ISSN (Print) : 0974-6846
Indian Journal of Science and Technology, *Vol 9(48), DOI: 10.17485/ijst/2016/v9i48/108015, December 2016* ISSN (Online) : 0974-5645

Zigbee-Based Collision Avoidance System in Blind Spot and Heavy Traffic using Ultrasonic Sensor

Shweta Raj[1], R. Ezhilarasie[2]* and A. Umamakeswari[2]

[1]Embedded System, School of computing, SASTRA University, Thanjavur - 613401, Tamil Nadu, India; er.shwetaraj@gmail.com
[2]CSE, School of computing, SASTRA University, Thanjavur - 613401, Tamil Nadu, India; ezhil@cse.sastra.edu, aum@cse.sastra.edu

Abstract

Objectives: In India, the frequency of traffic collisions is among the highest in the world. Most of the accidents are due to blind spots which cannot be directly observed by the driver at control. The paper proposes a collision avoidance system due to blind spots and in the case of heavy traffic scenarios. **Methods:** The proposed system avoids collision in blind spot and in heavy traffic and does not follow the path of preceding vehicle if the space between detector (Our Vehicle) and host vehicle is in proximity. For implementation of the system, Arduino boards and other drivers along with ultrasonic sensor are used and ZigBee is used for data communication between two nodes. **Findings:** The Blind Spot Detection (BSD) procedure based on wireless detecting technique ZigBee is proposed to monitor the blind spot region for the presence of interferences, automobiles, or other objects with the aid of ultrasonic sensor. For detecting the vehicles in blind spot, Neural Fuzzy Logic is used for the proposed system. The connection models for the developed system is identified and proposed. The paper also discusses about the advantages of ZigBee over other wireless technologies. The Wireless Technology identified is ZigBee which will lower the wiring connection in the vehicles. **Applications:** This method is useful to avoid collision in blind spot and also lowered the wiring connection in the vehicles by using ZigBee. Hence, the proposed system discovers its application in real time and gives collision free environment. The system is evaluated for different driving scenarios and results are discussed.

Keywords: Blind Spot Detection, Collision-Avoidance System, ZigBee Pair

1. Introduction

India being one of the most populated countries, accidents are prone as the driving is dangerous in congested roads. Thus, accidents are at high rate than any other part of the world. The records say that person die due to road accidents every four minute. There may be many causes for the accidents as it depends on the state of the driver and maintenance of the vehicle. But all, most accidents caused by blind spots and due to heavy traffic scenarios are avoidable. The blind spot occurs mainly in cars, trucks and boats. Motorcycles and bicycles are free from blind spots. The blind spots are areas which are not visible directly to the driver at control. Blind spots may also due the front and back vehicle pillar parts and improper adjustment of interior and exterior mirrors. The blind spots can be eliminated to an extent by proper adjusting of mirrors[1]. Now a day, people are encircled by highly sophisticated vehicles which consists many features for detecting objects. Several systems for obstacle detection are Blind Spot Observing, Path Departure Warning, Back Assist, Drift Assist etc. Blind Spot region generally helps during overtaking and changing the paths on NH Road[2]. Modern vehicles are highly computerized or extremely processed, and are controlled by ECUs inside the vehicle. The sensors are attached to ECUs through wires. FlexRay, CAN (Controller area network) are the basic innovations as of now utilized for the wired system inside vehicles[3]. These wires bring out about 40kg weight of the vehicles that cause fuel proficiency. However, many of the sensors

* *Author for correspondence*

are fixed at very complex parts of the vehicles. For this reason, cost of the vehicles increases and complexity also increases. So, minimizing the use of wires inside the vehicle may upgrade the efficiency, product features, reliability and performance diminishing building expense of a vehicle[4]. To accomplish this objective, wireless technique should be used to communicate between the sensors and ECUs. An ECUs, is the electronic circuit unit which is a part of the vehicle's inbuilt framework. This framework is in charge of controlling the unique parameters of the vehicle. Any movement of the vehicle can be controlled with the help of an inserted framework. This implanted framework is known as the ECU. Regularly ECUs are customized to perform a particular continuous operation[5] Figure 1.

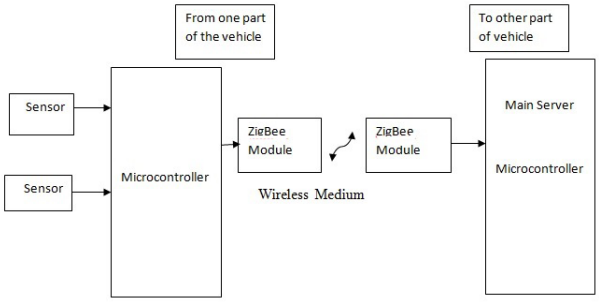

Figure 1. Block diagram of mote.

2. Selection of a Wireless Technology

Regarding selection of wireless technique there are mainly 6 leading communication devices are available namely, Bluetooth, WiFi, GSM, UWB and ZigBee[6]. While using Bluetooth, the positioning time and connectivity time is too large. Moreover, WiFi, the battery life is too short and location fault is too large. Almost same problem occurs with GSM. Furthermore, the cost of operator causes a disadvantage in GSM. With UWB, there are no commercial tools available in market but in future it could be developed[7]. However, ZigBee has a low power consumption device which permits longer life with smaller batteries. ZigBee was developed to provide wireless standard communication in IOT at low cost. Due to this reason ZigBee is used in this project.

Blind side location technique is device that especially essential to watch blindside spot during driving vehicle in ultra-modern traffic cases. Impact among vehicle can predominantly happen if the driver didn't observe the blind side spot throughout changing the path. The encircling regions of the driver and the current condition alertness have got to be viewed as driver wish to change the paths. Condition alertness play vital role when changing the lanes. For this reason, roughly 70% of the accident while path changes due to driver condition alertness negligence. Hence, Blind spot observing method is most important to give a boost to visibility and scale back the blind spot in order to implement safeguard driving[8]. In this day and age, blind spot observing approach is used in a couple of excessive and innovative vehicles. For example, BMW have the dynamic blind spot detection to alert driver if there any upcoming capabilities risk in blind spot zone. By utilizing Radar Sensor sensing, the entity vehicle is detected and alert the driver if any type of vehicles is present in their blind spot region[9]. The Volvo car also used radar sensing that actives the driver about vehicles in the blind spots on all sides of the vehicle. It is usually become aware of and signals the driver to swiftly coming near car as much as 65 meters beyond the vehicle[10]. The greater part of a couple of excessive and innovative vehicles are well on the way to have inserted arrangement of blind side identification and these dynamic blind side discovery frameworks are definitely not accessible for less cost vehicles. This blind side identification framework in innovative vehicle is additionally renovate go about as driving help framework for driver and actualize into less cost vehicles. On the other hand, the high item cost, establishment cost and the ability of the item utilitarian are a portion of the element which don't draw in the less cost cars to utilize BSA framework. The driving help of blind side recognition or checking framework for vehicles is exceedingly alluring to less cost vehicles to watching blind side location[11]. So the exploration of blind side discovery framework with high proportion of ability and more moderate cost for less cost vehicle is a critical work to decrease collision. Vehicles are controlled by many ECUs which are installed inside of the vehicles. ECUs need sensors to collect data so as to handle the processes of the vehicles. ZigBee wireless sensing elements are good techniques to exchange the wired network inside vehicle due to low power consumption

and its mesh networking abilities. The microcontroller performs all the data processing functions and controls the operation of other elements in the sensor node. Sensor senses or measures physical data of the region to be observed. The continual analog signal sensed by the sensors is digitized by an A/D converter and forward to controllers for the farther processing[12]. The existing Blind Spot Detection (BSD) methods are based on TPMS (Temperature pressure monitoring system) and Sonar which is high cost system and is very tough to decrease the cost[13]. Moreover, distance calculation is complex and it also suffers from the false alarm. These sensor systems connect with ECUs through Bluetooth for transmission of data from the vehicle to the ECUs. However, Bluetooth is not much encouraged for long duration applications due to power consumption limitations.

3. Proposed Scheme

The Blind Spot Detection (BSD) system based on wireless detecting technique ZigBee is proposed to observe the blind spot region for the presence of interference, automobiles, or other objects by Ultrasonic or IR sensor. The proposed schemes use the ultrasonic sensors which are usually mounted in the left rear and right rear positions on a vehicle, either back of the rear bumper or beyond each rear quarter panel and suggest to the driver (by a buzzer warning or a light indication on the back view mirror) if vehicles arrives in the blind spot of the host vehicle. This sensor connects with ECUs (Electronics Circuit Units) through ZigBee. The sensors transmit and receive signal to and from the vehicle's left and right blind zones. The system processes the signals and provides the visual and/or audible data to the driver. Thereafter also if driver is not awake then it will automatic reduce the speed of the vehicles. These values have given to the MATLAB based algorithm detection Figure 2. For collision avoidance scenario, this system will intimate the horn sound and light indication to driver awake signal. It can be done automatically and also the manual mode. The manual mode is used to deactivate the SBSA system in the full traffic environment. For this purpose we are using the two switches to deactivate the sound and light alert in traffic scenario Figure 3. All the information will be displayed using the dash board display, for the dash board display we are using the LCD screen (16*2).

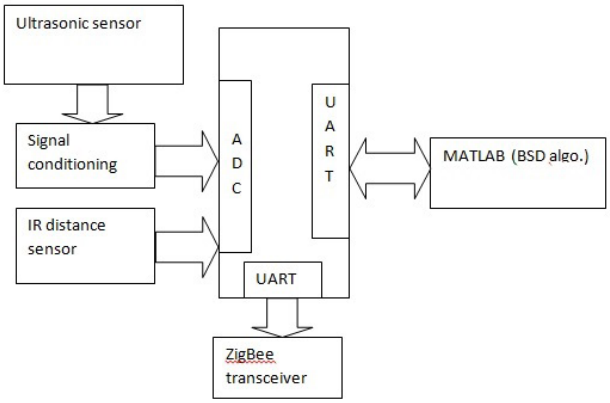

Figure 2. Vehicle section to blind spot.

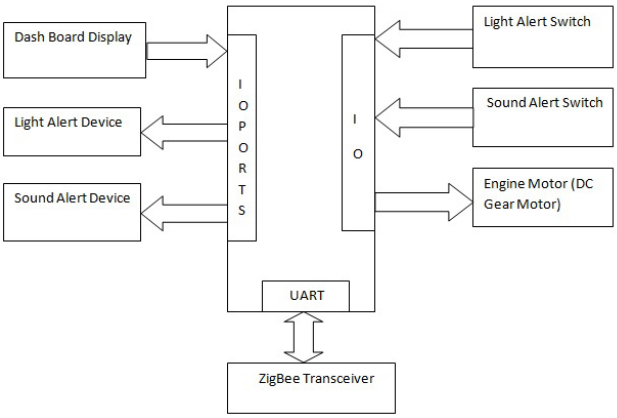

Figure 3. Vehicle section to ECUs.

3.1 Neural Fuzzy Logic for Side Blind Spot Alert system

The proposed system uses Neural Fuzzy Logic for detecting a couple of vehicles in blind spot. The detection system (our vehicle) most commonly collects the information from sensors on the host vehicle. In last, the detection system mixes the signal data of the collected information from the sensors and calculates usual average of the previous 3 considerations and observations (in training state) Figure 4.

$$Y_i = (y_{nT}' + y_{(n-1)}T' + {}^{y}(n-2)T') / 3$$

Where $\mathbf{y}_{nT'}$ is present observation or considerations, $\mathbf{y}_{(n-1)T'}$ is the previous observation and etc, i is index in training state. If detector finds the target (according to average observation y_i which has calculated in training

state) is in blind spot and the driver is utilising flip sign (turn signal), the process will utilize both light indication and buzzer to inform the driver. And if the driver shouldn't be utilizing the flip sign, the device will just utilize the light indicator. Thereafter also if the driver has not alert by these two indications then the motor is available for reducing the speed of the vehicles.

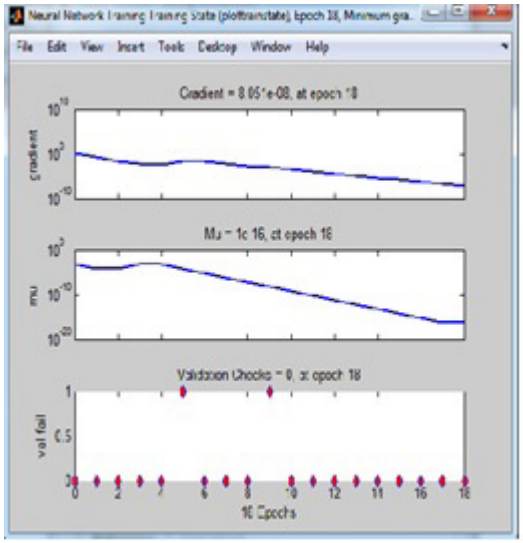

Figure 4. Training state graphs.

4. Evaluation and Result

The platform that was used in this application is MATLAB. Training state is standard techniques which give the information about various machine learning algorithms and give accurate predictions based on past observation values. The description has given in section (4.1). If any obstacle has been found in the blind spot region (i.e. Need to take driving decision) then the system processes the signals and provides the visual (warning message in LCD display and light indication) and/or audible (buzzer) data to the driver. Thereafter still if driver is not alert then it will automatically reduce the speed of the vehicles. Other than this the system will also find the distance between our vehicle and target vehicles in blind spot region Figure 5. If there is no obstacle (i.e. No need to take decision) the system will allow to driver to run the vehicle without any change in speed. The hardware setup, we are using two Arduino boards, one act as Master node (which work as ECUs.) another act as slave node. It includes the steps involved in connecting the controllers and drivers to build the ECU. The data communication between two nodes uses wireless techniques ZigBee.

5. Conclusion

The blind spot alert process is named as an example application; mainly designed method which is fixed in the back of a vehicles and it finds the presence of a goal vehicles, obstacles and interferences in its blind spot, which depends upon the obtained signal strength of the Ultrasonic sensors. The driver is made aware by a LED indication, sound buzzer. The process is carried out on a ZigBee platform. Because of its less cost (as compare the existing schemes for ex- sonar, TPMS and vision based methods), easy computation and low power consumption, ZigBee based blind spot alert process focused in our paper which would be a very attractive method for automobile manufacturer.

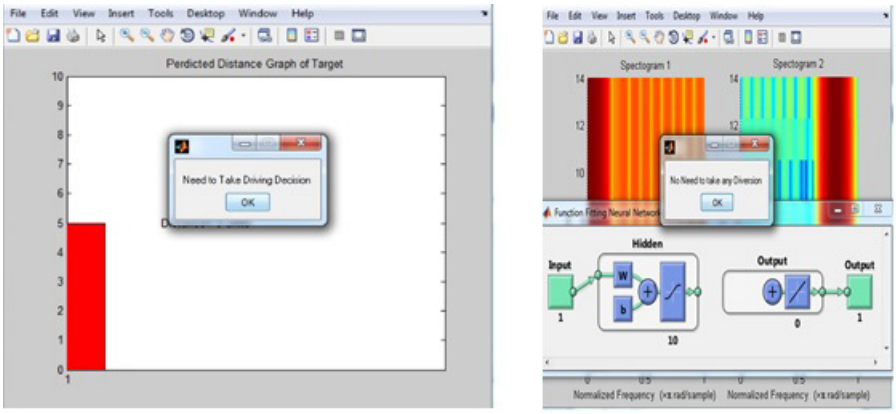

Figure 5. Driving decision scenario.

6. Acknowledgement

The authors wish to express their sincere thanks to the Department of Science & Technology, New Delhi, India (Project ID: SR/FST/ETI-371/2014) and SASTRA University, Thanjavur, India for extending the infrastructural support to carry out this work.

7. References

1. Mukhtar A, Xia L, Tang TB. vehicle detection techniques for collision avoidance systems: a review. IEEE Transactions on Intelligent Transportation Systems. 2015 Oct; 16(5):2318–38.
2. Liu W, Wen X, Duan B, Yuan H, Wang N. Rear vehicle detection and tracking for lane change assist. MVA2007 IAPR Conference on Machine Vision Applications; 2007 May. p. 82–5.
3. Nair SA, Pooja TV, Nair SV, Pillai VU, Rajalekshmi S. Verilog implementation of collision avoidance system based on flexray protocol. Indian Journal of Science and Technology. 2016 Jul; 9(28):1–5.
4. Simulation studies on zigbee network for in-vehicle wireless communications. 2014 International Conference on Computer Communication and Informatics (ICCCI), 2014 Jan 3–5; 2014 Oct.
5. Tsai HM, Tonguz OK, Saraydar C, Talty T, Ames M, Macdonald A. Zigbee-based intra-car wireless sensor networks: A case study. IEEE Wireless Communications. 2007 Dec; 14(6):67–77.
6. ZigBee v/s WiFi [Internet]. [cited 2015 Aug 07]. Available from: http://www.engineersgarage.com/contribution/zigbee-vs-wi-fi.
7. On the potential of bluetooth low energy technology for vehicular applications [Internet]. [cited 2015 Feb 11]. Available from: https://arxiv.org/pdf/1502.03493.pdf.
8. Design and experimental study of an ultrasonic sensor system for lateral collision avoidance at low speeds. Intelligent Vehicles Symposium, 2004 Jun 14–17; 2004 Oct.
9. Dynamic side-view mirror: Assisting situation awareness in blind spots. Intelligent Vehicles Symposium (IV), 2013 Jun 23–26; 2013 Oct.
10. Ros DE, Mota S, Botella G, Canas A, Sabatini S. The rear mirror blind spot problem. IEEE Intelligent Vehicles Symposium; 2005. p. 50–7.
11. Sun Z, Bebis G, Miller R. On-road vehicle detection: A review. IEEE Transactions on Pattern Analysis and Machine Intelligence. 2006 May; 28(5):694–711.
12. Modeling for deployment techniques for intra-car wireless sensor networks. 2014 18th International Conference System Theory, Control and Computing (ICSTCC), 2014 Oct 17–19; 2014 Dec.
13. Design and implementation of TPMS based on wireless sensor network. Intelligent System 2010 International Conference on Design and Engineering Application (ISDEA), 2010 Oct 13–14; 2011 Apr.