IoT Based Smart Transport Management System

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IoT based Smart Transport Management System

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Abstract. Currently, vehicle to vehicle communication is an important application and thrust area of research. In this paper the author highlighted the workings, executions, implementations and the application of the Internet of Things (IoT) in transport management and vehicle to vehicle communication systems. The main advantage of this Industry 4.0 based IoT technology is that it helps us to reduce road traffic and accidents. The limitations of GPS like accuracy, precision, effective analysis, etc. has led to the evolution of Mobile based V2V communication which is more effective, error proof, result oriented and smart. For proper analysis of traffic vehicle to vehicle communication is established. Random Data from vehicles taken by numerous sensors. Any car coming in its variety could effortlessly share the data by either of two cars nearby. With the help of vehicle to vehicle communication we can provide a path of emergency vehicles to reach the destination quickly. Based on the V2V application, Red and Green signals can be marked on the path as per traffic density and the emergency vehicle can take the shortest, fastest and low density route. Similar such examples are elaborated in the current research manuscript that will help the researcher in effectively finding the research gap for further advancement, analysis, innovation and optimization.

Keywords: Anisotropic magneto resistive sensor, RFID, ultrasonic sensor node, wifi, traffic management module, traffic density monitoring module.

1. Introduction

Transportation systems is the need of today. No of vehicles on roads are increasing day by day [1]. Every person has their transportation due to the increasing no of vehicles risk of accidents are also increasing [2]. Traffic congestion makes a great impact on productivity and economic growth. After a lot of research, many solutions have been proposed using IoT [3]. Some communication is using RFID, Lifi or many other technologies. Purpose of such model is to predict and control traffic flow [4].

2. Traffic Congestion Control System

Sensor array is used by traffic congestion control system. Such sensor is used to measure traffic density and then send this information to the phone via bluetooth. Work of android phone is to collect information about traffic density and send to the server [5], [6]. This server analyzes these traffic by extracting data to detect traffic and manage such traffic signal. After it information about traffic density to central server transfer from phone to server through internet [7].

3. Traffic Density Monitoring Module (TDMM)

Ultrasonic sensor is used by this model. This model is used to detect the length of vehicle queue. This model use microcontroller. Microcontroller is used to receive data from ultrasonic sensor. It also has a Wi-Fi module which is used to send data to traffic management module. Limitation of this system is that no experimental result has been found to verify the accuracy of system [8], [9].

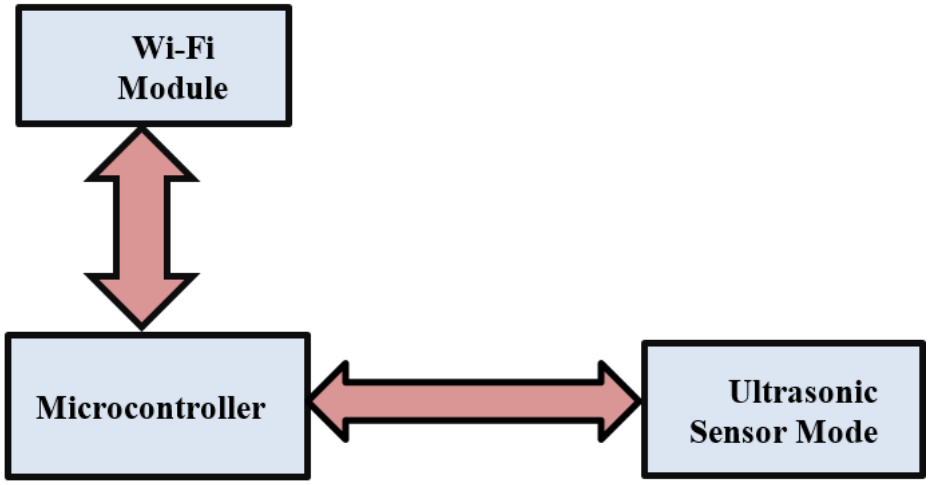

Fig. 1. Diagrammatic representation of traffic density monitoring module.

4. Traffic Message Channel (TMC)

Major Drawback of GPS is that we can't find exact route. So concept of Traffic message channel was evolved. Main work of TMC is to transmit information about current traffic. If roads are blocked. TMC suggest an alternative route for vehicle. But congestion could occur on an additional route too if many vehicles uses TMC. To overcome such drawbacks, concept of vehicle to everything technology was evolved [10].

5. Traffic Management Module (TMM)

It is attached to the LED and connected to a microcontroller

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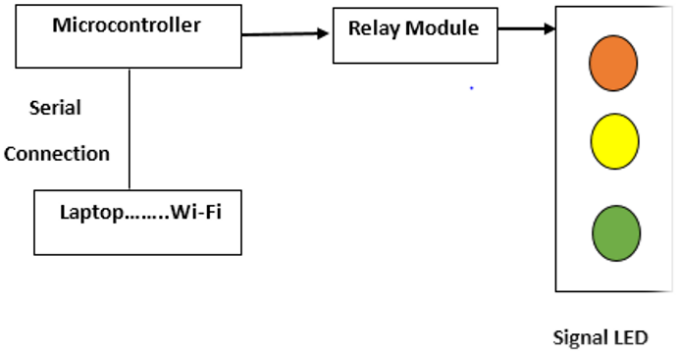

Fig. 2. Working of Traffic Management Module (TMM).

Relay module: Relay module works like an electromagnetic switch which is responsible for any traffic congestion.

6. Working of Traffic Density Monitoring Module

i. We have used USN (Ultrasonic Sensor node) for detecting the vehicle presence.

ii. We detect the presence of vehicle if measured distance is less then reference distance. We can symbolize measured distance by d_m and reference distance by d_r.

Reference distance (d_r) = width of road
Measured distance (d_m) = C * (T_r - T_s)
Where,
C = speed of sound waves
T_r = Time of reception.
T_s = Sending time of emitted signal of ultrasonic sensor.

iii. We have assigned a unique ID to TDMM.

iv. TDMM is used to detect vehicle presence. TDMM would construct a packet and then broadcasts it through Wi-Fi module. TDMM would broadcast packet if these conditions are satisfied.

a. $T_p > T_c - T^{th}$ where T_p = Timestamp value and T_c = current timestamp and T^{th} means threshold time value

b. Unique Road id of local TDMM is equal to the road id of remote TDMM.

The following algorithm is used for traffic congestion

i. We have to find out timestamp value (Tp) of packet and we have to compare these values with current timestamp (Tc). We should ignore if Tp<Tc-tth, where T^{th} is threshold time. Otherwise

ii. Check id of TDMM and then divide all received packets on the basis of road id.

iii. There are 3 TDMMs on each road having traffic congestion density.

a. Zero TDMM means traffic queue is smaller.

b. 1^{st} TDMM means traffic queue length lies between first and 2^{nd} TDMM.

c. 1^{st} and 2^{nd} TDMM both indicates traffic queue length is between the 2^{nd} or 3^{rd} TDMM.

d. TMM find out the operation time of traffic signal add this into microcontroller.

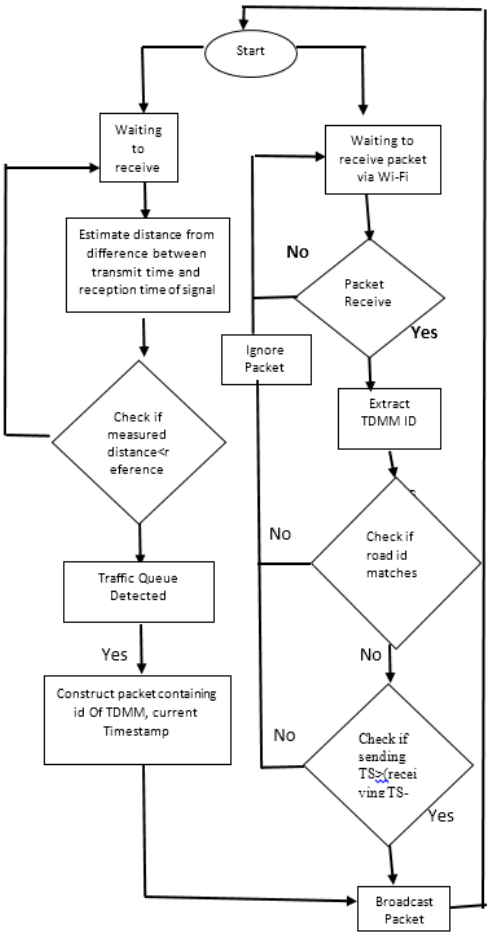

Fig. 3. Diagrammatic representation of detecting vehicle presence in queue.

7. Case Study: 1

The purpose of this case study is to discover the vehicle-to-vehicle contact impact. For research, the subset of I-5 in the orange country is used.

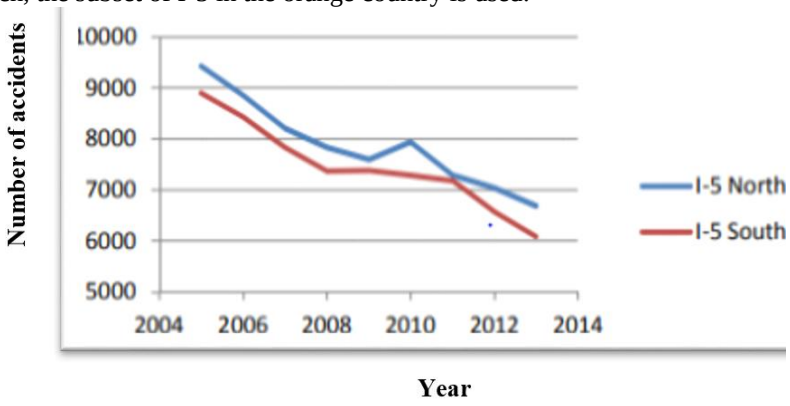

Fig. 4. Annual accident data on I-5.

California Highway Patrol report tells that no of vehicle involved accidents in the state of California is very high, it has gone down significantly in last seven years [Table 1].

Table 1. An accident comparison between 2005 and 2012 in California.

	Year 2005	Year 2012
Persons Injured	292,798	226,544
2 Persons Killed	4,304	2,995
Mileage Death Rate	1.31	0.92
Injury Collisions	198,708	159,696
Fatal Collisions	3,822	2,758

The data of accident shows a decreasing trend on I-5 in northbound and southbound directions as discussed in Fig. 5 and Fig. 6.

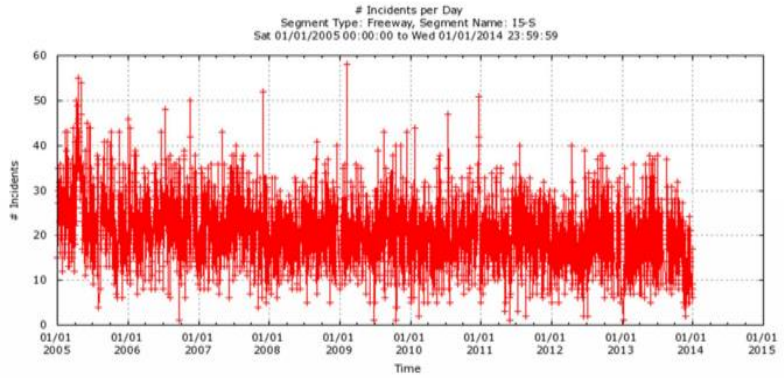

Fig. 5. Number of accidents per day on the northbound direction in orange county.

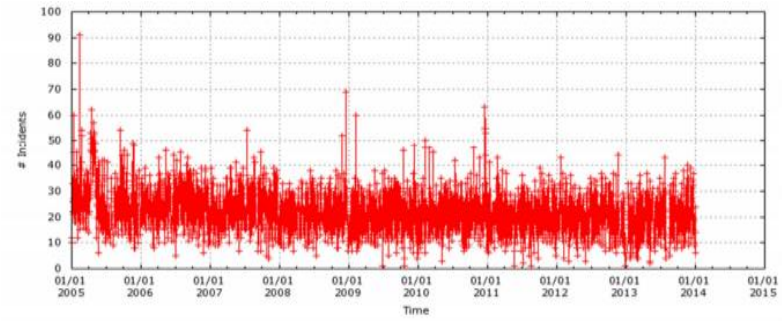

Fig. 6. Number of accidents per day on the southbound direction in orange county.

In Fig.7, we can see that large no of accidents occurred on freeway mainlines and rest 31% occurred either on or off ramps.

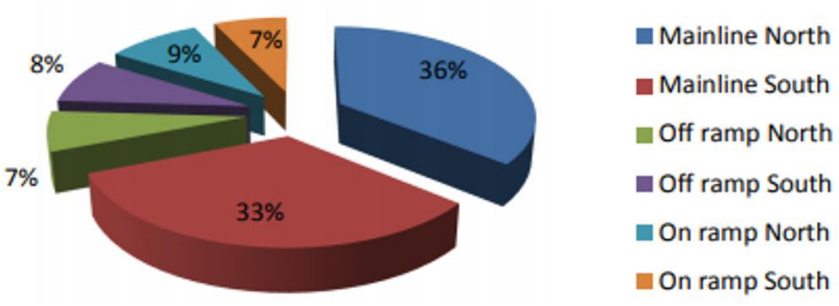

Fig. 7. Location of accident on I-5.

The number of accidents decreased when new technology was evolved. These systems warn driver about collision.

8. Case Study: 2

A significant number of injuries are minimized by the use of V2V technology. In 2012, there have been 1120 vehicle collisions. There is description from these accidents are as follows:
373 = rear end, 241 = hit object, sideswipe = 165.
We can see type of accident are mentioned in Fig.8. Rear end collision occurred when there is any collision occurred with leading vehicle. rear end collision represents 34% of accidents. Sideswipe accidents occurred when there is not enough visibility. It represents 15% of accident. Hit objects are done by automated emergency braking system. It represents 12% of accident.

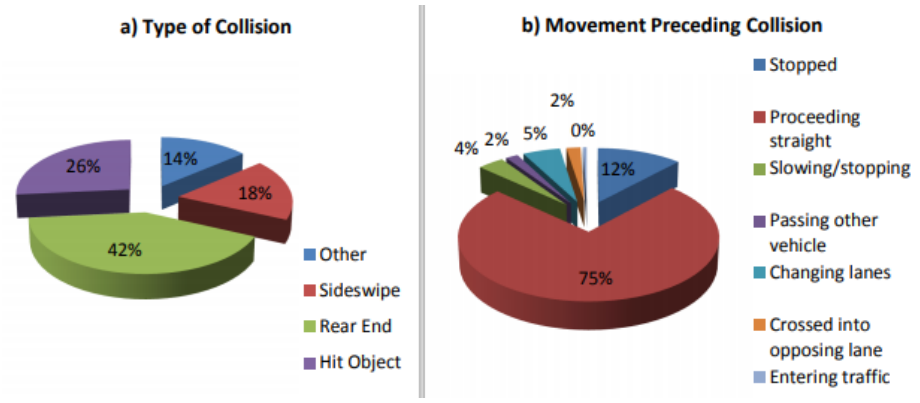

Fig. 8. Diagrammatic representation of movements before collision and accidents occurred due to this movement in 2012.

9. Vehicle to Vehicle Communication Protocol Design

A new communication protocol can be established in the following steps:

i. Object identification
ii. Information gathering
iii. Study the current and standard V2V communication protocols
iv. Design protocol
v. Handling the constraint
vi. Phase of implementation
vii. Prototype version
viii. Test phase
ix. Phase of validation
x. UAT Phase

V2V communication security

i. Security Scalability: The security is the main factor in vehicle to vehicle communication model. Information sharing is in encrypted or decrypted form.
ii. Authenticated Connections: The connection between vehicles should be authenticated.

Components used in V2V communication

i. Nodes: The node should support GSM Module.
ii. Server: It is a web application and it is used to capture the event log in ITS network.

10. Conclusion

Traffic congestion is the major issues now a day because need of vehicles is increasing. Fuel consumption and risk of heart attacks are also increasing due to increasing demand of vehicle. Our future goal of research is to apply some test and technique for checking the effectiveness of system.

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