An Internet - of - things device for identifying and ensuring public safety among especially at night

HEMANTA PAIKRAY*, RASHMITA SAHOO
Dept. OF Computer Science and Engineering, NIT , BBSR
hemantapaikray@thenalanda.com*,rasmitasahoo@thenalanda.com

ABSTRACT: Understanding the psychological state of drivers can help prevent fatal traffic accidents. The majority of traffic accidents happen at night because of distracted drivers (Subject). This study offers an Eye Blink Monitoring System (EBM) that warns the subject when they are starting to nod off. Drivers can be warned when they are beginning to nod off by using an embedded system that is based on psychological state of the subject and monitors eye and head movements. Analyzing the subject's physiological sleep status involves tracking their head movement with an accelerometer and their eye-blink rate using an Infrared sensor. The output of the device is unaffected by an average eye blink rate. But, if the individual is in a deep sleep cycle, the IR sensor detects aberrant eye blinking and sets off an alarm to rouse the person up. For the quick reaction team to act in an emergency, Internet of Things (IOT) enabled sensors are utilised to relay all the data they have collected across a smart grid network.

KEYWORDS: Internet Of Things (IOT) , RFID, Eye Blink Monitoring System (EBM) , M2M- machine to machine communication, IPv6, URL- universal resource locator, URN- universal resource name, sensors, drowsiness, accident prevention system.

I. INTRODUCTION

The Internet of Things (IOT) is the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure. Typically, IOT offers advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications (M2M) and covers a variety of protocols, domains, and applications. The interconnection of these embedded devices (including smart objects), is implemented in nearly all fields of automation enabling advanced applications like a Smart Grid. The term ―things‖ in the IOT refers to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, or field operation devices that assist fire-fighters in search and rescue. Current market examples include thermostat systems and washer/dryers that utilize Wi-Fi for remote monitoring.

In this project we are presenting an internet based system entitled ‗Eye Blink and head movement Monitoring System‘ which will help drivers to alert in drowsiness. This system is based on principle of monitoring eye movements of driver continuously using an IR sensor and head movement using accelerometer. If he/she falls asleep, then an alarm will ring to wake him/her up.

Integration with the Internet implies that devices will utilize an IP address as a unique identifier. However, due to the limited address space of IPv4 (which allows for 4.3 billion unique addresses), objects in the IOT will have to use IPv6 to accommodate the extremely large address space required. Objects in the IOT will not only be devices with sensory capabilities, but also provide actuation capabilities (e.g., bulbs or locks controlled over the Internet). Largely, the future of the Internet of Things will not be possible without the support of IPv6; and consequently the global adoption of IPv6 in the coming years will be critical for the successful development of the IOT in the future.

II. RELATED WORK

In this project we are implementing EBM (Eye Blink Monitoring Technique) to detect drowsiness of night drivers and preventing accidents. The other technologies that detect Drowsiness are EEG or Brain waves monitoring technique. Such a technique requires sophisticated system to map or monitor the brain of subject and determine the state of drowsiness based on the neurological sleep cycle. Though EEG technique is accurate to a larger extent, yet it is not cost effective and has a difficult implementation. On the other hand Eye Blink Monitoring Technique is dependent on physiological state of sleep of the subject and by understanding it, drowsiness can be detected and accident can be prevented. Drowsiness causing accident can be effectively prevented by designing an embedded system that is efficient enough to take critical decisions during emergency conditions. Majority of accident prevention systems come into picture when accident happens , however the proposed system is equipped with advantage of taking decisions by analyzing the symptoms of accident causing events. Brain wave technique only measures the drowsiness level but, EBM technique can be interfaced with a network of sensors in a cost effective manner to provide an efficient accident prevention system. The following key points were considered while estimating the feasibility and wide expansion of IOT based devices :

1. Gartner, Inc. (a technology research and advisory corporation), there will be nearly 26 billion devices on the Internet of Things by 2020.
2. ABI Research estimates that more than 30 billion devices will be wirelessly connected to the Internet of Things (Internet of Everything) by 2025.
3. Pew research Survey indicates that a large majority of the technology experts and engaged Internet users who responded—83 percent—agreed with the notion that the Internet/Cloud of Things, embedded and wearable computing (and the corresponding dynamic systems) will have widespread and beneficial effects by 2025.

III. GAPS IN LITERATURE

On comparison of proposed technology for accident prevention and existing similar technologies, the following factors were taken into consideration to enhance the functionality of design of proposed embeded system :

1. Majority of accident prevention technology take response after accident occurrence, causing delay in emergency response and could not be prevented.
2. From the literature review carried out it is found that dependence/load on Satellite services for tracking and locating (GSM and GPS) could be shared by smart grids but cannot be eliminated.
3. Standardized technologies governing IOT are not well defined on very large scale. Prominent standardization bodies, such as the IETF, IPSO Alliance and ETSI, are working on developing protocols, systems, architectures and frameworks to enable the IOT services.

IV. AIMS & OBJECTIVES OF PROPOSED PROTOTYPE

This project prototyped is aimed to design & implement uniquely identifiable embedded computing devices within existing internet infrastructure for night vehicle drivers to locate and prevent road accident caused due to drowsiness.
The objectives of proposed model are summarized below :

I. Establish an eye blink & head movement monitoring sensor system for Drowsiness detection.
II. In case of drowsiness detected
   a) Alert the driver via a wake call (vibration /Buzzer)
   b) Reduce speed and stabilize vehicle.
III. Mediate the Sensor information and locate accident location using GPRS for help and rescue.
III. Display the activities of designed system on LCD display.

V. PROBLEM STATEMENT

The problem statement includes improving the quality of data acquisition about distraction-related crashes along with better analysis techniques. By analysing the understanding of the extent and nature of the distraction problem. The main aim is to reduce the driver workload associated with performing tasks using both built-in and portable in-vehicle devices via limiting the visual and manual demand associated with in-vehicle device interface designs. Better device

interfaces and integrated wearable computers will help to minimize the amount of time and effort involved in a driver performing a task using the device. Minimizing the workload associated with performing non-driving, or –secondary,‖ tasks with a device enables the driver to maximize the attention they focus toward the primary task of driving. Keep drivers safe through the introduction of crash avoidance technologies. These include the use of crash warning systems to re-focus the attention of distracted drivers as well as vehicle initiated (i.e., automatic) braking and steering to prevent or mitigate distracted driver crashes. Educate drivers about the risks and consequences of distracted driving are performed by targeted media messages, drafting and publishing sample text messaging laws.

VI. NEED FOR PROJECT PROTOTYPE

The following are the motivating factors that determines the need for the development of the project prototype:

1. To develop a standard specification template to describe distraction detection and mitigation systems
2. With demand for portable electronic products, there is a need to design devices that could be accessed anytime in case of emergency.
3. It is required to enable the emergency services for quick response during road accidents.
4. To initiate advanced connectivity services that goes beyond machine-to-machine communication and covers variety of protocols, domains & application
5. To establish device systems that are Automatic, Intelligent and Response.
6. Provide a safety benefits framework for estimating the overall effect on driving safety
7. Develop alternative distraction detection and distraction mitigation design concepts.

VII. BLOCK DIAGRAM

The Block diagram of proposed prototype consists of the following Components :

1. LCD Display
2. Drowse Sensors (IR sensors)
3. LM358 Comparator
4. NXP RD25 (8051 Microcontroller)
5. Vibrator
6. Engine Speed Controller
7. Analog to Digital Converter (ADC)
8. Gravity Sensors (3- axis accelerometer)
9. GSM & GPRS Module (Mobile phone)
10. Power Supply (12V 2Amp. DC+ SMPS)

The above components are integrated as per the block diagram given in Fig 1. The designed embedded system is interfaced with another mobile phone having an android platform through an IOT application. Such an application is designed on an android platform and it provides notification to the host about the status of embedded system in case of drowsiness and accident occurrence via alarms, text messages and voice notifications.

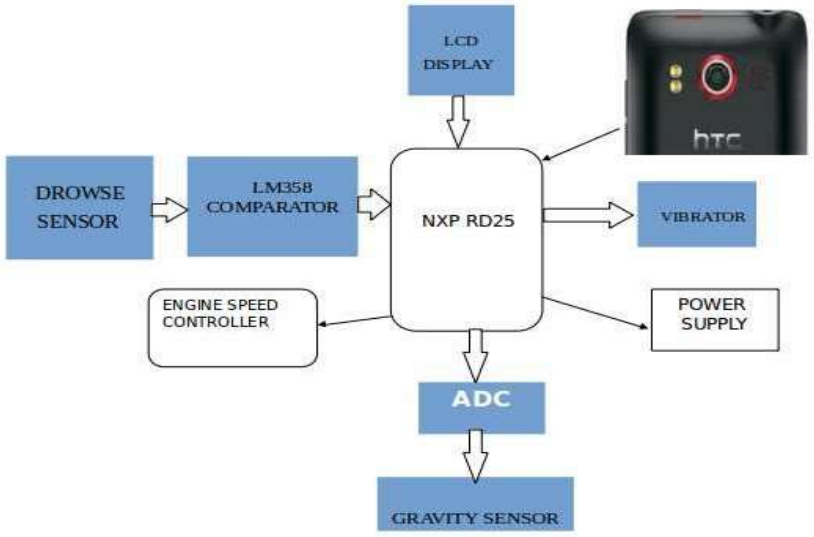

Fig.1 Block diagram of implemented prototype

DESCRIPTION:

The process of working of above block diagram is explained as follows.

This project involves measurement of eye blink using IR sensor and head movement using accelerometer. The IR transmitter is used to transmit the infrared rays in our eye. The IR receiver is used to receive the reflected infrared rays of eye. If the eye is closed then the output of IR receiver would be high ,otherwise the IR receiver output is low. To know whether the eye is in closing or opening position. The output is provided to a logic circuit for alarm indication and status will displayed on LCD display. Accelerometer is placed on driver fore-head it measures tilt angle of the drivers in vertical either forward or backward direction and left or right direction from the driver knee. If tilting angle exceeds certain threshold range, This output is give to logic circuit to indicate the alarm and status is displayed on LCD

Monitoring Eye movement:

By monitoring the eye of a human being, we can determine whether he/she is sleeping or not. One common technique of monitoring eye blink rate is by measuring infrared (IR) light reflected from the surface of the eye. The eye is illuminated by an IR LED, which is powered by the +5V power supply and the reflected light is recorded by an IR photo diode. The IR photo diode converts this reflected light into electrical signal and given to Op-Amp.

The output of Op-Amp. depending on the intensity of light received by the IR photo diode. The micro-controller drives the buzzer according to output of Op-Amp. The digital display provides various messages to the user. When the eye is open, maximum amount of light will be reflected from the eye because our eyeball is transparent, while minimum of light will be reflected from the eye, when it is closed as skin part of eye is opaque.

Monitoring Head movement:

Head movement detection is done through single step Accelerometer eg: ADXL330 which measures 3-axis detection. It consists of angle based accelerometer (ACC) input to simulate accurate head movement. For the movement analysis, it is needed to somehow translate the tilt angle data to displacement of mouse cursor that is calculating new head position. There are two main methods when calculating the new head cursor position:

i. Absolute mapping in which every tilt angle corresponds to a position on screen.
ii. Relative mapping in which every tilt angle corresponds to a head displacement amount (step size) and this amount is summed by the coordinates of the head‘s old position, to calculate new position.

VIII. FEATURES OF PROPOSED PROTOTYPE

The following are the exclusive features provided by the designed prototype :

1. Solution for drunkards when they are over drunk wake them when they are drowsing
2. Solution for night drivers when they feel sleepy while driving overnight to wake them up
3. Solution for rash driving , cut the speed by stoping the spark to the starter or sparkplug & wake them up
4. Solution for wheel grip using gravity sensor
5. Advice for drivers by their loved ones when they are overdrunk or rash driving
6. Solution for preventing accidents
7. Solution for detecting accidents using impact sensors
8. Tracking & locating the location of accident using GPS.
9.

IX. ADVANTAGES

1. The methodology aims at preventing accident before it‘s occurrence hence, increases the safety of both person driving the vehicle and other people on roads.
2. Involvement of Cloud computing reduces the load on satellite services (GPS and GSM) and are easily implementable
3. Assists emergency services and quick response teams to take quick action in case of occurrence.
4. Enables implementation of effective safety regulations for four-wheel drive on roads at both day and night.
5. User friendly interface enable it‘s easy usage by vehicle drivers.
6. Gravity sensors prevents over speeding of vehicles and maintains vehicle stability.
7. Fast growth in Smart grid and cloud services makes it effective and easy implementation

X. DISADVANTAGES

1. The device requires an active internet connection.
2. For implementation over a smart grid network, security issues such as terror attacks aimed at disrupting emergency services are yet to be resolved.
3. Diverse applications call for different deployment scenarios and requirement are needed , which, are usually proprietary i.e IOT technology is very new with less application based companies that grew very fast over a span of two years.
4. Prominent standardization bodies, such as the IETF, IPSO Alliance and ETSI, are required on developing protocols, systems, architectures and frameworks to enable the IOT
5.

XI. APPLICATIONS

1. Solution for Night drivers to wake them from drowsiness caused due to sleeplessness.
2. Prevention of Accident caused due to Substance abuse (Alcohol, Drugs, etc)
3. Solution for rash driving by automatically controlling the vehicle speed
4. Vehicle stability by maintain a better wheel grip through gravity sensors.
5. Tracking and locating the location of accident using GPS and plotting it on Google maps

XII. RESULTS

The following conclusions can be made from the following proposed prototype :

1. The subject (night drivers) drowsiness can be effectively measured based on eye blink monitoring system.
2. If drowsiness is detected then automatic responses from designed embedded system is possible such as alarm and reducing the speed of vehicle.
3. In case of accident occurrence the designed system is equipped with the capability of sending response messages to the host android device by means of an IoT enabled application. The response messages are in form of voice and text notifications.

4. The GSM module involved in the designed system is used to effectively track the location of the vehicle. The location of vehicle and nearby emergency service facilities are effectively displayed on the portable android devices of host device and embedded device through Google Maps.

Fig (a) depicts the IR sensors and accelerometer connected to designed hardware for drowsiness detection and indicates the two sensor inputs into the designed embedded system. The drowsiness of driver is detected based on the threshold values on IR sensor and accelerometer and the corresponding results are shown on LCD screen mounted on the hardware. At the same time the required response in terms of physical alarm (vibration) and text messages are sent over IoT android application to intimidate driver and host emergency response in respective case of initial drowsiness and accident occurrence.

Fig (b) and Fig (c) indicates the LCD messages displayed during response of drowsiness detection conditions. In case of normal eye-blink LCD Screen displays the voltage recorded during opening and closing of eyelids. While in case of drowsiness LCD screen Shows ―Sleeping‖ message and initiates the physical alarm.

Fig (a) : IR sensor & Accelerometer

Fig (b) LCD response on drowsiness detection

Fig (c): normal eyeblink message on LCD

XIII. CONCLUSIONS AND FUTURE ENHANCEMENTS

Majority of portable devices are aimed at providing unlimited access to internet services for data storage and synchronization with other remote devices. Hence, there is a need of faster data acquisition and quick decision making of embedded computing system for real time applications for making vehicles safe, automatic, responsive and intelligent. Interfacing of simple sensors to various micro-controller platforms enables the ease of regulating the embedded system at a sophisticated levels of automation and mediating the sensor information over a smart grid

enables large amount of data acquisition for taking accurate decisions over the emergency conditions. Further, the development of smart grids fascinates the overall process of communication between human and machine rather than machine to machine communication. Hence, IoT can revolutionize the way embedded systems interact and respond for variety of applications especially in case of vulnerable night drivers by monitoring the state of their drowsiness for a quick, safe and effective response for a safer road travel.

The following future enhancement can be made into proposed system by devising software algorithms, hardware implantations and interfacing sensors :

1. Solution for drink and drive cases.
2. Solutions for emergency speed control of vehicles.
3. Solution for rash driving by obstructing Spark-plug.
4. Solution for wheel grip using gravity sensor.
5. Voice based real time advice for drivers by their loved ones when they are over-drunk Or Rash-driving.
6. Solution For Preventing Accidents.
7. Solution For Detecting Accidents Using Impact Sensors.
8. Global Photos Transfer Using GPRS In Arm 11 Device And Mailing It To Required People

REFERENCES

1. ***EFFECTIVE CONTROL OF ACCIDENTS USING ROUTING AND TRACKINGSYSTEM WITH INTEGRATED NETWORK OF SENSORS (2013)****Authors: R. MANOJ KUMAR, DR.R. SENTHIL DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION, PANIMALAR ENGINEERING COLLEGE, ANNA UNIVERSITY , International Journal of Advancements in Research & Technology, Volume 2, Issue4, April-2013 69ISSN 2278-7763*
2. *The Research on Fatigue Driving Detection Algorithm(2013) Authors: Zhui Lin, Lide Wang, Jieqiong Zhou, Tao Wang, School of Electrical Engineering, Beijing Jiaotong University, Beijing, China*
3. ***Distraction Detection and Mitigation Through Driver Feedback (2013 A REAL TIME SYSTEM FOR DETECTING DROWSINESS OF DRIVER (2013)*** *Authors: Puja Authors: John D. Lee, Jane Moeckli, Timothy L. Brown, Shannon C. Roberts, Chris Schwarz, Lora Yekhshatyan, Eric Nadler, Yulan Liang, Trent Victor, Dawn Marshall, Claire Davis, DOT HS 811 547A*
4. *Malvadkar, Bhavana Pansar e& Sachin Pansar* International Journal of Management, InformationTechnology and Engineering (BEST: IJMITE) Vol. 1, Issue 1, Oct 2013
5. ***Detecting Driver Drowsiness Based on Sensors (2012)*** Authors: ArunSahayadhas *, Kenneth Sundaraj and MurugappanMurugappan AI-Rehab Research Group, Universiti Malaysia Perlis (UniMAP), KampusPauh Putra, 02600 Arau, Perlis, Malaysia Sensors 2012, 12, 16937-16953; doi:10.3390/s121216937
6. **Sleepy driving in truck drivers: Insights from a self-report survey (2011)** Authors: Raymond Misa, Russell Conduit and Grahame Coleman, HFESA 47th Annual Conference 2011. *Ergonomics Austral*
7. **Controlled Inducement and measurement of drowsiness in a driving simulator. (2010)** Authors: Helios De Rosario,a* José S. Solaz,a Noelia Rodríguez,b Luis M. Bergasac doi:10.1049/iet-its.2009.0110)
8. **Real-time Nonintrusive Detection of Driver Drowsiness (2009)** Author: Xun Yu, Department of Mechanical and Industrial Engineering University of Minnesota Duluth
9. **Asleep at wheels : Report of special commission on drowsy driving (2009)** Authors: Senator Richard T. Moore, Senate ChairJoint Committee on Health Care Financing Rachel Kaprielian, RegistrarMassachusetts Registry of Motor Vehicles, Massachusetts.
10. **Automatic recognition of vigilance state by using a wavelet-based artificial neural network (2005)** Authors:AbdulhamitSubasi, M. Kemal Kiymik, Mehmet Akin & Osman Erogul Springer-Verlag London Limited 2005Neural Comput&Applic (2005) 14: 45–55DOI 10.1007/s00521-004-0441-0
11. EEG-Based Drowsiness Estimation for Safety Driving Using Independent Component Analysis (2005) Authors: Chin-Teng Lin, *Fellow, IEEE*, Ruei-Cheng Wu, Sheng-Fu Liang, Wen-Hung Chao, Yu-Jie Chen, and Tzyy-Ping Jung, IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—I: REGULAR PAPERS, VOL. 52, NO. 12, DECEMBER 2005
12. **Driver Attention Detection System (DADs) (2002)**Author : Mathew Parks U.S. DEPARTMENT OF TRANSPORTATION SMALL BUSINESS INNOVATION RESEARCH PROGRAM SOLICITATION NO. DTRS57-02-R-SBIR
13. **EEG-Based Drowsiness Estimation for Safety Driving Using Independent Component Analysis** ; IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—I: REGULAR PAPERS, VOL. 52, NO. 12, DECEMBER 2005
14. **EFFECTIVE CONTROL OF ACCIDENTS USING ROUTING AND TRACKING SYSTEM WITH INTEGRATED NETWORK OF SENSORS International Journal of Advancements in Research & Technology**, Volume 2, Issue4, April-2013 69 , ISSN 2278-7763