A Hardware Based Technique with an Android Application to Avoid Road Accidents

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Abstract. With the ever-increasing population of the world, increase the accidents at an alarming rate. Accidents are the most uninvited and unintentional miss-happening that causes a lot of injury and loss to human life. So there is an urgent need to stop these accidents to save mankind from destruction. Deaths by accidents have increased and have become the second largest reason for death in the world. Keeping in mind the status of accidents, a working hardware prototype has been proposed along with android based application to avoid road accident. A technique has been suggested where collision of vehicles can be avoided by alerting the driver with a buzzer and a message. Position of the approaching vehicles can be seen on an android application installed on a mobile device that aims to depict the exact location of the vehicles on Google map This whole proposed method is different from other methods as the methods that have been invented until date are mostly in-built techniques while the method proposed here is a prototype that can be implemented in real world.

Keywords: Accident · WSN · VANET · Vehicle

1 Introduction

Billions of people are losing their lives due to accidents. The accidents are the most uninvited, unintentional event that causes lot of damage and even cost person's life. Road accidents are the major integral part of accidents. Road accidents occur due to collision of vehicle with another vehicle or any object. Road accidents are responsible for almost 2.2 million of deaths all over the world each year. Death by accidents has increased to a greater level and has become the second largest reason for death after heart disease. Road injuries have resulted in death of many people in 1991; it was around 1.0 billion which has been increased up to 1.8 billion in 2013. Major reason for road accidents is driving at excess speeds, poorly under-developed highways, poor traffic rules, poor infrastructure and unattended zones. Road accidents occur daily in large number. Most prone areas are highways or sharp turns over road ends. By integrating VANETs with sensor networks, road accidents can be reduced to a greater level. The sensors will send their vehicle's information to the other vehicle using ZigBee. The

S.C. Satapathy and A. Joshi (eds.), *Information and Communication Technology for Intelligent Systems (ICTIS 2017) - Volume 1*, Smart Innovation, Systems and Technologies 83, DOI 10.1007/978-3-319-63673-3_3

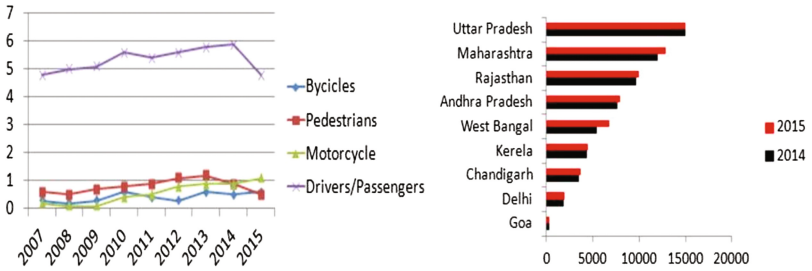

Fig. 1. (a) Traffic death per year (b) Fatality rate due to road accidents in various states in year 2014 and 2015

exchange of information will occur only when the two ZigBee embedded vehicles will fall within the range. Also the position of the nearby vehicle will be displayed on an android application. Figure 1(a) below shows the death rate over years. Figure 1(b) shows the fatality rate due to road accidents in various states of India in past two years.

2 Literature Review

See Table 1.

Table 1. Literature review

Published year	Description
2015	H. Qin et al. has raised an issue on lack of real time sensing of road conditions. A system has been proposed for avoiding road side accidents. In this paper, there are two types of nodes defined vehicle node and sensor nodes. Each vehicle node has two communication interfaces: Wi-Fi (for communication with other vehicle nodes) and ZigBee (for communication with roadside sensor nodes) Vehicle moves in clusters and one of the vehicle nodes will act as a cluster head, cluster head communicate with roadside sensors. Every access point periodically broadcast a beacon message, passerby cluster head hears this beacon message, it sends its registration request to that access point in return access point activates sensor nodes in forward direction, these sensors will monitor the road conditions. These sensors are active only when they find a cluster approaching towards them. If any dangerous condition is detected the sensors will send a warming message in backward direction. After simulation, it was concluded that integration of VANET-WSN will be better than using only VANET based systems [4]

(*continued*)

Table 1. (*continued*)

Published year	Description
2011	R. Alagu et al. stated that mobility models are important factor for performance of MANET. Authors explained Random Waypoint, Manhattan, Gauss-Markov and Random point group mobility models and two routing protocols namely Destination Sequenced Distance Vector (DSDV) and Ad-Hoc on Demand Distance Vector (AODV). Spatial dependency (measure of node mobility direction) and temporal dependency (velocity of different mobile node at different time slot) have been listed. The performances of these mobility models are compared on various parameters and have been found out that Random Point Group-AODV is better than DSDV [6]
2013	Anas Abu Taleb et al. stated that mobility model adopted by the mobile nodes in a network have a good impact on the performance of the whole WSNs. It reduces delay and enhances lifetime of the network and reduces the energy in sending and receiving data. Therefore, the routing protocol used for mobility in WSNs has a good impact on the network performance [7]
2013	Nisha Somani and Yask Patel in defined ZigBee Alliance which was established in 2001. It has two options for implementations: ZigBee (for smaller network) and ZigBee PRO (for larger networks) ZigBee devices are the combination of ZigBee logical (coordinator, router, end devices), application (such as lightening control) and ZigBee physical devices (full function devices and reduced function devices) Its low power consumption limits transmission distances to 10–100 meters line-of-sight. It can be used to transfer data over long distance by passing data through mesh network of intermediate devices. It supports star and tree network. It is built upon physical layer and media access control layer. In a ZigBee network there are 3 types of nodes- • **Coordinator:** its forms the root of network tree and helps to connect other networks. There exists only one coordinator in a network • **ZigBee Router(ZR):** It acts as an intermediate node, carrying data from one device to another. It helps to connect a device to an existing network • **ZigBee Sleepy End Devices:** These devices may be battery-oriented devices. They collect information from sensors [9]

3 Area of Concern

In this paper, a method is proposed to reduce number of collisions to reduce death rates. Collisions likely occur at blind turns, on highways during lane changing and on hilly areas. So an effort has been made to avoid accidents in these areas so as to make world a better and safe place to live Table 2.

Table 2. Various techniques along with their problems

Year	Technique	Problem
2012	Road accidents are increasing day by day. Considerable amount of work has been done in this area like eye blink and alcohol detection sensors. An intelligent car system was proposed by S.P. Bhumkar et al.	The Problem in this system is it cannot avoid collision of vehicle with other vehicles. If a vehicle is coming from back and is on the verge of colliding then this technique will fail [2]
2013	Another technique proposed by T.U. Anand Kumar and J. Mrudula, to avoid accidents that occur due to bad weather conditions	In case if accidents occur, its location is captured and its information is forwarded to a pre-defined numbers but this system also fails if there are no signals in the accident's location [1]
2014	An approach suggested by S. Sasikumar and Dr. J. Kalaivanan, in which NFC reader will be used to detect collision between vehicles. It will send an alert message to the driver if collision is likely to happen. If accident occurs, GSM sends message to server and server will send it to the hospital and nearby police station	The problem arises since signals will be affected by change in environment and also when the car is likely to collide there wouldn't be any time for driver to check his mobile device for the alert message and GPS data will be of little significance to the server if delay is more [3]

4 Proposed Work

This system works for accident prone areas like highways, dead ends and blind turns. The selection of area is the most crucial part of the implementation of the proposed work. The vehicle moving in the areas will act as sensor nodes. Users must have installed android application (developed in this work) on their mobile devices. This application will also help to track the other vehicles over Google Map. For the development of proposed model, the work has been divided into two phases. The first phase involves implementation of prototype and the next phase is to develop android based application for generation of alert signals and to trace location of vehicles on roads.

DETECTION stage: This stage first checks the vehicle is either standing or in motion. If standing, check if it is a blind turn (i.e. vehicle making angle $> 90°$ or $< 270°$ with the road), then collision is likely to occur. If the vehicle is moving, check if the approaching vehicle is within ZigBee's range. It is assumed that these vehicles have ZigBees installed in them and whenever a vehicle comes within this range, an alert message will be generated. The same scenario can be considered for vehicles coming from front as well as from back.

ALERT stage: An alert in the form of buzzer beep will be generated and a message will be flashed on the LCD screen installed inside the vehicle. After the driver gets alert, he then checks the android application to get the location of nearby heading vehicle on Google map. After getting the location, the driver acts accordingly to avoid collision. An algorithm for the scenario is defined below.

ALGORITHM

Notations

A: Area
R1: ZigBee Range R2:
IR Sensor Range V1:
Vehicle 1
V2: Vehicle 2

Step 1: /*Find Accident prone area*/
For all A such that A belongs to {Highways, Sharp turns, Dead ends, Hilly areas}
Step 2: Is vehicle equipped with IR sensor
Is there ZigBee installed in the vehicle
Eligible for application to run
successfully Else
Only detect the vehicles from
behind No detection possible
End

Step 3: Build an android tracking application
Step 4: Collision detection among vehicles
Vehicles belongs to areas, vehicles belongs to
{V1, V2, V3,.....} If |V1, V2| < R1, R1 belongs to
ZigBee Range
ALERT BUZZER (B1)
Driver gets alert and checks the android
application V2 location traced and COLLISION
AVOIDED
Else
No vehicle detected || No ZigBee installed GOTO Step
2 End

Step 5: No application found GOTO Step 3

Step 6: If (V1, V2) < R2, R2 belongs to IR Sensor
Range ALERT BUZZER (B2)
Else
No vehicle detection || No IR sensor installed GOTO Step
2 Else
No application found GOTO Step 3
End

5 Design Philosophy

5.1 Hardware Module

To verify the working of the proposed system, a hardware prototype is developed. A block diagram showing hardware module representing vehicle is shown in Fig. 2. In this, IR sensor is used as a proximity sensor as these sensors have minimum range. A ZigBee attach with the vehicle is used for communication purpose. This protocol has a pre-defined range which is 70–80 m. When a vehicle falls within the ZigBee's range of another vehicle, an alert warning in the form of buzzer will be generated and a message will be flashed on the LCD screen equipped inside the vehicle. Crystal in the model is used to avoid oscillations in the power supply. Microcontroller works at 5 V, the power supply that we are providing is via adapter or by 9 V battery.

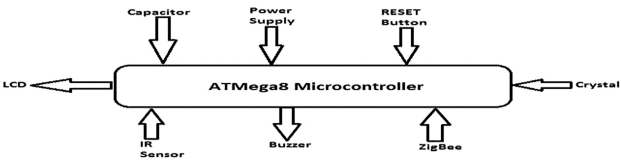

Fig. 2. Block diagram of a vehicle

Figure 3 given below shows the circuit diagram of a vehicle in detail:

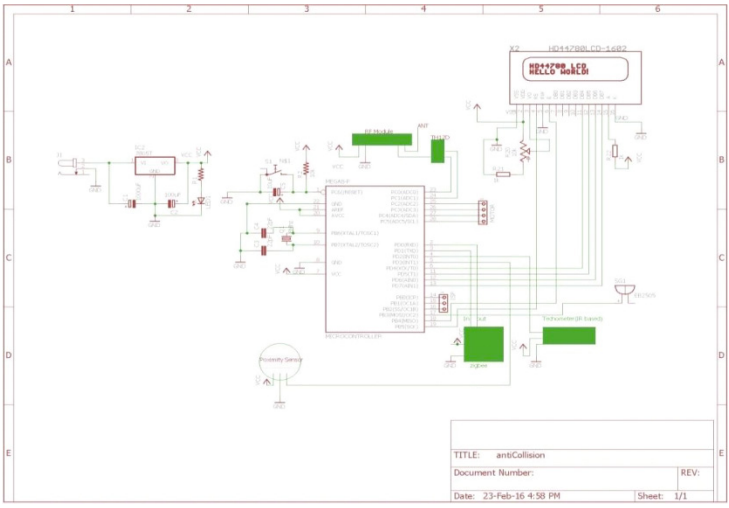

Fig. 3. Circuit diagram of a vehicle

- LED is connected with 5 V VCC along with a resistor, VCC is also connected to one end of 100 microFarad capacitor whose other end is grounded.

- There is an LCD whose pin VSS, RW and K is grounded, VDD is connected to 5 V VCC, VO is connected to a resistance of 10 k along with the load of 1 k, RS is connected to PB5 of microcontroller, E is connected to pin PB4 of microcontroller, DB4, DB5, DB6 and DB7 is connected to pin PD4, PD5, PD6, and PD7 of microcontroller respectively and A is connected to 5 V VCC along with the load of 1 k.
- A Tachometer has 3 pins out of which one is grounded, other one connected to pin PD2 of the microcontroller and the third one is connected to 5 V VCC. ZigBee has four pins one of which is ground, other is connected to 5 V VCC and rest two are input and output pins connected to PD0 and PD1 of microcontroller respectively.
- An RF Module has four pins connected to ground, 5 V VCC, ANT and TH12D respectively. TH12 takes one connection from RF Module and split it into two lines connected with pins PC0 and PC1 which are AC-to-Dc converter. A microcontroller having 28 pins.

A prototype presenting the circuit of the vehicle is shown in Fig. 4(a). The circuit is mounted over vehicle prototype whose movement is controlled via remote control. The prototype is designed to note how vehicle prototype will behave during the emergency, before actually implementing it on real scenarios.

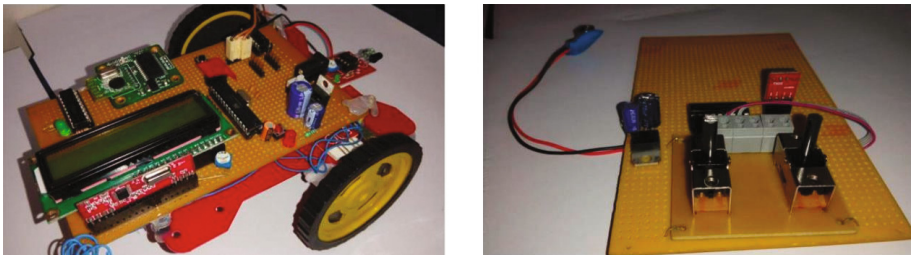

Fig. 4. (a) Vehicle prototype (b) Remote control

The remote control is shown in Fig. 4(b). IR sensors are used for sending and receiving signals. These sensors control the vehicle movement in either forward or backward direction.

5.2 Android Application

Android application to track the approaching vehicle was developed. This application is executed in phases.

Phase1: In this phase the application will get the current vehicle's location via GPS on the display screen of the cellular device.
Phase2: The location captured is then transfer to the server where it is stored for later use. This transfer is done with the help of File Transfer Protocol.

Phase3: From server this application fetches location of all the other vehicles except for its own location. This process also takes place via File Transfer Protocol.
Phase4: All the location accessed by the application i.e. its own along with other vehicles are plotted over Google Map with different color markings(purple for its own and cyan for other vehicles) as shown in Fig. 6.

Figure 5 shows the four phases of android application.

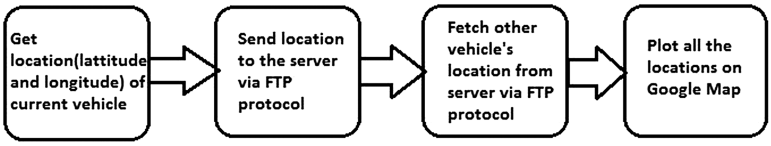

Fig. 5. Four phases of Android application

Android application code consists of five classes.

GPSTracker class make use of Location Manager which provide the location of vehicle.
Background Task class take the url of the server and POST the data onto the server.
Track class basically takes the location and separates them with a comma and then returns the values.
Maps Activity class takes latitude and longitude values from server and plot it into Google Map.
Main Activity class which is the main class, it makes use of Telephony Manager which is for getting the id of Mobile phone. This class calls all the above classes. Figure 6 below shows the screenshot of the android application.

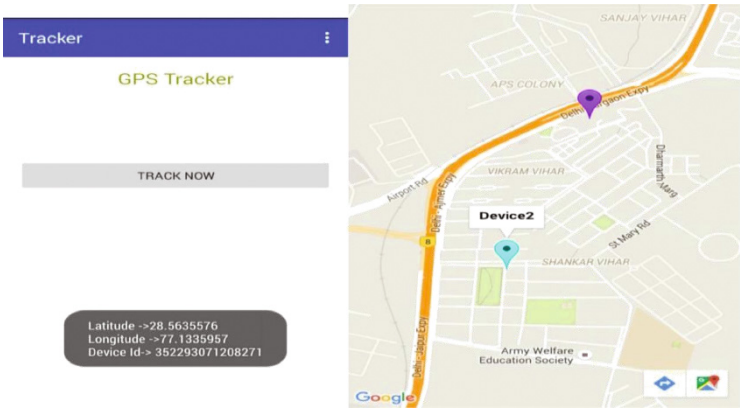

Fig. 6. Android application screenshots

6 Results

For evaluation of the above proposed model, different scenarios are considered. The results have been analyzed on monitoring the behavior of the vehicles.

Scenario 1: *Vehicles within range of each other*

When approaching vehicles comes within each other range, a buzzer will buzz and a message will be displayed on LCD screen "Vehicle Detected Nearby". Vehicle position can be seen on an android application installed on user's mobile. User can clearly see the position of approaching vehicle and will get sufficient time to take suitable action.

Scenario 2: *Vehicle moving infront of other vehicle*

When there is a vehicle in front of another vehicle. At some specific range a buzzer will ring to alert the driver and also a message will be displayed on LCD screen as "Vehicle in the Front Wake Up".

Scenario 3: *Vehicle moving at the back of other vehicle*

An IR sensor is also mounted at the back of the vehicle to alert the driver about approaching danger from back. A buzzer alert along the message on LCD "Vehicle at the Back Beware" will be signaled.

7 Conclusion and Future Work

The vehicle prototype mentioned in the paper is a defensive way of approaching the problem of road accidents by vehicle collision. Road accidents will be reduced by avoiding the collision of vehicles. There will be a buzzer alert inside the vehicle whenever the vehicle falls within the ZigBee range, a message will be displayed on the LCD of the vehicle stating "Vehicle Detected Nearby", the driver then will check the android application which will give the exact location of the preceding vehicle. In this way collision between the vehicles will be avoided. In addition to this, if there is a vehicle preceding from the back on a great speed the proximity sensor at the back of the vehicle will detect it and there will be an alert message in the front car stating "Vehicle Detected at the Back" and in the back car will be "Vehicle Detected in the Front Wake Up". Further if this prototype is made to work upon real time in future there will be changes in the type of sensors used, as then the sensors having large range will be used and the environment conditions will also be taken into account.

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