ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

PCS Based Vehicle Collision Avoidance and Communication System

S.Sivajothi Kavitha[1], M. Bharathi*[2], Dr. S. Senthil Kumar[3]

Assistant Professor, Dept. of Electronics & Instrumentation Engineering, Jerusalem College of Engineering, Chennai, Tamil Nadu, India[1]

Associate Professor, Dept. of Electronics & Instrumentation Engineering, Bharath University, Chennai, Tamil Nadu, India [2]

Associate Professor, Dept. of Electronics & Instrumentation Engineering, Bharath University, Chennai, Tamil Nadu, India [3]

*Corresponding Author

:

ABSTRACT: This paper presents a vehicle Rear-End collision avoidance system using Pre-Collision System (PCS) algorithm. It allows evaluating the potential effectiveness of the pre-collision system (PCS) algorithms: 1) forward collision warning 2) Pre-crash brake assist; and 3) Autonomous pre-crash brake. In addition, this allows us to explore the communication technologies between the vehicles. VCAS consist of the integration of the three components of the PCS, the FCW,PBA and PB in one unit .FCW gives warning to the driver and PBA amplifies the braking effort of driver and PB triggers near end of collision. The collision information is communicated to the behind vehicle and the side vehicles. Moreover, it offers for the emergence of new technologies (e.g., Vehicle-to-vehicle, Vehicle-to-Building communication), which will become a reality in the near future. The simulation results provide an overview of the impact of the integrated PCS algorithm in terms of time to collision, frequency, severity and cost.

KEYWORDS: Pre-collision System, Vehicle Collision Avoidance Safety System, Forward Collision Warning, Pre-crash brake assist, Pre-crash Brake, Embedded system, ARM Controller.

I. INTRODUCTION

The unpredicted increase in the number of vehicles in the developed and the developing countries has created the automobile manufacturers to have greater responsibility to produce/market vehicles with sophiscated features and safety devices and to avoid/avert the road accidents. The vehicles are equipped with new active safety devices and technologies. Innovative techniques are employed to reduce the frequency of collisions of vehicles and to increase the safety of the life to the vehicle users. Forward collisions, Rear –End collisions and multiple collisions or chain reaction collisions are the major types of collision taking place on highways

A rear-end collision is one in which the front of one vehicle (the striking vehicle) impacts another vehicle that travels in the same direction of travel as the first vehicle (the struck vehicle). The struck vehicle can be decelerating, stopped, or moving at a lesser speed than the striking vehicle. The active safety systems should prevent the crash or at least mitigate crash-related injuries and property damage. Forward collision warning (FCW), pre-crash brake assist (PBA), and autonomous pre-crash braking (PB) systems are called Pre-collision system (PCS) components and are currently implemented separately in the newly manufactured vehicles. But integrated systems with all the PCS Components in a system will avoid the frequency of rear-end collisions taking place in the highways. This is called as Vehicle Collision Avoidance System (VCAS) .Thus a low-cost navigation system with high integrity and reliability is proposed for enhancing highway collision avoidance.

Regan, et al. (2002) estimated that approximately 7% of all rear-end crashes could be reduced with forward collision warning systems, resulting in an economic benefit of $40 million (AU). Depending on various levels of effectiveness and acceptability, it was estimated up to 30% of fatal crashes could become serious injury and up to 30%

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

of serious injury crashes becoming injury crashes, while reductions of up to 12% of other injury and minor injury crashes were predicted[2]. In a simulator study, Lee, et al. (2002) found that forward collision warning systems that issues early auditory warnings reduced the number of crashes by 80.7% and reduced crash severity by 96.5%. Late warning systems were associated with a 50% reduction in crash occurrence and an 87.5% reduction in severity [2]. Thus the need for collision avoidance system is becoming more popular

The remainder of this paper is organized as follows: Section II introduces the PCS Algorithm and section III details modeling of the PCS components and the Time to collision (TTC) of the vehicles. Section IV discusses the proposed transportation system and Section V describes the communications module. In Section VI the simulation results and summary of the paper is presented in section VII respectively.

II. PRECRASH SYSTEM ALGORITHM

A. Algorithm

The PCS Algorithm consists of integration of the three PCS components, Forward collision warning (FCW), pre-crash brake assist (PBA), and autonomous pre-crash braking (PB) systems. These systems often depend on the millimeter-wave radar scanning technology to track vehicles and objects in front of the equipped vehicle. These systems use sensor inputs to interact with other systems such as speed sensors, steering angle sensors, and airbag control modules. FCW systems warn the driver through visual, audio, and/or tactile means of an impending collision. FCW has been designed to warn the driver close to the last possible moment before a driver corrective action can be possible which avoids the collision.PBA is triggered when the vehicle recognizes an emergency-braking scenario and amplifies the driver braking input when the driver applies the brake. In systems with multiple pre-collision system (PCS) components, PBA is designed to activate following the FCW warning. Finally, PB is intended to autonomously add to the vehicle's braking deceleration, even if there is no driver input. In systems with multiple components, PB is triggered last, closest to the collision. Therefore, most PB systems are designed to trigger only when the unavoidable collision occurs.

B. Time to collision

The activation of each of the PCS components varies by manufacturer and system. A simple metric that some PCSs use to judge collision threat is the time to collision (TTC). TTC is the ratio of range x to range rate of relative velocity $V12$, i.e.

$$TTC = x/V12$$

Where, x = Distance range;
$V12$ = Range of relative collision;

TTC is directly related to driver's threat recognition in frontal collisions and is readily measured by radar sensors.

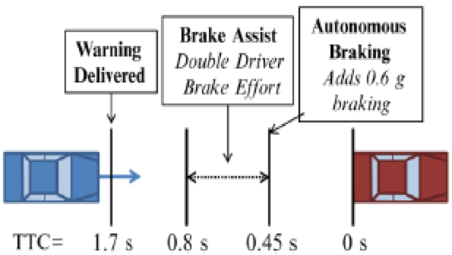


Fig .1. Activation timing of PCS components leading to a crash.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

The activation times and system components in this system will be used as the basis for the PCS components, which is shown in the fig 1.

Consider a rear-end collision where the striking vehicle (vehicle 1) collides with a second vehicle (vehicle 2). ΔV for this collision for vehicle 1 is defined as

$$\Delta V1 = \Delta V12 - VC$$

Where V12 is the velocity of vehicle 1 with respect to Vehicle 2 at impact, and VC is the common velocity that was achieved following the collision. The change in velocity of Vehicle 2 is simply VC.

The time from the issue of the warning to the time that the driver applies the brakes is the driver's reaction time. Reaction time is important for PCS algorithms, because it determines what systems will activate. The four scenarios of drivers applying the brakes in response to a warning is shown in Fig. 2.

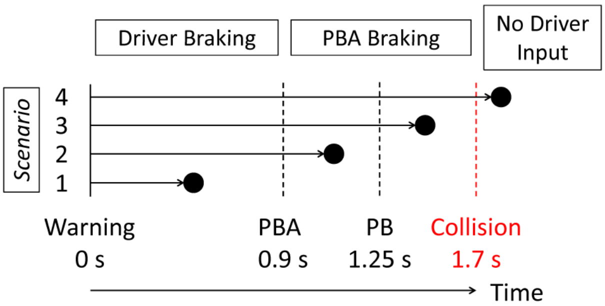


Fig 2: Schematic of PCS component activation based on reaction time

The figure 2 shows the PCS component activation based on reaction time for (1) fast, (2) normal, (3) slow, and (4) no response. Filled circles indicate the time at which the driver applies brake. FCW warns the driver 1.7 s before the collision. A fast reaction time (scenario 1) will cause the driver to apply the brakes before the threshold for PBA, resulting in only driver braking effort. However, a medium reaction time (scenario 2) will cause PBA to activate once the driver starts braking, doubling the driver braking effort. A slow reaction time (scenario 3) will still cause PBA to activate, but the braking time will be shorter. Finally, if the reaction time is greater than 1.7 s, the crash will occur before the driver applies the brake (scenario 4).

III. PRECOLLISION SYSTEM COMPONENT DESIGN

Nowadays prediction of vehicle's dangerous driving conditions or maneuvers can help for preventing accidents. One of the major causes is a result of keeping no safe distance between neighboring vehicles while driving. A system that warns drivers if they are heading too close and dangerously towards other vehicles would help to reduce the road accidents significantly. This system would be particularly useful in low visibility conditions, like fog and rain, which leads the major cause of a large number of road accidents.[1]

The vehicle collision avoidance system (VCAS) is a device that consists of a microcontroller, vibration sensor, ultrasonic sensor, RF transceiver, GSM and a GPS. There is also other or near vehicle section.. This system consists of a microcontroller decoder unit ,alarm unit and a reader device .The Vehicle Collision Avoidance System (VCAS) provides the vehicle navigation solution for the striking vehicle and the other vehicle section provides vehicle navigation solution for the struck vehicle that is the behind and side vehicles. This VCAS is used only for the rear –end vehicle collision mode.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

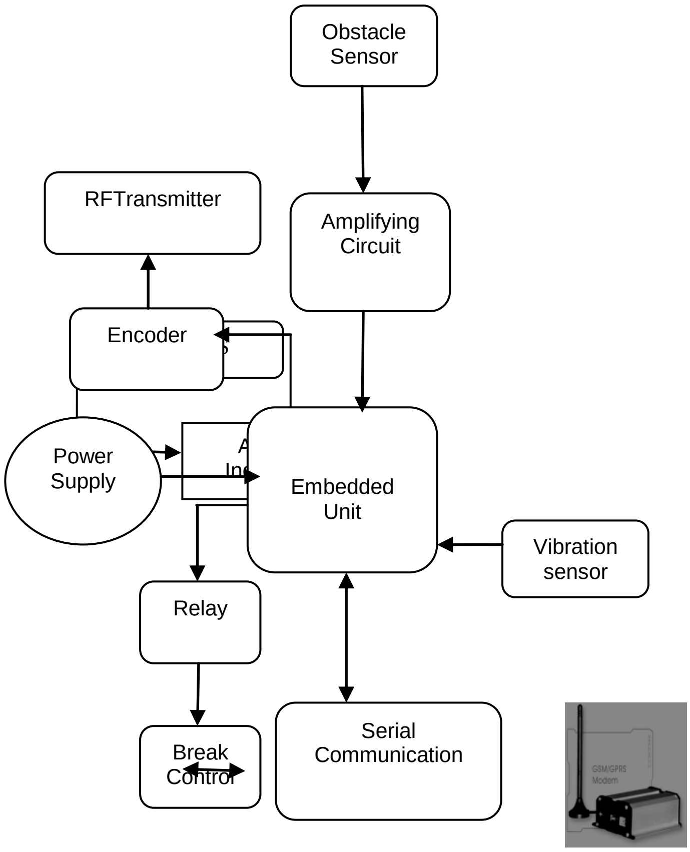


Fig.3: Block Diagram of Vehicle Collision Avoidance System

The block diagram of the expanded (VCAS) is shown in Fig.3, The obstacles are detected by using ultrasonic sensor. The vibration sensor estimates the distance between vehicles just before the collision. The currently proposed system uses wireless technologies for the transferring information's. If the system detects the obstacle vehicle it sends an alert to the driver to and if the driver cannot provide brake then the system helps in braking and if it goes towards colliding then it turns the car to certain extent to avoid damage. Then the location of collision is found using GPS and information is sent to the authorized person's mobile and ambulance using GSM. This information is also passed to the vehicle behind and also to the near-by side vehicles to reduce speed or to stop the vehicle.

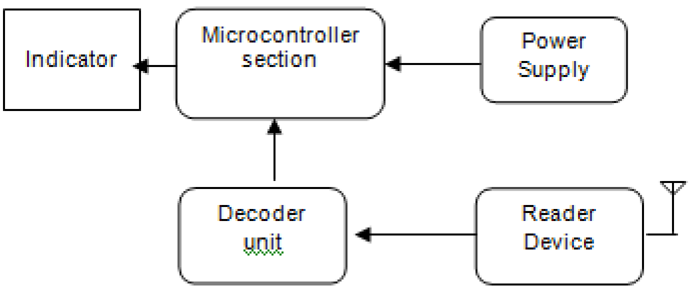


Fig 4: Block Diagram of other vehicle section.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

The Other vehicle system consists of a microcontroller section, a decoder unit, an indicator and a reader device for the vehicle navigation.[2] The information transferred from the front vehicle or side vehicle is in the encoded format ,this has to be decoded into a readable format for the user to read the information such as reduce the speed or stop the vehicle due the collision. Also and alarm is given to alert the people.[3]

The currently proposed system uses wireless technologies like GSM for transferring information and GPS for finding the location of the accident. The efficiency will be estimated in terms of reduction in the number of collisions, collision severity (ΔV), and the number of injured drivers.[4]

IV. PROPOSED TRANSPORTATION SYSTEM

This section describes the structure and functions of the new proposed transportation system which provides the basic platform to simulate the future transportation system in the vehicle to vehicle communication environment which emulates the Intelligent Transportation Systems (ITS). ITS build as a network based, integrated navigation system with different modules that combine together to communicate from one vehicle to another.[5]

One of the most promising areas of research is the study of the communications among vehicles and road-side units, or more specifically the Vehicular Ad-hoc Network (VANET).[6]This kind of networks are self-configuring networks composed of a collection of vehicles and elements of roadside infrastructure connected with each other without requiring an underlying infrastructure, sending and receiving information and warnings about the current traffic situation.[7]

In this system the VANET is used to communicate from one system to another. The information such as speed reduction and collision information is transferred from one vehicle to another vehicle.[8] Currently, DSRC (Dedicated Short-Range Communication has been proposed as the communications standard specifically for VANETs, it is a short medium range communications service that offers very low latency and high data rate. DSRC is based upon the standards IEEE 802.11p and IEEE 1609 family.[9]

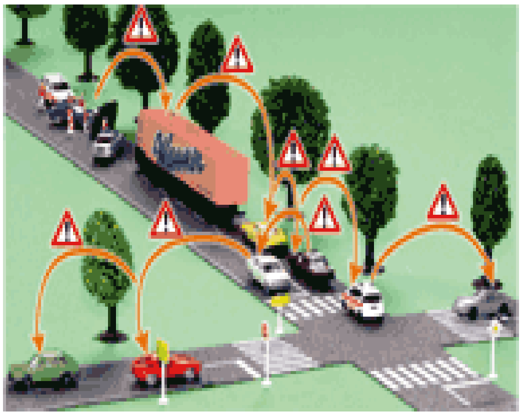


Fig 5: Schematic Diagram of VANET.

V. COMMUNICATION MODULE

Low-cost and effective communications with sufficient bandwidth is necessary to pass information between vehicles and the controllers in order to perform effective process. Various communication protocols achieve reliable, two-way communication networks such as ZigBee, Bluetooth, but sending information through mobile phone or GSM/GPRS modem is used.[10] This is used to send SMS messages to the authorized user

A GSM modem is a wireless modem that works with a GSM wireless network.[11] A wireless modem behaves like

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

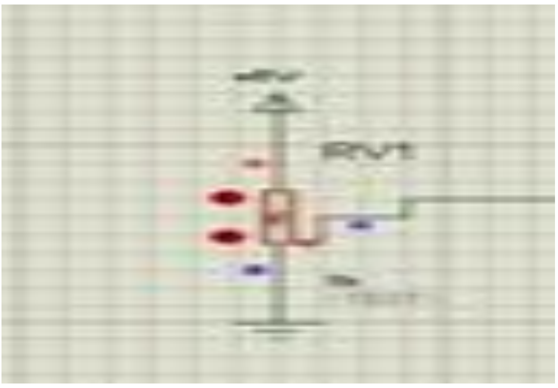
Vol. 4, Issue 7, July 2015

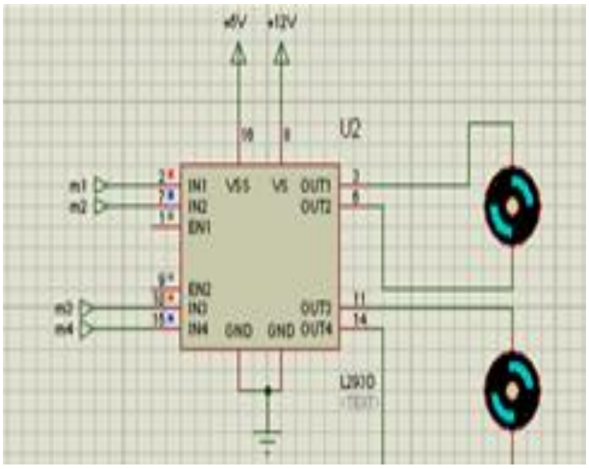
a dial-up-modem; it sends and receives data through radio waves. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier to operate. A GSM modem can be an external device or a PC Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable .Also GPS system is used to find the location of the vehicle collision.[12]

VI. SIMULATION RESULTS

Simulation is done using Proteus Simulation software .Proteus is hardware simulation tool.[12] It is compatible with windows XP. The simulation output is shown below for both before and after collision. The parameters are set for the steering control as variable resistor and LED's for alarm to the driver, next vehicle and the vehicle behind.[13]

A. Simulation before Crash





Instead of the steering, a potentiometer is used to vary the distance.[13] When it is in zero position the motor will be running and wheels will be in moving condition. When it is in full position the motor and the wheels will be stopped due to collision.[14]

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

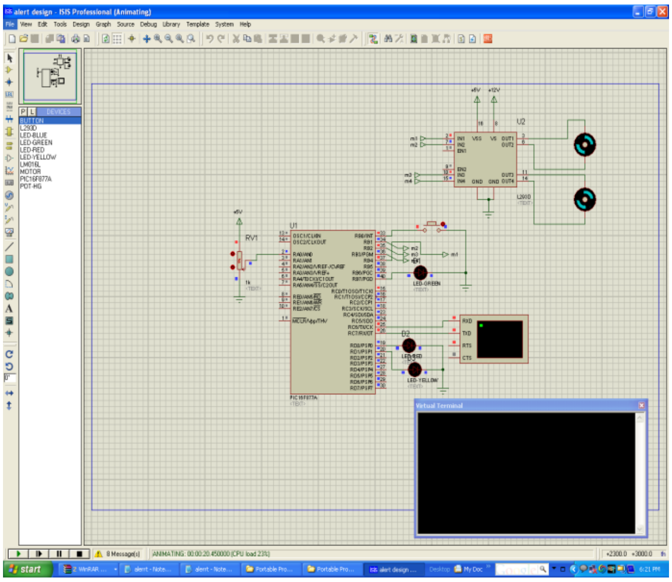
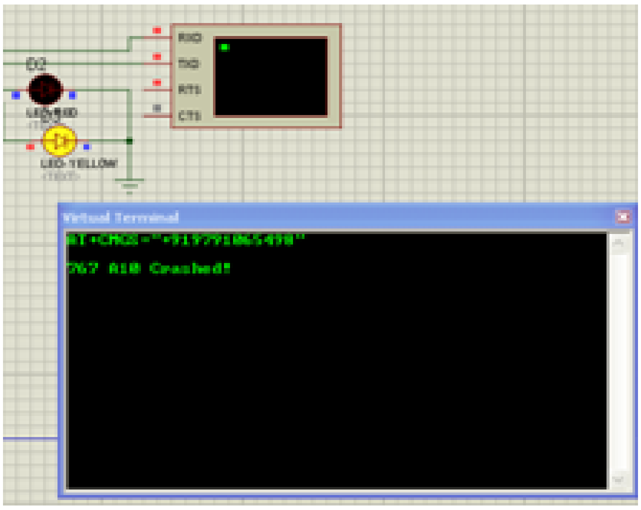


Fig 5: Simulation before collision.

In this simulation output the condition before crash is shown, the wheels will be rotating and all the LED's will be in OFF condition and the potentiometer is in initial position and no transmission to the virtual terminal.[15]

B. Simulation after Crash



In this the yellow LED glows and the information is transferred to the virtual terminal (ie) mobile

Mobile No: 9791065498

" 767 A10 Crashed"

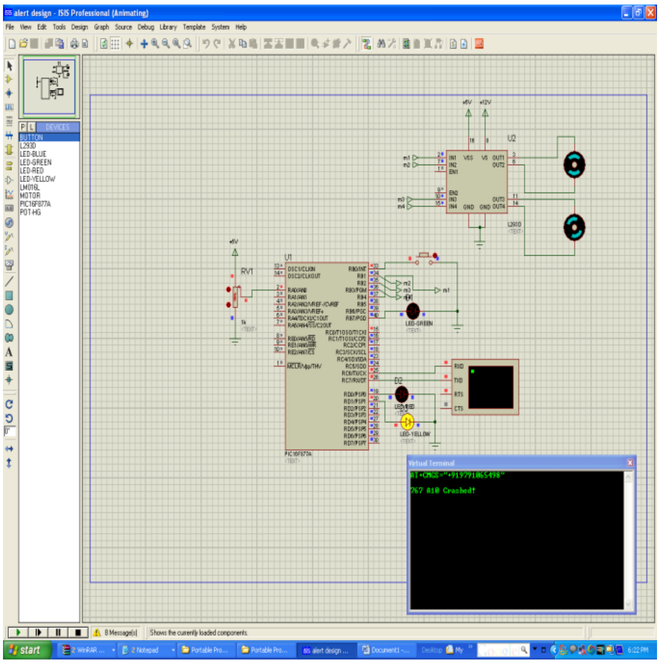


Fig 6: Simulation after collision.

In this simulation output the condition after crash is shown, the wheels are in stopped position and the two LED's one for driver alarm and the side vehicle will be in off position and the switch is in closed position and the information that the vehicle is crashed is sent to the authorized mobile number

VII. CONCLUSION

This paper proposed an vehicle rear end collision avoidance system based on PCS algorithm. This provides a highly secure system for vehicles. Collision avoidance and property damage reduction is mainly the benefit of this system and communication between vehicles is done using wireless communication.

Proposed system have application in the area of vehicle networks, traffic control and security system etc Here the time to collision is in the sufficient bandwidth so crash is avoided and driver is alerted and corrective action is also taken. The severity of the collision and property damage is reduced in the highways. Also it consumes less power. As a result we can implement a less expensive system. The simulation result is viewed using PROTEUS software.

REFERENCES

1. Kristofer D. Kusano and Hampton Gabler, "Method for Estimating Time to Collision at Braking in Real- World, Lead Vehicle Stopped Rear-End Crashes for Use in Pre-Crash System Design", Virginia Tech2011-01-0576 published in 04/12/2011.
2. Kichun Jo, Student Member, IEEE, Keounyup Chu, Student Member, IEEE, and Myoungho Sunwoo, Member ,"Interacting Multiple Model Filter-Based Sensor fusion of GPS With In-Vehicle Sensors for Real-Time Vehicle Positioning", IEEE 2011.
3. Krishnamoorthy P., Jayalakshmi T., "Preparation, characterization and synthesis of silver nanoparticles by using phyllanthusniruri for the antimicrobial activity and cytotoxic effects", Journal of Chemical and Pharmaceutical Research, ISSN : 0975 – 7384, 4(11) (2012) pp.4783-4794.
4. Jacques Georgy , Member, IEEE, Aboelmagd Noureldin, Senior member, IEEE, and Chris Goodall ,"Vehicle Navigator using a Mixture Particle Filter for Inertial Sensors/Odometer/Map Data/GPS integration", IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS, VOL. 13, NO. 1, MARCH 2012
5. Aoki, H., Aga, M., Miichi, Y., Matsuo, Y. et al., "Safety Impact Methodology (SIM) for Effectiveness Estimation of a Pre-Collision System (PCS) by Utilizing Driving Simulator Test and EDR Data Analysis," SAE Technical Paper 2010-01-1003, 2010, doi:10.4271/2010-01-1003.
6. Madhubala V., Subhashree A.R., Shanthi B., "Serum carbohydrate deficient transferrin as a sensitive marker in diagnosing alcohol abuse: A case - Control study", Journal of Clinical and Diagnostic Research, ISSN : 0973 - 709X, 7(2) (2013) pp.197-200.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

7. Kusano, K. and Gabler, H., “Target Population for Injury reduction from Pre-Crash Systems,” SAE Technical Paper”2010-01-0463, 2010, doi:10.4271/2010-01-0463.
8. Megan Bayly, Brian Fildes, Michael Regan, Kristie Young, “Review of Crash Effectiveness of Intelligent Transportation Systems”, TRACE Project, Deliverable D4.1.1–D6, November 2007.
9. Khanaa V., Thooyamani K.P., Saravanan T., "Simulation of an all optical full adder using optical switch", Indian Journal of Science and Technology, ISSN : 0974-6846, 6(S6)(2013) pp.4733-4736.
10. M. Bayly, B. Fildes, M. Regan, and K. Young, *Review of Crash Effectivenessof Intelligent Transportation Systems*, 2007 TRACE Project,Deliverable D4.1.1–D6.2.
11. Bal′azs N′emeth and P′eter G′asp′ar ,”Road conditions in the design of vehicle speed control using the LPV method”, IEEE 2006.
12. Nagarajan C., Madheswaran M., "Stability analysis of series parallel resonant converter with fuzzy logic controller using state space techniques", Electric Power Components and Systems, ISSN : 1532-5008, 39(8) (2011) pp.780-793.
13. R. Rajamani, *Vehicle Dynamics and Control*. New York: Springer-Verlag, 2006.
14. Bhat V., "A close-up on obturators using magnets: Part I - Magnets in dentistry", Journal of Indian Prosthodontist Society, ISSN : 0972-4052 , 5(3) (2005) pp.114-118.
15. J. D. Lee, D. V. McGehee, T. L. Brown, and. L. Reyes, “Collision warning timing, driver distraction, and driver response to imminent rear-end collisions in a high-fidelity driving simulator,” Human Factors, vol. 44,no. 2, pp. 314–334, Summer 2002 .
16. P Thamarai, B Karthik, Automatic Braking and Evasive Steering for Active Pedestrian Safety, Middle-East Journal of Scientific Research 20 (10), PP 1271-1276, 2014.
17. Shriram, Revati; Sundhararajan, M; Daimiwal, Nivedita; , Human Brain Mapping based on COLD Signal Hemodynamic Response and Electrical NeuroimagingarXiv preprint arXiv:1307.4171, 2013. Daimiwal, Nivedita; Sundhararajan, M; Shriram, Revati; , Respiratory rate, heart rate and continuous measurement of BP using PPGIEEE Communications and Signal Processing (ICCSP), 2014 International Conference on, PP 999-1002,2014.
18. Shriram, Revati; Sundhararajan, M; Daimiwal, Nivedita; , Effect of change in intensity of infrared LED on a photoplethysmogramIEEE Communications and Signal Processing (ICCSP), 2014 International Conference on, PP 1064-1067,2014.
19. Daimiwal, Nivedita; Sundhararajan, M; Shriram, Revati; , Comparative analysis of LDR and OPT 101 detectors in reflectance type PPG sensorIEEE Communications and Signal Processing (ICCSP), 2014 International Conference on, PP 1078-1081,2014.
20. Shriram, Revati; Sundhararajan, M; Daimiwal, Nivedita; , EEG Based Cognitive Workload Assessment for Maximum Efficiency.
21. Daimiwal, Nivedita; Sundhararajan, M; Shriram, Revati; , Non Invasive FNIR and FMRI system for Brain Mapping .

.