CHAPTER-1

INTRODUCTION

The chapter introduces the role of embedded system, sensor nodes in automotive industries, road safety rules in India, background of road accidents, role of security, history and types of helmets. The chapter comprises the outline of the thesis. The chapter also focuses to the background and need the research.

1.1 Role of Embedded System in Automotive Industries

India is one of the largest automobile markets in world. A wide range of automobile industries are involved in the manufacturing and selling of buses, cars and bikes etc. Automobile produced 1.73 million vehicles in feb.2013 including two-wheeler, three wheeler and four wheeler vehicles and increased to 1.81 million in 2014.

The role of an advanced embedded system has increased rapidly in automobiles in the past two decades. Embedded systems are important as various functions are dependent on this like ignition, audio system, security. Volkswagen is the first automobile industry to implement embedded system in 1968.

In the automobile industries rapidly mechanical systems are replaced with the electronic systems. It is due to versatility and flexibility which embedded system offers. In present scenario a vehicle comprises of around 25-35 microcontrollers and in luxury vehicle this counts increases upto 60-70. Embedded system [edgefx.in] in vehicles include airbags, black box, anti-lock braking system, telematics, traction control, automatic parking, entertainment, collision sensors, climate control etc.

Lot of microcontrollers are placed in the cars and they are part of complete system but in two wheeler vehicles use of so many microcontroller are not common. For the first time BMW introduced electronic ABS for BMW100 series motorcycles in 1988 followed by ABS option on Honda ST1100 and Yamaha FJ1200 in 1992. Bosch presents light weight integral ABS in 2009. But still safety features are not implemented on the two wheeler vehicles and this are needs to be explored.

European Transport Safety report showed that it is 20 times dangerous to ride a motorcycle than driving a car for the same distance. A study of accident situation in Germany from 1990 to 2011 showed that traffic fatalities drastically decreased but two wheeler vehicle fatalities remained same. A study was conducted by The Insurance Institute for Highway Safety which shows motorcycles above than 250cc without ABS are more likely to be involved in crashes. Swedish Administration [en.wikipedia.org] study shows 48% of motorcycle accidents could be avoided with ABS. On the basis of these studies EU commission initiated a legislative process and passed in 2012 and made ABS mandatory for above 125cc from 2016 onwards.

1.2 Role of Sensors in Automotive Industries

Sensors play major role in automation of any system. The sensors measurers physical quantity of the real world and convey the status of system to central processing unit and made it "Intelligent" [ifros.org].

Sensors are of two types- active sensor (requires power source to operate) and passive sensor (doesn't require any power source). The use of sensors increases the use of visual information prominently, due to which by 2011 machine vision market rises by 10%. Sensor converts the physical parameters into electrical signal for further processing. For example temperature sensor, pressure sensor etc. The certain feature needs to be considered for choosing a sensor like:

- Accuracy
- Range
- Environment Condition
- Cost
- Resolution
- Cost
- Calibration
- Repeatability

In the automation industries choice of sensor depends on the application. For example in process industries availability is required, In mining sector machine accuracy is in highest priority, Iron and steel plants wireless and smart sensors are required, In chemical and Petrochemical industries accuracy and processing is of more importance, In the food & beverages industry product quality sensors are required, Proximity and safety are considered for power plants. It can be concluded that, in the present scenario automation needs to be smart which can be achieved with the help sensors.

Sensors also play an important role in the automotive sector. For example in manufacturing, sensors are used to measure the thickness of coating when a car is being painted. Micro- Epsilon designed the eddy current displacement sensors and placed them inside the piston to measure the displacement. Faults detections in tires is done with the sensors by Micro-Epsilon to help automotive OEMs. "Automotive Industries, Johann Salzberger, Marketing, Micro-Epsilon and Karl Wisspeintner, managing director, Micro-Epsilon", Issue: Jul 2007 [ai-online.com].

Sensors are also the crucial parts of vehicle safety systems. It main task of sensors in safety system is recognizing accident events and activate and control crash avoidance. When any accident happens, controlling airbags and seat belt pre tensioners according to the impact of accident is a crucial decision taken by the sensors. Driver assistance system based on camera is developed to control the vehicle in the lane and pedestrian can be recognized. Vehicle brake system activation in case of multiple collisions in order to reduce the crash severity. Inertial sensors are used to monitor the vehicle movements. GPS and C2C2X plays an important role in future of automotive safety [edgefx.in].

1.3 Road Safety Rules in India

In the early 20th century there was no serious need for rules and regulation for the traffic control in India, due to very less number of vehicles on the roads. But

by 1914 roads flooded with vehicles of different class due to revolutionary start of mass production of vehicles.

India had its first motor act in 1914 "Indian Motor Vehicle Act 1914", since then regular upgradation is processed time to time as per requirement. The motor act 1914 was amended and revised in 1988 which was known as "The Motor Vehicle Act 1998". The rules and regulations are not only for the drivers but also for the pedestrians, cyclist, traffic signs and markings. The motor vehicles Act, 1939 consolidates and amends the law. In 1984 a revision along with suggestions and recommendations was proposed for Motor Vehicle Act 1939 by Central Institute of Road Transport (CIRT), Automotive Research Association of India (ARAI), and other transport organizations. Then in 1987 the supreme court had made changes to the compensation payable in respect of death and permanent disability. Act 39 of 2001 was amendment in Motor Vehicles Act, 1998 for road transport regulatory. Motor Act, 1994 were made provisions under 66 & 67 to provide exemption from the requirements of permit. The traffic rules awareness prevents the accident and develop a healthy and safe traffic system [ifros.org].

In India road safety rules are designed adequately provided the people follow it. Some of the road safety rules in India for driving are as follows-

- Eligibility age for driving license is 18 years and above.
- Using Mobile phones are prohibited while driving.
- Wearing seat belt is mandatory for four wheeler driver and the person sitting next to driver.
- Driving with drinking is prohibited.
- Unnecessary honking is prohibited near the hospitals and schools.
- Speed limit for vehicles has been set for some defined areas.
- Jumping red light is an offence.
- Wearing helmet is mandatory for driving two-wheeler.
- Cyclist should keep left on road.
- For license knowledge of sign boards is must.

- Pedestrians should walk on the footpath and cross the road at zebra crossings.
- Bus stops are made for boarding the bus by commuters.

These rules are made for the safety of the people and everyone should follow them for their own safety. The ministry of roads, transport and highways in India is in process of identifying the blackspots on the roads so that proper preventions can be taken. A black spot is area where in three calendar years either 5 accidents or 10 fatalities took place [indiatransportportal.com].

Road Safety council in India is formed to take prevention against any mishap. Surveys shows count of road accidents in India is highest in the world. The road safety council in India is formed to measure and enforce the safety rules. Government organizations work collectively with the councils to address the problems and to get innovative solutions for the road safety. The periodic upgradation in laws helps in preventing mishap rate on roads.

The council is formed to achieve E's of road safety [ifros.org]-
- Educate the people about road safety.
- Engineering of roads.
- Engineering of Vehicles.
- Emergency on the roads.
- Enforcements of the laws for roads.

The trauma on accident due to the violation of road safety rules needs to be considered seriously.

One of the major reasons of deaths due to accidents of two-wheeler is not wearing helmets. Sometimes it also leads to serious injuries. Safety is the precaution everyone needs to follow. Government is also taking help of technology for safety rules [indiatransportportal.com].

In India the safety of two-wheeler is a serious concern to the traffic department. As two-wheeler is exposed to the weather conditions and also to road

conditions, so the drivers are always encouraged to wear helmet to prevent head injury in case of any accident.

To control the accident rate of two-wheelers some rules are set like not to overtake the other vehicle on wrong side and wearing helmet is compulsory for both the driver and passenger [assamtransport.gov.in].

In India 60% of total motorisd vehicles are two-wheeler. According to hghway ministry death rate due to accidents is increasing yearly, it has been increased by 25% in 2012 as compared to 2009 [jotr.in].

According to records by Regional Transport Authority's in Mangalore, total 1231 two-wheeler accidents were on the roads during 2000 to 2004. Maximum accidents occurred between 6p.m to 10p.m and 77% of the victims were between 18 and 44 years old including 83% males and 17% females. Results also show that gearless vehicles accidents results in more deaths.

According to National Transportation Planning and Research Center (NTPRC), the number of road accidents in India is three times more than the developed countries.

Lack of protection like helmets has led more deaths on two-wheeler accidents because most of the accidents occurred due to bad road conditions. The statics shows some innovative idea needs to explore to prevent deaths due to not wearing helmets [east.org].

1.4 Background of Road Accidents in India

"In India 382 kills in road accidents, which is 1,682 times more than terrorism". A Road Traffic Accident (RTA) is defined as, "A collision on a public way where moving vehicle is involved, causing injury or death of one or more persons".

Due to road accidents approximately 1.3 million people die, which is predicted around 1.9 million annually by 2020 and 20-50 million people suffers by non-fatal injuries. Road accidents are one of the top most reasons which cause of the death of 15-29 years youngsters [en.wikipedia.org].

In 2012 maximum road accidents occurred in Tamil Nadu counting 67,757 which is 15.4% of total accidents in India. 10.9% road accidents reported by Uttar Pradesh, 10.8% by Andhra Pradesh, 10% by Maharashtra were reported. The death rate in Jammu & Kashmir was reported 69.6%, in Nagaland 67.5%, in Uttar Pradesh 53.5% and in Andhra Pradesh 51.9% were reported.

For the mega cities with population of at least 10 lakhs, in 2011 maximum road accidents 9,663 were reported in Chennai results in 1,401 deaths followed by Delhi with 5,865 cases and 1,527 deaths. In Bengaluru 5,508 accidents were reported with 725 deaths. In Lucknow 97.6% and in Asansol 81.2% death rates were reported.

In 2008-09, 7.8 million two-wheelers were purchased in India annually and the approximate sale in 2016 was 15 million. India suffers from highest death rate due to road accidents which is around 1, 05,000 annually, owing to the poor infrastructure and dangerous driving habits of drivers. Around 27% of the road-related deaths victims are riders of motorized two wheelers. It is observed that major reason for accidental deaths by two-wheeler are due to not wearing helmet. In 2012 total 35.2% of accidents caused deaths of victims from which 23.2% were on two-wheelers. In 2012, month-wise data shows May month had maximum accidents with 8.8% followed by April 8.74%, January 8.72% and least number of accidents were in September [en.wikipedia.org].

In 2008, total 96,000 were injured and 5,290 motorcyclists, as per records of National Highway Traffic Safety Association. More than 50% of fatalities turned into death, due to head injuries. The majority of drivers approximately 90% of victims had head injuries with other injuries. In 2011, total 4,97,686 road accidents occurred which is increase by 24.4% from 18.1% since 2002.

National reports by Transport Research Wing, Ministry of Road Transport & Highways with National Crimes Records Bureau of Ministry of Home Affairs, Government of India describes India contributes 0.7% publications on road injuries, which shows the need of local evidence research initiatives taken by professionals. According to National Crime Records Bureau (NCRB), dangerous

driving and over speeding were major reasons for road fatalities. While 13,787 were killed on two-wheeler, 23,529 were killed with other vehicles. In 2014 total 30% of the deaths due to accident were on two-wheeler. According to World Health Organization 72% of severe head injuries can be reduced by wearing helmet.

The existing systems don't provide any detection of wearing helmet and human authentication to ignition of two-wheeler. So it's very important that the responsibility is shared by just not the owner of the bike but even by the manufacturer of bike [bhsi.org].

1.5 History and Types of Helmets

The requirement of helmet [lashelmets.com] arises from the bike racers due to head injuries when they fell down during racing and the first helmet was invented by Bell Auto parts in 1975. It was made of a plastic shell padded with form. In 1974 a survey on protection by helmet brands was done by Washington Area Bicyclist Association and need of standardization arises.

The standards for helmets were first introduced in 1984 by The American National Standards Institute and were widely accepted. Testing of helmets was started in 1980's by Dr. George Snively of the Snell Foundation and WABA's. The first workable helmet standard for the US was introduced in 1984 by ANSI headgear committee. Chrono helmet were developed for Olympics in 1980's. Earlier to 2002 all helmets [law.resource.org] were without impact protection after that Louis Garneau introduced the helmet, which met the US CPSC standards. In 2006 CASCO Warp II helmet was introduced in Europe, it was designed for track racer with round and smooth design.

Types of Helmet
- Full face
- Open face' or ¾
- Off road/ motocross

- Modular

- Half

General Size Parameters [pc-control.co.uk]

- Extra-small helmet: below 20" (51cm)

- Small helmet: 20"–21.75" (51cm–55cm)

- Medium helmet: 21.75"–23.25" (55cm–59cm)

- Large helmet: 23.25"–24.75" (59cm–63cm)

- Extra-large helmet: above 24.75 (63cm)

- One size for all (male) helmet: 21.25"–24" (54cm–61cm)

- One size for all (female) helmet: 19.75"–22.5" (50cm–57cm)

- One size for all (children) helmet: 18"–22.5" (46cm–57cm)

Helmet Standards [ca.com]

International Standards

Snell M-2005, M-2010, CMS/CMR 2007, DOT FMVSS 218

Indian Standards

IS No.	Specification
1884 : 1981	Specification for electric horns
7692 : 1993	wooden head-forms Specification for testing of helmets
9695 : 1980	Helmet sampling methods
9779 : 1981	Sound level meters specification
9844 : 1987	Testing for corrosion resistance methods

Latest Revision of Standards

Protective Helmets for two wheeler riders – Specification (Fourth Revision of IS 4151) ICS No. 13.340.20;43.140.

1.6 Role of Authentication in Security

Security is a system where only authenticate or authorized person can access the data to protect it from intruders. The difference between authentication and authorization is very clear and needs to understand. Authentication is the process of verifying the user's identity which is done by comparing the credentials with the stored database. Authorization is the process of granting rights to user for checking user account. It depends on the level of access to data for a user. Authentication can be categorized into two parts- user authentication and machine authentication. User authentication is the process of authentication user needs to choose a unique ID and provide password for the same.

The process can be wired or wireless depending on the demand of the system. In the machine authentication credentials are like a user's ID and needs to submit password only by the device in question. Secure communication for home automation is an example of machine authentication. In the most of computer networks (including IoT), it is done through login ID and passwords. But it is observed that password based authentication is weak method of authentication due to possibility of being stolen or forgotten of the password. It generates the needs of the new methods of authentication to be explored. Some of the authentication factors are as follows-

- Knowledge factors – It is a category of authentication where user possesses personal identification number (PIN) along with answer to a secret question.
- Possession factors - a category of where user has some hardware device like security token to access the data.
- Inherence factors - a category with biometric information as authentication of user.

Some of the most used methods are fingerprint authentication and smart card authentication. Smart cards hold a small chip which stores the private keys and authenticate a person to the system. ATM card is best example for this type. Also RFID based cards are part of this category where a unique code is matched with

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predefined data and only authenticate the user if it is same. Biometric authentication is even more secure authentication method like fingerprint & iris patterns are unique to each person and can be used for verifying the authenticity.

1.7 Background of Communication Media

Comfort at low cost and less energy consumption are important parameters to be considered in the smart cities. Wireless is preferred media for the communication in intelligent systems. Internet of things is new advanced method to float data on the cloud so that it can be accessed from any place of the world. Apps on android mobile phone provide a vast platform for remote controlling of the systems through SMS or voice command, but it need some protocols to operate globally.

For short range [assamtransport.gov.in] communication many wired and wireless modules are available. X10 is one of the known protocols which operates on 120 KHz and uses power line bandwidth without inference with power signals. Other protocol is Insteon invented by Smart Labs working on AC power and RF protocol. To avoid the complexity of wires, wireless communication comes in the role. IR remote control is a low cost solution to control the electronics devices but having limitation of line of sight. To overcome this limitation RF modules come into the role in many applications in smart cities. RF module operates on license free ISM band with IEEE 802 family standard. In India RF modules works 2.4 GHz & 433 MHz. For Europe, Africa, Former Soviet Union the frequency band is 434 MHz, in US it is 315 MHz. Wi-Fi module, Bluetooth, RF 2.4 GHz, RF 433 MHz all comes in ISM band frequency bandwidth. On the basis of features Zigbee can be used as communication module for sort range communication.

Internet of things (IoT) is latest solution to access the data from anywhere in the world. Internet of things can be defined as any object with an IP address and is capable of collecting and transferring data over a network without human intervention. IoT can connect devices of various systems with the internet. A

thing in the Internet of Things can be a health monitoring system or an automobile with sensors to alert the driver about vehicle parameters.

1.8 Motivation for Current Work

The rapid growth of population [56] with increased economic activities has been favored in tremendous growth of vehicles. It is one of the main factor responsible for road accidents. To avoid the road accidents many initiatives are taken by the govt. and researchers. In 1991 a study on the impact of helmet usage on motorcycle crash is discussed. It is concluded that helmets are helpful in reducing the impact of head injuries during motorcycle crash and reduces the cost of health issues than non-helmeted people.

A system is invented [18] in 2006, to provide facility to rider to listen and reply to a call coming to rider's mobile phone, for safety point of view without actually holding mobile phone in hands. It is done by using two different frequencies for transmitter/receiver modules attached with in helmet.

A study [65] on education on wearing helmet and correct method of wearing it was carried out in 2007. Study has been taken on three middle schools. The behavior of children inside the school and away from close proximity of the school has been studied. The study shows different behavior of children during morning and afternoon time.

In 2008 [22] a review was carried out on road behavior, accident reasons, road safety and also gives analysis on number of killed and serious injured victims. Paper raised the need of more proper and accurate management from government to reduce the deaths due to road accidents.

A wireless communication [66] was invented in 2010 in form of a helmet having inbuilt Bluetooth device to handle mobile phone or other Bluetooth devices while wearing helmet.

In 2011 [83] a Zigbee based system was proposed to prevent vehicle collision by generating a warning signal. The proposed system is low cost and reduces complexity of radar signal processing. In 2014 [32] a system was designed to send

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a warning signal to rider of bike to wear helmet when hazards is ahead. System also includes a MP3 player to listen to music while riding .

From the literature and studies it is observed that the reasons for major injuries two wheeler rider is not wearing the helmet while riding and the increased road accidents are major social problem due to loss of lives and human miseries.

On the basis of research gap a novel system in form of an intelligent helmet is proposed in this thesis. System also provides the authentication, which act as anti-theft system for the vehicle. Secondly even after authentication, the system doesn't allow rider to ignite the vehicle until he/she wearing helmet, which is important from safety point of view. The guardian who are worried for safety of their wards on road while driving, will get a solution in form of the developed system.

1.9 Objectives

The main objective is Modelling, Optimization and Implementation of Sensor Nodes to Authenticate Ignition of Two Wheeler.

Sub objectives

- Modelling of sensor nodes to authenticate the ignition of two wheeler
- Circuit simulation and performance analysis of the model
- Prototype development of the designed model
- Testing of developed prototype.

1.10 Thesis Organization

The Thesis is divided into eight chapters, according to the need of description of research work step by step so as to make the concept and results clear.

Chapter 1 is introduction to key words of designed system including introduction to the road safety rules in India, background of road accidents history, types of helmets and role of sensor nodes and authentication. Objectives

are concluded on the basis of research gap from prior art and motivation for the need of research.

Chapter 2 is the literature review, a sufficient review has been carried out to describe the existing art, by referring various research papers published in reputed journals. It includes the conclusion from existing art.

Chapter 3 explains the complete description of the working of the system with the help of block diagrams and circuit diagrams for both the sections (Two-wheeler section and Helmet section). Brief description of all the components used is also included in the chapter. Proteus simulation models are designed to check the feasibility of the circuit operation.

Chapter 4 describes the complete methodology to develop the system.

Chapter 5 explains the chip development and its results for the system.

Chapter 6 explains the experimental results analysis of the developed system

Chapter 7 includes major outcomes with conclusion and future scope of the system. The chapter also discusses the novelty of the developed system.

Chapter 8 elaborates the research publications with description for the current research, for the duration of research to support and prove the validity and originality of work.

1.11 Chapter Summary

This chapter gives brief introduction to keywords of the system and brief description of the history. The chapter includes the role of the sensors and security in the automation. It is concluded that for automation of any system some sensor needs to be implemented depending on its application. Introduction also includes the need and motivation of the current work.