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saraNi – An IoT based pathfinder

Ramyavathsala C V
ramyavathsala8@gmail.com
BNM Institute of Technology, Bengaluru, Karnataka

Dr. Shashikala
hebbar.shashikala@gmail.com
BNM Institute of Technology, Bengaluru, Karnataka

ABSTRACT

"Internet of Things" means the interconnection of things – a person, buildings, vehicles, electrical and electronic devices, mechanical devices and so on. There are huge applications in this area like smart home, smart city, medical applications, Traffic management system etc. Now a day's traffic congestion is a major problem which leads to the traffic jam in developing countries like India. Reaching the destination within the city limit is so unpredictable. It is necessary to analyse the traffic pattern in near real time. So it is necessary to develop an IoT based application with real-time data analysis to overcome the problem. In this paper, we present "saraNi – An IoT based pathfinder" is an application that is targeted to help daily commuters in reaching the destination from the source in the shortest and the fastest possible route. The application is indented to help the commuters using smart wireless sensor network. The application uses sensors that are placed in various junctions, which detects the congestions at the junction.

Keywords: *Piezoelectric sensor, Smart navigation, Wireless sensor network*

1. INTRODUCTION

Internet of Things is a 21st century phenomenon. The objects in the real world are connected with each other and they start communicates with each other by using sensors and actuators. Now a day's IoT is an emerging technology. By 2020, it is estimated that there will be up to 21 billion connected devices [1]. The main idea of proposing IoT is to provide wireless communication functionalities to all physical objects that support our daily activities. The entire world is moving towards IoT so there will be a huge impact on human lives in the coming few years. Internet of Things is a trend in which the huge number of devices gain benefit from communication services. Each and every day there is a lot of innovations and enhancements in the technology. It is to be expected that Internet of Things will be the next big thing in the market and can believe that within few years human way of living, work and communication will get change because everyone will be connected to everything and everywhere. Now a day's IoT playing a vital role in day to day activities of human life. There are a huge number of IoT applications like smart home, healthcare, retail, smart infrastructure, transportation, industry and so on. Traffic congestion is major problem in developing countries. It is quite complicated to predict the traffic congestion and density or volume of the traffic. It is necessary to analyse the traffic pattern in near real time. In the developing country like India, traffic congestion is a major problem. Reaching the destination within the city limit is so unpredictable. So it is necessary to develop an IoT based application with real-time data analysis to overcome the problem.

2. RELATED WORK

There are various methodologies for traffic management system based on IoT. Some of the methodologies are described here.

The Real-time traffic congestion detection and optimal path selection using smartphone [2] method will detect the situation of congestion in the traffic in near real-time and will provide the alternate less congested path. The data will be collected through mobile phones which act as a probe. The calculation of less congested path will be done with the help of GPS, Google map services, and servers. The system implementation for this task is divided into 1) collected data from client side 2) server receives the collected data 3) processing step 4) classification and filtering 5) server to the client.

In the first phase, the smartphone acts as a client. The smartphone is used to detect the speed of the vehicle. The current/present location of the vehicles is extracted at regular intervals by using the GPS system. The location information retrieved by GPS will be stored in the database. The processed data will be pushed to the Google Map Application programming interface. The map application programming interface uses JSON files to send back the direction between two locations. So that the server can suggest a path with less congestion. The limitation of this method is, the traffic congestion is estimated based on the smartphone rather than the actual vehicle on the road, then the accuracy is less.

In the Automated traffic measurement system based on FCD and image processing [3] method, the main idea is to use two techniques to measure the traffic in order to achieve accuracy. The measurement of the traffic is based on FCD and image processing. FCD means floating car data, can also be called as floating cellular data. This is the method to determine the speed of the traffic on the road network. FCD is a non-intrusive method of collecting traffic information. It is a simple method and it doesn't require additional components. The car itself acts as a sensor to generate information. Here every switched on mobile phone act as a traffic probe.

The working of this system begins with getting FCD from mobile phones using GSM over CDMA. The GSM cell towers monitor cellular data continuously. Once GSM cell data sent to the server, the cameras placed at the roadside will pick the image. The captured image will get converted to digital data to send it to the server. After processing of all the data, the TCD and image data will be compared with each other in order to check compatibility. If the result is beyond the threshold value, the collected data will be omitted, and a new request is sent back to the remote station in order to get a new dataset. The main advantage of this approach is, using two different vehicle detection methodologies will reduce the limitation of single model traffic detection technique. The main shortcoming of this approach is that it takes much processing time and using FCD method there is a chance of huge unwanted data along with real data which is obtained through cell-phones which are located inside the vehicles.

In the Design and Implementation for Ambulance Route Search Based on the Internet of Things [4] method, the main objective is to provide an optimal root for the ambulances by considering traffic conditions. The main components used are RFID tags and wireless sensor nodes. The RFID tags are placed inside the ambulances which send radio frequency to the wireless sensor nodes. The wireless sensor nodes are placed or installed on the roadside. The real-time traffic information condition will be sent to the dispatch control center which is located in the hospital. The report messages are sent to the control center by means of multi-hop method. Terminal nodes also called as WSN which are installed on the roadside can use contactless magnetic sensors in order to collect the vehicle information like vehicle speed, car safe distance and so on.

The magnetic sensors detect the vehicles based on measuring the change in the magnetic field when the vehicles pass over the detectors. When the vehicle enters into this sensor region the terminal nodes will collect the speed of the vehicles using magnetic sensors and then send collected information to the adjacent nodes by means of multi-hop method. Based on this information the condition of the traffic jam will get evaluated. The information collected by the sensors at different locations will be sent to the base station by terminal nodes in order to carry out data fusion. This will give the vehicle flow information.

In the Detection of entry and exit zones in image sequences for automatic traffic analysis [5] method, the main aim is to get the condition of the traffic on daily, monthly and season basis using video surveillance. The camera which is placed on the roadside will grab the video of the traffic. This video will be broken down into a sequence of frames. It is used to define an adaptive background model based on the hierarchical model. Image processing will be performed on these frames. In the image, the foreground object is characterized by its boundary, position centroid, and color. The Fourier descriptors are used to classify the objects as vehicles and pedestrians. The exit point of the scene is extracted using scattering process on image data structure. The entry points are obtained by reverse engineering on this data structure. The main limitation is authors only interested in counting the number of vehicles. They are not considering the speed of the moving object. So it is difficult to predict the traffic congestion.

The challenges of the Intelligent Transportation System should accurately detect a number of vehicles, vehicle speed and traffic occupancy at the given junction accurately. Vehicle detection is a big challenge in the congested junction, so building automated way of detecting vehicle is very important for solving traffic congestion. In the Vehicle Detection through Traffic Video in Congested Traffic Flow [6] method the authors aim is to present a method to analyze highway traffic information. The authors consider a number of factors like, detect congestion and must be efficient to calculate in real time and direction of vehicles flow on the road. The proposed algorithm is divided into three parts like background segmentation, vehicle detection and tracking, and vehicle speed detection.

Vehicle speed detection is the important part in analyzing the traffic information which is difficult to detect in real time with accurate data. There are numerous vehicle speed detection strategy and can be classified into two, like hardware and software. Hardware speed detection uses induction coil loop, laser speed measurement, radar speed measurement and so on. While the software-based vehicle is mostly dependent on video frame analyses. The authors propose to detect and analyze the traffic flow of using video frame analyses. They propose to use by background segmentation, blob cluster and improved three frame difference method.

The workflow of the system is as follows,

- Track vehicle by combining point tracking method and blob cluster method.
- Measure and check vehicle speed by improved three frame difference method.
- Improve vehicle detection by tracking vehicle speed measurement.

The experimental data of the algorithm used shows that it can get high accuracy, but there are some shortcomings like the author's considered data set is not big enough. The whole process is time-consuming. In case of extreme congestion, the algorithm fails to accurately represent the contour of the vehicle as the overlap of the vehicle is very large.

This paper contains an overview of related work in section 2, an in detail of proposed module in section 3, analysis about result in section 4, conclusion in section 5 and future enhancement in section 6.

3. PROPOSED SYSTEM

3.1 System Architecture

The figure depicts the architecture of the proposed model. This architecture contains the modules namely:

- User interface
- Search and Find engine
- Postgers database
- Geo server
- Route engine and sensor network

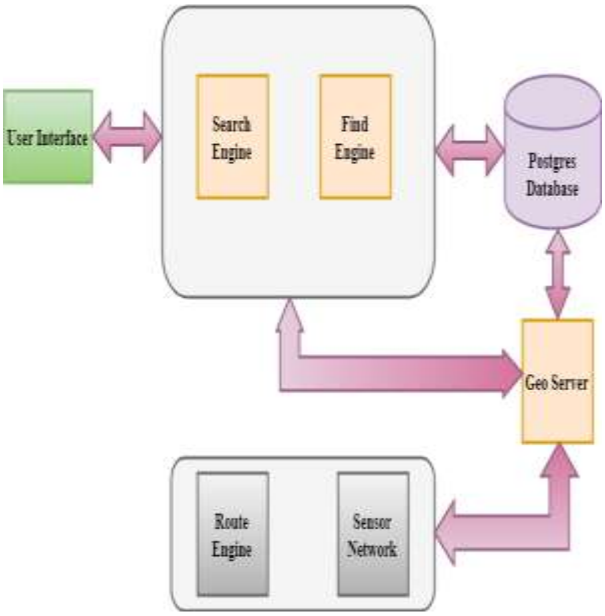

Fig. 1: System Architecture

In this architecture, when user enters for source and destination location, the search and find engine will search for those locations in the database and then locates the point in the map with the help of geo server. The route engine will provide path between those locations and also will calculate less congested path from source to destination using sensor network (piezo sensors), it will be outputted to the user for every few seconds.

3.2 Hardware Circuit Design

Piezoelectric transducer outputs an electric signal whenever a force is exerted on it. A typical electric signal generated by a sensor is captured in the figure. The output of sensor includes multiple frequencies, noise and non-standard amplitudes; it is cumbersome to process those signals by directly connecting to a processor or a controller. To interface this sensor to controller, initially the signal should be monitored to output standard TTL (Transistor-Transistor Logic) levels. For this a voltage level crossing detector should suffice the purpose. A detailed schematic is mentioned in the figure 2.

3.3 Working

Whenever an electric signal is generated from the sensor, it is fed through the impedance matching resistor of 300kΩ to the non-inverting terminal of Op-amp as specified in the above circuit. A signal of 0.7V is applied across inverting terminal which acts as threshold reference for the circuit. Whenever an input from the sensor crosses threshold reference of 0.7V, it results to generate a stable output voltage level of 4 to 4.5V which comes under TTL level. If the sensor output is less than the 0.7V, it will be treated as noise and results to logic zero. The typical output signal generated is captured which is shown in the figure 3. The captured output signal will be fed to the Microcontroller GPIO_PIN through pull-down resistor of 10kΩ for further processing.

3.4 Application Dataflow

The idea behind this module is to bring out the data flow of the application. The piezoelectric sensor senses the vehicles and the sensed data is sent to Arduino board, then the data is read on a serial port using NodeJS.

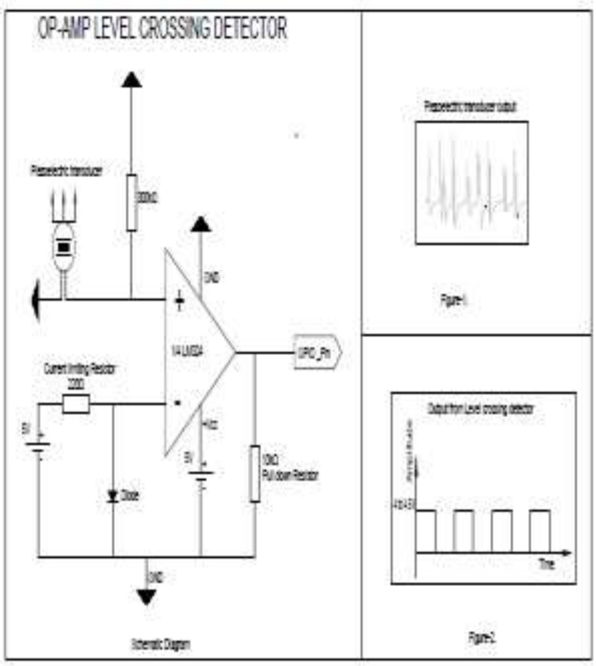

Fig. 2: OP-AMP level crossing detector

The sensed data is pushed to SQS using NodeJS and the data remains in the queue for 15 minutes in the FIFO queue, AWS SQS FIFO queue ensures the data delivery at least once, so for the same reason FIFO queue is chosen while developing the application. On the other hand, whenever the end-user requests for the route, the request is sent to API that is developed using Rails framework is called. Rails application collects all the sensor sensed data from SQS and the shortest and the fastest path is calculated using pgRouting.

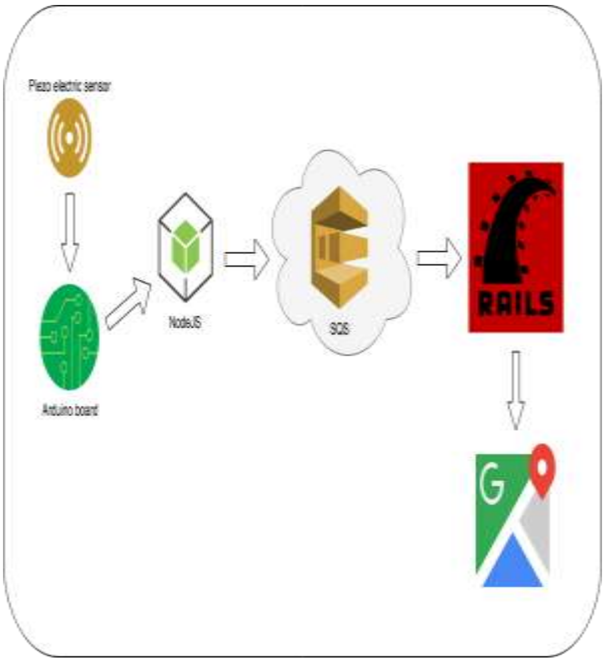

Fig. 3: Application Dataflow

4. RESULTS

The detection of traffic is done based on real-time sensor data which are installed on the roadside. The figure 4 represents the path between source and destination before sensor installation and figure 5 represents the path between the same source and destination after detection of traffic based on the real-time data collected from sensors.

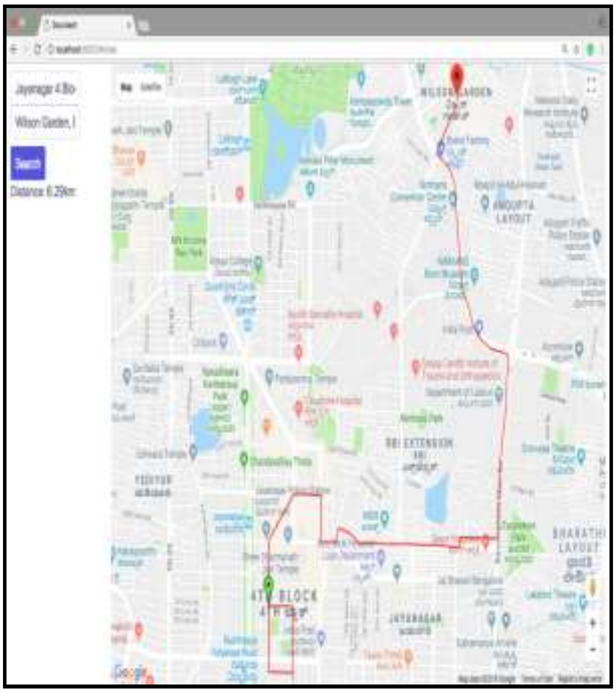

Fig. 4: Routing path between source and destination before sensor installation

Fig 5: Alternate less congested path based on traffic detection

5. CONCLUSION

In this work, a novel approach is discussed to find an alternative route to reach the destination at the earliest. The piezoelectric sensors are used to detect the traffic density and an alternate path is proposed to the user. It can be further enhanced to detect the heavy vehicle and light vehicle on the road to increase the accuracy and provide a shortest alternative route.

6. FUTURE ENHANCEMENT

The current developed application is finding shortest and fastest path based on sensed data. In future, the application can be extended to detect the actual number of vehicles, type of vehicles that have passed through the junctions.

Currently, the application decides the traffic congestion at any given junction by the same threshold set for each and every junction, but in future traffic, the threshold could be decided based on road capacity, good or bad road etc. In future there should be UI developed to configure sensors at each junction, currently, it is done using SQL Queries. In future piezoelectric sensor can be coupled with IR and camera module to increase the accuracy. Map data should also be improved.

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