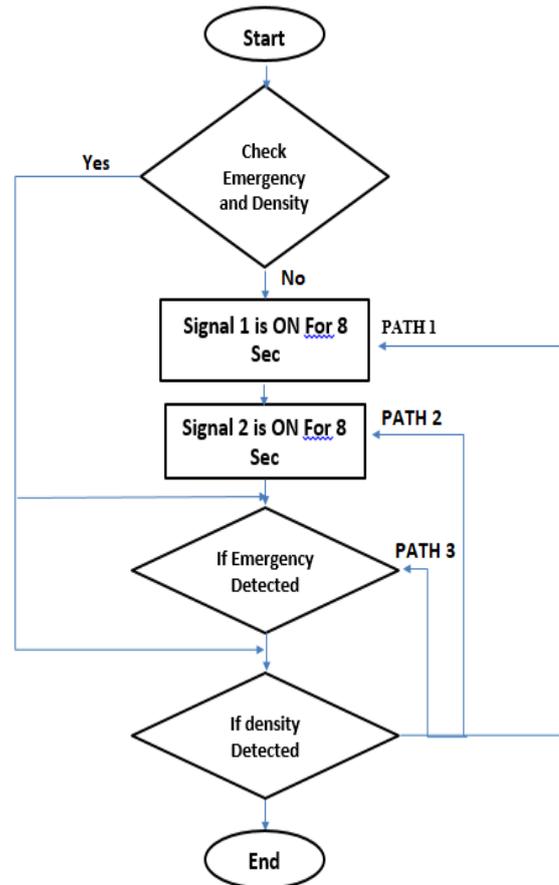


Fig. 5 flowchart for traffic signal

B. Block diagram of setup

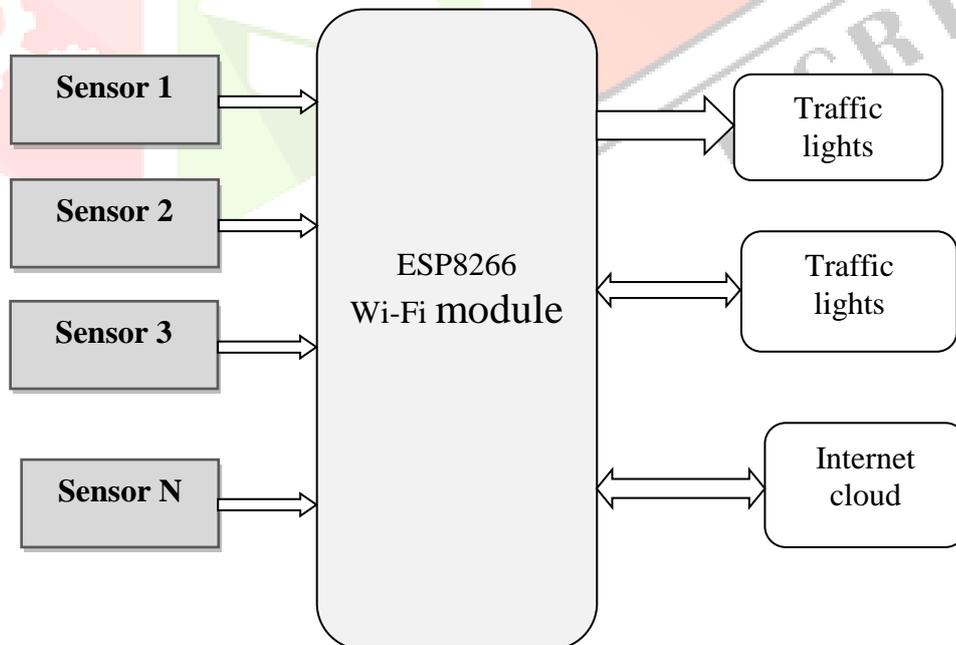


Fig.5 Block Diagram Of Density Based Traffic Control System Using DPA

As shown in Fig 5 the block diagram of density based traffic control system using DPA consist of number of IR sensor as per the requirement of measuring the traffic density on the road, the RF receiver is receives the signals from RF module which is placed in emergency vehicles like ambulance and the Wi-Fi module which is used for data communication with IoT. And the heart of this project the ESP8266 Wi-Fi module acts as controller.

C. IoT Implementation

For IoT implementation we are using ThingSpeak cloud which is an Internet of Things (IoT) platform that lets you collect and store sensor data in the cloud and develop IoT applications. The ThingSpeak IoT platform provides apps that let you analyse and visualize your data in MATLAB and then act on the data. Sensor data can be sent to ThingSpeak from Arduino, Raspberry Pi, BeagleBone Black, and other hardware.

Steps to make cloud server on ThingSpeak:

- Log in with mail id on ThingSpeak website.
- Create channel – private, public.
- Get the API keys - This tab displays your channel API keys. Use the keys to read from and write to your channel.
- Import/Export the data on channel.
- Save your channel.
- Your channel is available for future use by clicking Channels > My Channels.
- After creating the web cloud server or channel we have to configure the wireless sensor network data with it. So the data from ultrasonic sensors are used in three different nodes are given to the three different channels on the ThingSpeak.

Channel:

Channels store all the data that a ThingSpeak application collects. Each channel includes eight fields that can hold any type of data, plus three fields for location data and one for status data. Once you collect data in a channel, you can use ThingSpeak apps to analyse and visualize it.

D. Android application designing for Ambulance

In this project we are using the MIT App Inventor to design the android app for the ambulance. App Inventor for Android is an open-source web application originally provided by Google, and now maintained by the Massachusetts Institute of Technology (MIT). It allows newcomers to computer programming to create software applications for the Android operating system (OS). It uses a graphical interface, very similar to Scratch and the Star Logo TNG user interface, which allows users to drag-and-drop visual objects to create an application that can run on Android devices. In creating App Inventor, Google drew upon significant prior research in educational computing, as well as work done within Google on online development environments.

App Inventor and the projects on which it is based are informed by constructionist learning theories, which emphasizes that programming can be a vehicle for engaging powerful ideas through active learning. As such, it is part of an ongoing movement in computers and education that began with the work of Seymour Papert and the MIT Logo Group in the 1960s and has also manifested itself with Mitchel Resnick's work on Lego Mind storms and Star Logo.

Working:

App Inventor consists of the Designer and the Blocks Editor. These are described in detail below. Design the App's User Interface by arranging both on- and off-screen components. The App Inventor servers store your work and help you keep track of your projects. The App Inventor Blocks Editor, where you assemble program blocks that specify how the components should work.

The Design Window, or simply "Designer" is where you lay out the look and feel of your app, and specify what functionalities it should have. You choose things for the user interface things like Buttons, Images, and Text boxes, and functionalities like Text-to-Speech, Sensors, and GPS.

One of the neatest things about App Inventor is that you can see and test your app while you're building it, on a connected device.

VI. RESULT AND DISCUSSION

A. Customisation

As per the requirement of two module in this project for defining the use of IoT we required to communicate both the module with each other through internet. Hence it is possible with two ESP8266 Wi-Fi modules which increased the cost of project. So for avoiding this we are using direct connection between them. But this solution with one problem i.e. the ESP8266 module provides 3.3volt dc to the each output pin and atmega328p microcontroller required input voltage is 5volt dc. So by evaluating this problem we required some hardware means its again increases the cost.

So we are solving this problem by customizing in source code of traffic signal i.e. we have to use analog pins of atmega328p microcontroller. By setting the input on 3.3.volts at PORT A pins we can received the ESP8266 output at atmega328p microcontroller.

B. Traffic Control with DPA

The result of traffic control with dynamic priority assignment (DPA) is display on LCD module as well as on Traffic light signals which contains two important light i.e. red and green. In DPA the traffic lights are working on three different priorities that are first is emergency signal of ambulance that provide from android app, second is traffic density and third is normal traffic density. The fig. 7 shows that the result of DPA on LCD display. It shows different priority on each road.



Fig. 7. Result of DPA on LCD display

C. Traffic monitoring for shortest path

The result of traffic monitoring for shortest path is display on ThingSpeak cloud server as well as on the LED. In this project there are three predefine node and we are monitoring the traffic on these nodes. So on ThingSpeak cloud we have required three channels. On this channel the ultrasonic sensor data send through the ESP8266 Wi-Fi module which is on node MCU. This data can be analyze and visualize in MATLAB. The fig. 8 shows that the result of traffic monitoring system of different nodes on different channels.

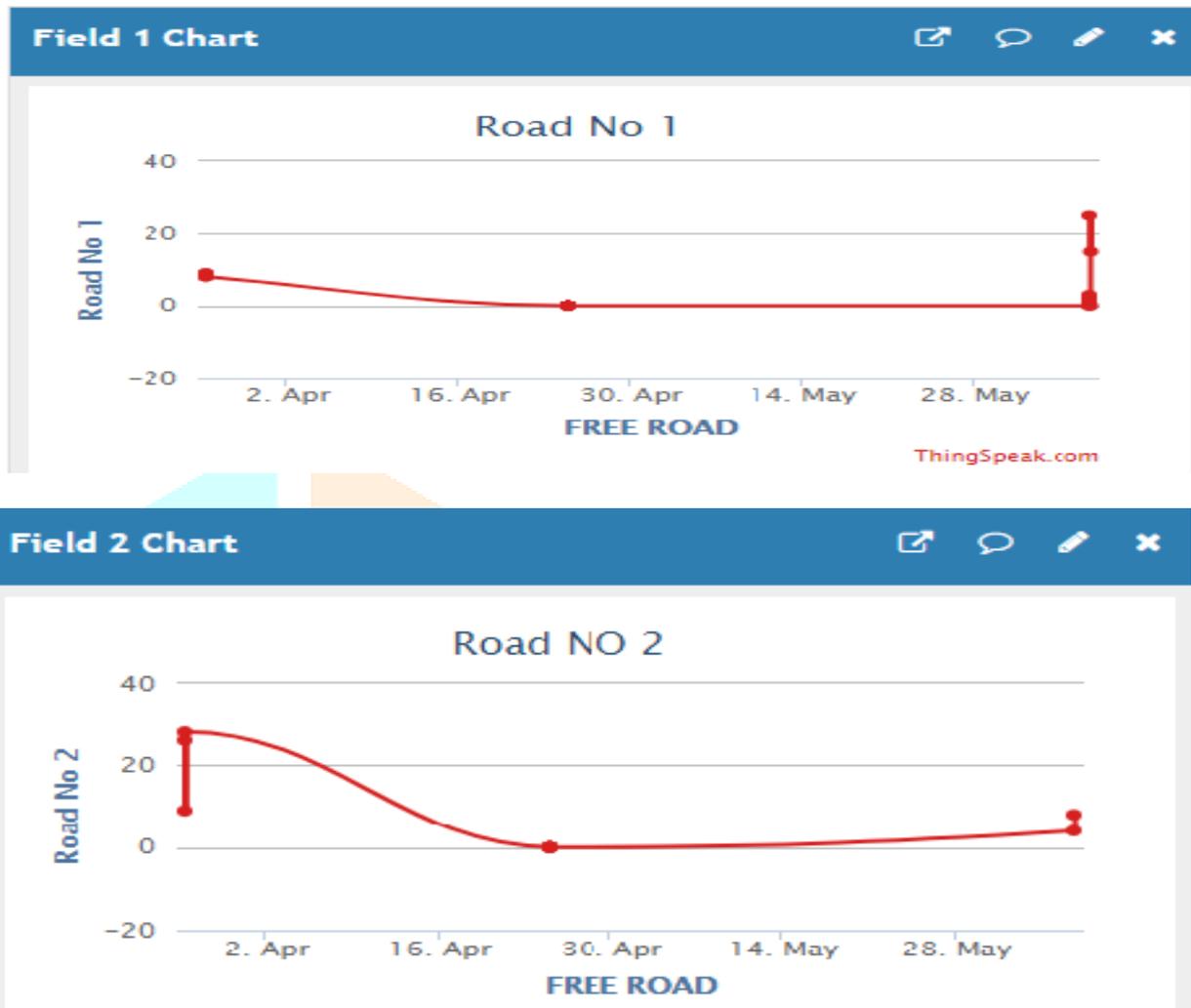


Fig. 8 Traffic monitoring output on ThingSpeak

VII. CONCLUSION

Shortest path or alternative shortest paths are proposed using multicast routing protocol which gives the multiple energy sources from the wireless network sensors. In this project the three predefined node's ultrasonic sensors are monitoring the traffic data on cloud server. By that three multiple sources ambulance get the information about the low traffic path. Hence the cloud server is able to provide shortest path to the ambulance. The ambulance uses android app for determining the traffic coral on different paths and it helps in obtaining the shortest path to the destination. This is used as a powerful functionality for planning optimal routes based on online travel time information. The results of this project illustrate that dynamic routing of emergency vehicle compared with static solution is much more efficient. This efficiency will be most important when unwanted incident takes place in roads and serious traffic congestion is occurred.

To reduce the congestion and unwanted time delay in traffic, an advanced system is required. One such advanced technology is automatic signaling using wireless sensors. The sensors help in monitoring traffic of vehicles entering roads and subsequently allot time delay thereby giving accurate priority to each road for the time being and the multicast routing protocol helps to find shortest path to the emergency vehicle. With this technique we have entered a new era of automatic traffic signal control. By using this system configuration we can reduce the possibilities of traffic jams caused by traffic lights to an extent. The number of passing vehicles on the road decides the density range of traffics and on the basis of vehicle count arduino decides the traffic light delays. And if there is any emergency vehicle on this road it gives first priority to it.

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