Vehicle-To-Vehicle Communication and Collision Avoidance System for Conveyance Units

[1]Nihal Kulkarni, [2]Kulkarni Nikhil
[1,2]Dept. of ECE, GITAM University, Hyderabad, Telangana, India

Abstract
Cruise control and accident avoidance have been a major point of interest in the recent past with the sophistication of vehicles. Driving assistance is provided with cameras and sensors in most of the high-end vehicles and is furnished as an additional system to them. Increasing population and rapid aging have increased the cause of accidents especially, of the senior age group. Smart and automatic driving systems have been developed to provide assistance. The on-board system processes are not utilized to the extent they have been developed and thereby causing misguidance to the users. In this project an embedded system is developed with omnipresent modules that are communicating with each other and the system processing unit designed for the vehicle. It helps the driver to identify the vehicles and monitor their speed. This system will also guide them to know the traffic present in the lane they are traveling and will help them to re-route in case of emergency.

Keywords
Cruise Control, Driving Assistance, On-Board Processes, Smart System, Re-Route

I. Introduction

The on-board processing system is considered as an important part of the vehicle and is concentrated to the greatest extent by the automobile manufacturers. They include the sensors and cameras installed in the vehicle along with the engine control unit. The ecu is a buzzword in the trending automobile world that can access and control every part of the vehicle. It is designed to detect and monitor the proper functioning and rectify the faults present in the system.

Electric vehicles can be also be monitored for speed tracking and platooning as described in [2]. The speed calculations and accuracies in speed and GPS measurements present in ecu has been addressed in the [1]. The ecu is directly intact with the sensors which monitor the environmental data for the smooth flow of traffic and this is achieved through the communication between the ecu and the traffic signals as described in [3]. [4] and [6] worked on minimal collision time and cooperative time for packet switching in order to avoid the outage and collision among vehicles. They have come up with co-operative communication between each vehicle which will significantly handle the detrimental situations that arise in vehicles.

Here we propose a module which is an auxiliary component to the ecu we referred to in the earlier which not only coordinates with the vehicle components but also communicates with the other vehicle device to keep the driver of the vehicle well informed. This module is a low cost, well equipped, wireless communication unit that enables the user to exploit the merits of proper communication which avoids any traumata. This paper is divided into three subsections wherein we describe the individual modules used to design the device followed by the way they operate and finally work on the practical operation and constraints. We end our discussion with the possible alternatives and the future scope of this system.

II. Description

The major module used here is the microcontroller which is programmed to act and respond according to the work assigned. It communicates with the rest of the devices and processes the information. The communication is achieved through an RF module that is interacting with the systems installed in other vehicles. The signals being transmitted and received are converted into required for using the suitable transducers. We use the processed information and analyze the current traffic and help the driver to have proper cruise control. The different modules that can be used as a part of this project are shown below.

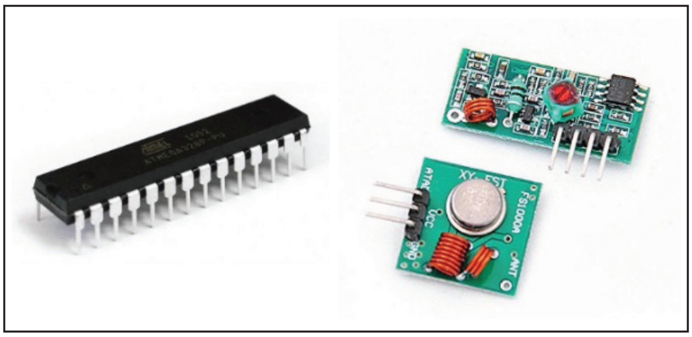

Fig. 1: Components Used in the Device

III. Working

The basic block diagram of communication is shown in the form of the figure. It is the flow chart of communication information analysis between two or many components in the system.

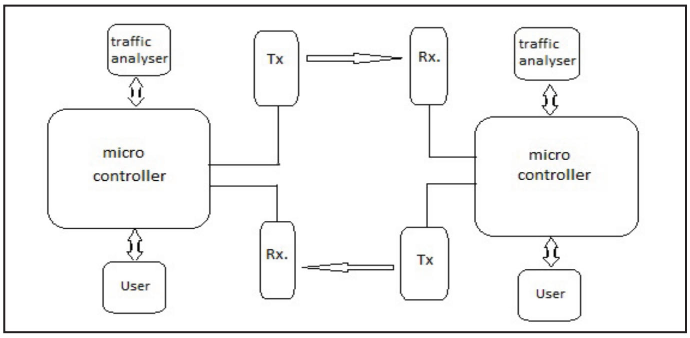

Fig. 2: Block Diagram of Working Module

The microcontroller is programmed to continuously interact with the proximity of the vehicle. The transceivers act as antennas and continuously send and receive information and present it to the user. the transceivers are the Omni-directional antennas that spread out the signals in all directions and these signal waves are intercepted by other receiver modules to identify the distance between the vehicles. This project analyses the situations for vehicles traveling in different directions with respect to neighboringvehicles. The following pre-requisites must be analyzed prior we move into our discussion.

 ISSN : 2230-7109 (Online) | ISSN : 2230-9543 (Print)

A. Speed/Velocity

It is the physical quantity that expresses the rate of motion of a body (here, vehicle). It is used as an important parameter to understand and predict the circumstantial conditions that arise for a vehicle.

B. Time

The collision and congestion in a system can be understood only by knowing the time for which the state of the vehicle remains unchanged or varies slightly.

C. Distance

The separation between the two vehicles or obstacles will play a major role in identifying if the vehicle is on the verge of the crash and can be notified to the driver and alert about the sitch.

The quantities mentioned above are described using the notations and they mean the same hereafter. The speed (α,β), the angular velocity (ω), the relative velocity (γ), the distance (λ), direction (ψ) and the time (Ʈ). The theme of our project is the common relation between Ʈ, γ, λ.

The distance (λ) can be measured as a function of time and speed and is given as:

$$\alpha/\beta = \frac{\lambda}{\text{Ʈ}};$$

The relative speed (γ) is the measure of the velocity of one vehicle with respect to the other vehicle and is given as:

γ = α ± β depending on the relative directions of the vehicles;

The algorithm involved here is to reduce the speeds of the vehicles in order to avoid collision based on the distance between them and identify the congestion in the route by analyzing the stationary time which can also be calculated from the changing distance parameter.

We first analyze the distance (λ) between the vehicles and store it as the basic parameter to evaluate the other required components. The alert message is sent to the driver of the vehicle and is achieved through another RF unit used in the design of the system.

The mathematical approach and flow chart in technical aspects are as given in the fig. 3.

The vehicle is said to be aligned with another if at least 50% of any of the dimensions line-up. This increases the probability of occurrence of accidents or collisions. Here we use the distance calculated by the sensors to find alignment and angular velocity (ω). This will help us identify the relative velocity. an observation must be made that γ is calculated with respect to the primary vehicle under consideration. The speed of the vehicle is reduced after two alerts are notified to the driver. This is achieved by the ecu which is interlinked with this module. More positive is the condition which evaluates the relative speed to be nearer to the primary vehicle speed (or even more than that when the vehicles are traveling towards each other). γ is calculated periodically and is monitored with other parameters including λ. The first alert is sent with respect to the γ and λ i.e. when the distance is considerably small with respect to the velocity of the vehicle. The device will continuously monitor these parameters and sends a second alert notification. After a certain period of time when the distance is very small compared to initial notification and if speed remains constant the ecu taken control of the vehicle and reduces the speed to one-third of the initial speed in regular steps.

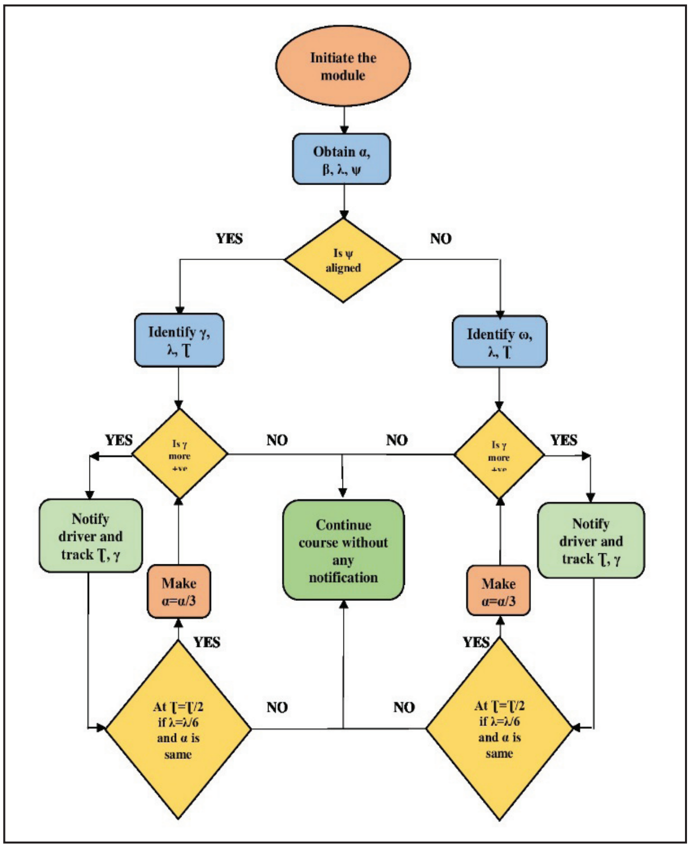

Fig. 3: Flow Chart for onboard processing of the System

The traffic analysis and congestion in a lane are understood by the response time of the sensors from the multiple devices that are connected to the vehicles. This response time is monitored with vehicle speed and distance. If the distance decreases continuously and the response time is reduced along with it then the user is notified with appropriate message about the vehicles in the lane and congestion scenario. The procedure is understood with the algorithms described below.

Algorithm to identify collision

1. INITIATE THE MODULE AND SENSORS.
2. OBTAIN α, β, AND λ.
3. CALCULATE γ, ω, AND Ʈ.
4. IF γ POSITIVE AND LARGE ALERT MESSAGE IS SENT ELSE GOTO 7.
5. MONITOR λ AND γ, AT λ= λ/6, MAKE α= α/3 AND MONITOR γ.
6. REPEAT UNTIL γ IS SMALL.
7. CONTINUE WITHOUT ANY ALERT.

Algorithm to analyze traffic

1. BEGIN A COUNTER AT ZERO.
2. CALCULATE Ʈ AND λ FOR ALL UNITS.
3. MONITOR λ AND INCREMENT COUNTER FOR EACH NEW MODULE DETECTED.
4. IF λi DECREASES FOR EVERY Ʈi NOTIFY COUNTER VALUE where i=1, 2….
5. RESET COUNTER IF FALSE.

IV. Simulation and Results

An experimental setup has been made with two cars pre-installed with auxiliary systems are deployed to test for the real-time scenario. Multiple cars can be deployed to test the working of the module. The two cars are traveling with certain different speeds. When the car with greater velocity approached the car moving with minimal speed, the former vehicle speed has been automatically reduced to match the required speed to avoid the collision. The simulation results have been analyzed one after the other below.

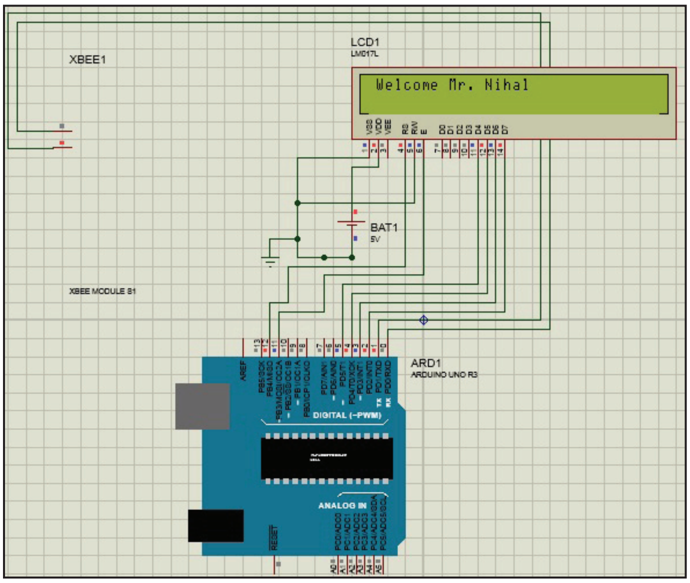

Fig. 4: Isolated vehicle with Auxiliary system

This module continuously monitors the speed of the vehicle and shares the information related to it to all the vehicles within the range of the transmitting system. A situation where both the vehicles align more than 50% has been created and tested for the consequences. The operator has been alerted twice before the speed of the vehicle is automatically reduced. The first alert described the possibility of occurrence of collision as shown in fig. 5. Whereas, the second alert in fig. 6 also included the distance between the two vehicles which described the detriment.

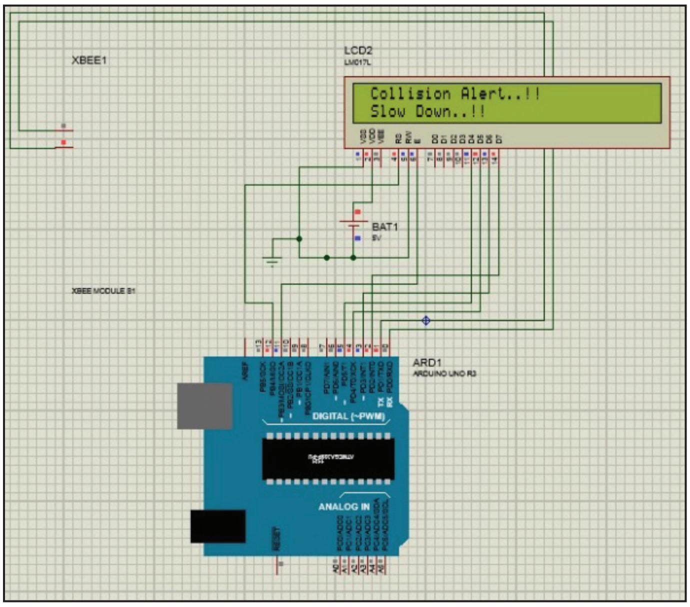

Fig. 5: Alert-1 to Inform Motorists that Accidents Might Occur

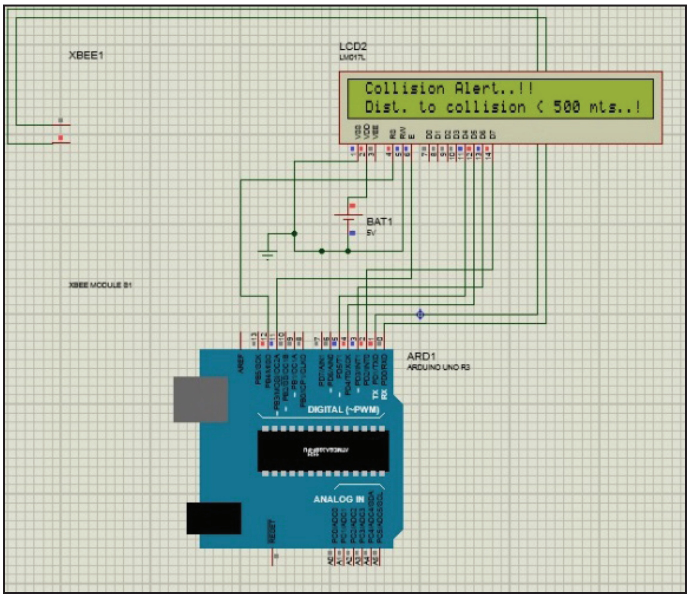

Fig. 6: Alert-2 Indicates the Distance Along with the Notification

Eventually, if the speed is unmonitored the auxiliary system sends a signal to the ecu of the vehicle and the speed is automatically reduced as per the requirement to avoid collision occurrence. This has been described in fig. 7 where a message is displayed stating the speed is reduced.

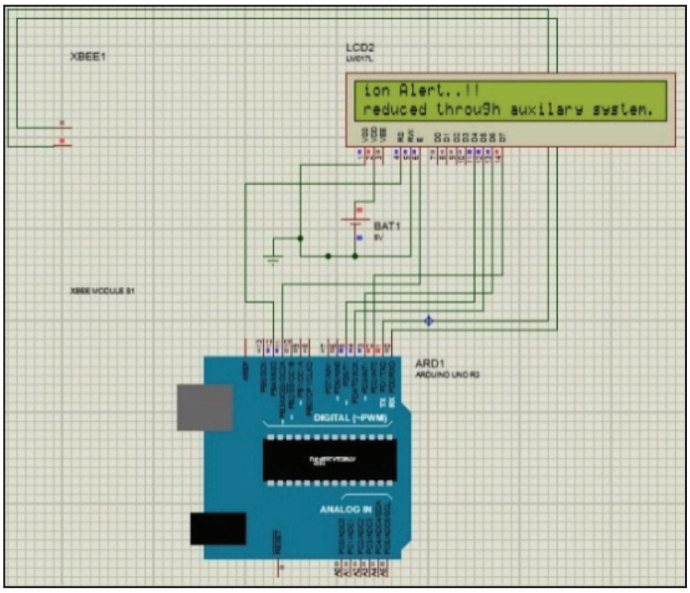

Fig. 7: The Speed of Vehicle is Controlled

V. Advantages and Constraints

Amount of accidents happening can be reduced significantly. Traffic analysis is improved and more accurate results are obtained. Vehicle safety is also improved with a reasonable amount to install the device. Law enforcement units can rely on this device to monitor traffic and schedule traffic lights dynamically based on the congestion. Reliability on the vehicles can be increased as we can have a proper track them and monitor their path. Parking assistance is provided to the driver by giving us information about nearby vehicles. Despite these advantages some practical constraints also come into picture which will limit the functioning of the device. The range of the device is limited and is dependent on the transceivers used in the design. This module will significantly reduce its performance in the vehicles which do not have ecu. For the effective utilization of the module applications we require a pre-installed ecu in the vehicle. The cost of the device will increase in the vehicles without ecu.

VI. Scope for Future Development

Though the device work on alerting the user and provide driving assistance including the mechanics of the vehicle, this device needs to be improved for its performance in the vehicles without ecu. This module is an auxiliary unit in the vehicles with ecu but can be used even in the vehicles that do not support ecu. Furthermore, the device is a short-range (approximately 500mts radius) can be worked on to increase its coverage and make it more secure from cyber-attacks which will increase the frequency of the false alarms to the user.

VII. Conclusion

Within this work, we provide an idea of vehicular control in collision avoidance and traffic analysis using the various modules embedded within one device. This will provide a wireless communication scenario among the vehicles and help the drivers in driving assistance by providing periodic updates. The counter used is used to identify the traffic on the route and help the centralized grid to re-route emergency vehicle path or to provide proper assistance as required. Practical implementation is possible as this device is cost-efficient and easy to design. The device will make efficient use of on-board processing systems and will improve its functionality.

References

[1] Mallikarjuna Gowda C P, Raju Hajare, C S Mala,"Design and Implementation of Real Time Wireless System for Vehicle Safety and Vehicle to Vehicle Communication", International Conference on Electrical, Electronics, Communication, Computer and Optimization Techniques (ICEEECCOT), 2017.

[2] Siyang Zhao, Tianshou Zhang, Nan Wu, Harutoshi Ogai, Shigeyuki Tateno,"Vehicle to Vehicle Communication and platooning for EV with Wireless Sensor Network", SICE annual conference, Hangzhou, China, 2015.

[3] Bernhard Knauder, Michael Karner, Markus Schratter, "Predictive longitudinal vehicle control based on vehicle-to-infrastructure communication", International Conference on Connected Vehicles and Expo (ICCVE), 2014.

[4] "Trajectory Tracking and Collision Avoidance Against a Non-cooperative Omnidirectional Vehicle Based on Minimal Collision Time", Naritaka Isoda, Ayumu Kitagaki, Toru Asai Osaka University, SICE Annual Conference 2010, Taipei, Taiwan.

[5] Elecia White,"Making Embedded Systems", O'Reilley media, 2015.

[6] Yunsung Choi, Dongwoo Kim,"Quality-Supporting Duration in Vehicle-to-Vehicle Cooperative Communication with a Decode-and-Forward Relaying Vehicle", IEEE ISCE 2014.

Nihal Kulkarni pursued under-graduate studies at GITAM University, Hyderabad with Electronics and Communication Engineering as Majors in the year 2017. He has worked on improving the efficiency of the parallel prefix adder network by reducing delays. He worked for Amazon India for seven months. His research interests include Digital Image Processing and Wireless Communications. He is currently working on the Network layer encryption standards using various encryption algorithms.

Kulkarni Nikhil pursued his under-graduate studies in Electronics and Communication Engineering stream in GITAM University, Hyderabad in the year 2017. His areas of interest include Wireless Communication, Signal Processing, and Computer Networks. He has worked on Image Detection and Recognition mechanisms using Histogram of Oriented Gradients (HOG). He is exploring methods to improve energy efficiency and security of the mobile Ad-hoc networks using different energy harvesting techniques. He is currently working as Consultant Associate for Infor India Pvt Ltd.