

[Design and Fabrication of Smart Helmet]



SESSION: 2019 - 2023

Design Team

- 1) Saeed Afridi [Cu-1054-2020]
- 2) Ali Ahmad [Cu-1629-2020]

Supervisor Name = Engr. Muhammad Irfan khan

Co-Supervisor Name = Engr. Hashim Khan

**Department of Mechanical Engineering, Faculty of Engineering
CECOS University of Information Technology and Emerging
Science Peshawar, Pakistan**

DATE: / /

Approval Page

This is to clarify that the work contained in this thesis entitled "Design and fabrication of smart helmet" by my students "Ali Ahmad", "Saeed Afridi", was carried under my supervision and in my opinion, is fully adequate in scope and quality for the degree of Bachelor of Sciences in Mechanical Engineering.

Name (Supervisor)

Name (Internal Examiner)

Name (External Examiner)

Dedication

1) The Messenger of Allah, may God bless him and grant him peace, said: "Whoever sets out to acquire knowledge, he will be (numbered) in the way of Allah until he returns." (Sunan Tirmizi Hadees No # 2646)

2) The Holy Prophet (peace and blessings of Allah be upon him) said: "Whoever acquires knowledge, it will become an atonement for his past sins." (Sunan Tirmizi Hadees No # 2647)

We dedicate this work of ours to our loving parents, talented teachers, and hardworking

Copyright

We the Team Members

Team Members:

1. Ali Ahmad
2. Saeed Afridi

Email address:

ali.ahmad.me-2020a@cecosian.edu.pk

saeed.afridi.me-2020a@cecosian.edu.pk

Faculty Co-advisor

_____ Email: _____

And faculty advisor

_____ Email: _____

Hereby assign our copyright of this report and of the corresponding executive summary to the Mechanical Engineering (ME) Department of CECOS University.”

Publication of this report does not constitute approval by CECOS University, the ME Department or its faculty members of the findings or conclusions contained herein. It is published for the exchange and stimulation of ideas.

Abstract

Safety and security in vehicle travelling are pre-eminent concern for all. With the rapid urbanization and staggering growth of transport networks like two-wheeler vehicles, safety on the roads and security on the bike has emerged as an inescapable priority for us. It has expanded the rate of accident, which lead to several damages with loss of lives. The need for advanced safety measures to protect riders on the road. This paper presents the design and fabrication of a smart helmet specifically tailored for bike riders, integrating innovative technologies to enhance safety and connectivity.

The smart helmet incorporates a range of sensors including accelerometers, gyroscopes, and GPS modules to monitor the rider's movements, detect sudden changes in speed or direction, and track their location in real-time. These sensors are seamlessly integrated into the helmet structure, ensuring minimal interference with the rider's comfort and mobility.

In addition to safety features, the smart helmet also prioritizes connectivity, enabling riders to stay connected with their smartphones and other riders within a network. Through Bluetooth or Wi-Fi communication, riders can receive notifications, make hands-free calls, and share their location with friends or emergency services in case of an accident or distress situation.

The fabrication process emphasizes lightweight materials and aerodynamic design principles to minimize wind resistance and maximize comfort during prolonged rides. Advanced manufacturing techniques such as 3D printing and CNC machining are employed to achieve precise integration of electronic components while maintaining structural integrity.

In addition, in the design we follow (ECE 22.06) Standards and all the test in which we applied on the helmet is (ECE 22.06) Standards

Acknowledge

First and foremost, praises and thanks to the Allah Almighty, for His showers of blessings throughout our project. I am grateful to the Allah for good health and wellbeing that were necessary to complete this thesis.

First and foremost, we want to thank **Engr. Muhammad Irfan Khan** Academic Coordinator of Mechanical Engineering for his regular encouragement of our whole FYP journey. His understanding with students, and communication are very appreciated. Always gives us time when we need some help.

Secondly, we would like to thank our family for all the time support and encouragement throughout life. We also thank to our co-supervisor **Engr. Hashim Khan** lab supervisor of Mechanical Engineering who help us in software used in our FYP project.

Special thanks to Dr. Naseer Ahmad (Vice Chancellor of CECOS University) for giving us the opportunity to take on his FYP project.

Table of Contents

- Approval Page..... ii
- Dedication iii
- Copyright..... iv
- Abstract v
- Acknowledge vi
- Table of Contents..... vii
- Chapter 01
- 1 INTRODUCTION.....1
 - 1.1 Overview2
 - 1.2 Motivation.....2
 - 1.3 Accidents.....3
 - 1.4 Accidents Detection system7
 - 1.4.1 Manual Detection System7
 - 1.4.2 Driver Initiated System9
 - 1.4.3 Automatic Detection System10
 - 1.5 Objectives10
 - 1.6 Components.....11

CHAPTER 01

INTRODUCTION:

OVERVIEW:

Motorcycles have become a prominent mode of transportation, particularly in Asian countries, and people are becoming more interested in motorcycling as an alternative to car travel and public-transportation to reach any destination easily. In our country, road accidents particularly, motorcycle accidents have currently become one of the most critical issues. [1] A traffic accident is defined as any vehicle accident occurring on a public highway. These accidents therefore include collisions between vehicles and animals, vehicles and pedestrians, vehicles and fixed obstacles. [2] Accidents occur for a number of reasons, such as over-speeding, overtaking another bike, driving alcohol, bad environmental conditions, dozing while driving etc. As a result, many people died and were injured due to a bike accident. Sometimes the person got injured in an accident may not be directly responsible for that accident, it may be fault of something else, but at the end of the day it is the people involved in the accidents who are going to suffer. More than 80% of all motorcycle crashes result in injury or death to the motorcyclist. A motorcyclist is 16 times more likely to die in a crash than a car driver per mile driven. Wearing a motorcycle helmet decreases this hazard by almost one-third (29%). Now, head injury is the leading cause of death in motorcycle crashes. Riders who do not wear helmets and have an accident are 40 percent more likely to have a fatal head injury. A study of 900 motorcycle crashes (led by the University of Southern California) showed that wearing a helmet was the single most critical factor in the prevention or reduction of head and neck injuries among motorcycle drivers and passengers. From 1984 through 1995, helmets saved the lives of more than 7,400 motorcyclists. But more than 6,300 additional deaths could have been avoided if all riders had been wearing helmets. Studies show that legislation requiring the use of helmets is very effective in reducing motorcycle deaths, as such legislation impacts more people wearing helmets. If no action is taken, road accidents are expected to result in the deaths of about 1.9 million people per year by 2024. [3] If accident is one issue lack of treatment in proper time is another reason for deaths. Nearly half of the injured people die due to lack of treatment in proper time. Late arrival of ambulance, absence of people at the accident site to inform the family in proper time or to provide the victim first aid.

Considering four main factors for preventing the causes of an incident, such as:

1. Consider wearing the helmet mandatory.
2. Avoid getting drunk and driving.
3. Alarming the biker when he's in a drowsy state.
4. Not getting treatment at proper time after conducting accident

1.2 Motivation:

The thought of developing this project comes to do some good things towards the society. Day by day, the two-wheeler accidents are increasing and leads to loss of many lives. According to a survey of Pakistan bureau of statistics, there are around 10,379 accidents due to bike crashes per year. The reasons may be many bike, fast riding of the bike, drunken, drive, and dozing while driving. Sometime the person gets injured, the rider may not be directly responsible for the accident, it may be fault of rider, but end of the day it is both the drivers involve in the accidents who is going to suffer. If accident is one issue, lack of treatment in proper time is another reason for deaths. According to survey in Pakistan bureau of statistics (PBS) 10,379 accidents occur per year, nearly half of the injured people die due to lack of treatment in proper time. Many reasons for this are late arrival of ambulance, absence of pupil at the accident site to inform the family or to provide the victim first aid.

Considering four major factors for reducing loss due to bike accidents are:

1. Make wearing the helmet compulsory.
2. Avoid drunk and driving.
3. Alarming the biker when he is on drowsy condition.
4. If the rider met with an accident and there is no one to help him. Simply leaving or ignoring the person he may die. In such situation informing to family member or caregiver through mobile to rescue him to an extent.

So we thought of this work is to give information about the rider wearing the helmet or not, whether the rider drunk and or not, whether he is on dozy condition or not and also if he met with an accident it gives an information about location where he is met with an accident through GPS and with GSM module sending a message to mobile number of the caregiver.

1.3 Accidents:

Automotive vehicles mainly used for rapid transportation of people and goods. To go home, workplace and most of the ordinal movements requires vehicles. Generally, they are considered safe until accident took place with bad impact. According to Wikipedia, an accident, also known as an unintentional injury, is an undesirable, incidental, and unplanned event that could have been prevented had circumstances leading up to the accident been recognized and acted upon prior to occurrence. [4] Most scientists who study unintentional injuries avoid using the term "accident" and focus on factors that increase risk of severe injury and that reduce injury incidence and severity. Most of the road users are quite well aware of the general rules and safety measures while using roads but it is only the laxity on part of road users, which cause accidents and crashes. Main cause of accidents and crashes are due to human errors.

Following are the major reasons of accidents:

1. Over Speeding
2. Driving by alcoholic drivers
3. Environmental distractions to Driver
4. Avoiding safety equipment like Seat belts and Helmets
5. Overtaking in a wrong manner.

1.4 Accident detection system:

It detects the accident rather than predicting it. They are of three types.

1. Manual detection system
2. Driver initiated detection system
3. Automatic detection system

1.4.1 Manual Detection System:

In this method, accident is detected from.

- Motorist report
- Transportation department

- Public crews report
- Aerial surveillance
- Close circuit camera surveillance

The drawback of this type of detection system is that someone has to witness the Incident. Driver initiated detection system. Moreover, there are delays and Inaccuracies due to the expression problem of the witness.

1.4.2 Driver Initiated System:

Driver initiated system is more advantageous than manual detection as it includes the quick reaction by the driver about the accident information. However, with the severity of the accident, driver may not be able to report at all.

1.4.3 Automatic Detection System:

The proposed method is one of the automatic detection System. The system will run whenever the vehicle is turned on automatically.

1.5 Objectives:

Main objectives of this project are:

1. To detect the driver worn helmet or not
2. To detect different unable conditions (Alcohol and Sleepy mode detection)
3. To find and send information to care giver about location of the accident using GPS & GSM module.

Chapter # 02

Concept
Synthesis

2.1 Introduction

Different types of attempt have been taken to develop a helmet with distinguished about safety of biker. A number of works done on this field of study.

2.2 Literature Review

2.2.1 S. Tapadar et al. [8]

Explain a helmet made for alcohol detection, accident detection and helmet wear detection and the helmet can connect to any smartphone via Bluetooth so that it can communicate with the server using smartphone internet access. A protective helmet can be traced when a person wears a helmet, using pressure sensors, which are enclosed in a foam padding. A helmet can detect the potential danger, using a board-based accelerometer and pressure sensor

2.2.2 M. K. A. Mohd Rasli et al. [7]

Focus on the small control that is used in this project to control the system. The little controller used to run the project is the Peripheral Interface Controller (PIC) 16F84a. PIC is an 8-bit control. With a small number of inputs and outputs, PIC kit software is required to write a program in the basic language of integration. In addition, the Force Sensing Resistance (FSR) and the speed sensor (BLDC Fan) are used as sensors to run the project.

2.2.3 Divyasudha et al. [9]

Say that IOT based protective helmet that predicts trafca accident and detects alcohol consumption will be able to track the motorist and send GPS coordinates periodically to the predefined number. Also, it receives a crash and will be able to send a notification to a predefined number and to the nearest police station. The system contains a small controller, position sensor, alcohol sensor, piezoelectric sensor, RF Transmitter, IoM Modem, GPS receiver, Power supply and solar window.

2.2.4 K. Vidhya et al. [6]

Have shown the intention to create a defense system in the safety helmet for good motorist safety. A smart protective helmet with nerves that work to track if the helmet is worn or not. To avoid accidents, they make accident detection, theft and drive protection using the smart wireless safety helmet. It contains an intelligent system attached to a helmet and a motorcycle. The helmet unit ensures that the motorist wearing a helmet and should not come under the influence of alcohol during the journey. It contacts the vehicle unit to turn off the ignition system of the motorcycle if the above condition is not met. By using geometric links, the location of the injured motorist can be tracked using the global positioning system tracking app. By using this program, a motorcycle safety trip is possible which can reduce head injuries during accidents and reduce the risk of accidents due to driving after drinking alcohol.

2.2.5 The system discussed by Prashant Ahuja et al. [4]

Requires Arduino microcontroller (Atmega 328), where various sensors are used to detect danger, integration of GSM technology (Arduino GSM Shield) is done to provide information by sending a message that includes the location of GPRS in the message you are sending in the registered number will have a complete description of where and when the accident happened. The purpose of the proposed project is to inform the responsible persons at the earliest about the accident so that they can take the necessary steps to save the life of the injured person.

2.2.6 V. Surange et al. [3]

Illustrate the severity of the adverse effects of the identified risks that is related to five different criteria: economics, factory operations, corporate reputation, scheduling, and final product/process quality, is considered in the prescribing decision matrix. The overall ranking was informed by his seven experts in India's leading automotive industry. Among the identified risks, 'delay risk', 'management risk' and 'supplier risk' are ranked as the top three risks facing the Indian automotive industry

2.2.7 After identifying the risks, V.Surange et al.

Discuss the ordered priority and similarity to ideal solution (TOPSIS) [10] methodology to consider five different above criteria to determine the vehicle's severity based on the severity of the adverse impact. Rank the risk factors that are important to supply chain. Table 1 shows how technology can be felt year after year in a protective helmet.

2.3 RESEARCH GAP IDENTIFICATION

3. Vibration sensors or shock sensors are used in past projects which results sometimes detection of illogical & erroneous output as many roads are not smooth in most of the countries of Asia. As a result, natural vibration does occur. In this case, tilt sensor is much simple and gives accurate reading with the help of gravitational forces.
4. There is a tendency of the driver to wear helmet only where the checking may take place, they do not wear helmet where no checking is done. In this case, previous cases did not give importance on obligatory environment of wearing of helmet. This project allows a compulsion for wearing the helmet. Otherwise, bike engine remains shut down.
5. The vehicle may be turn on or may be stolen by passing the ignition switch. On the other hand, vehicle may be carried away with support of another vehicle. Anti-theft functionalities were absent previously or separated along with other singular projects. Which would be a challenge

for the portability of any safety modules. Current work gives a solution for this type of drawback and includes simple procedure.

6. Raspberry Pi, Arduino UNO or ARM7 was used in previous projects, which is too costly & programming language is difficult to handle. MCU PIC16F876A & PIC16F73 is much easy solution for smooth programming and handling/responding the sensor databases.
7. Previous projects expressed significant values on cloud system for the detections & communications. In this case, it has to be notified that cloud system has limitations outside the metro area and sometimes latency does fall that results delayed response from the server. For this purpose, global GSM/GPS technology have been utilized for the detection of real time locations and data transfer.
8. Most reports highlighted the report based on 4 wheelers scenarios, where the nature of bike is much different as it includes helmet and outer layer free ridings. That is why, two-wheeler solution is given importance in current work.
9. Some projects advised modem system for receiving the GSM/GPS signal which is a drawback in current scenario as it requires more electricity supply and separated connections are needed. There exists latency problem while in riding conditions that causes delayed responses. Current work supports any sort of smart devices for transferring the data without any extra medium or layer
10. Reducing production costs while maintaining quality is another gap, which can be addressed by innovative manufacturing techniques like 3D printing. Finally, adapting the **ECE 22.06** standards to include smart technologies is necessary, requiring expanded criteria to ensure safety and functionality.

2.4 CONCEPT GENERATION

1. Modular Sensor Integration

- Concept: Develop a modular system where sensors and electronic components can be easily attached or detached without compromising helmet integrity.
- Details: Use flexible circuits and shock-absorbing mounts to ensure sensors don't affect the helmet's protective properties.

2. Advanced Composite Materials

- Concept: Use advanced composites like graphene-infused carbon fiber to create a lightweight yet strong helmet shell.
- Details: These materials provide high strength-to-weight ratios, maintaining

helmet safety while accommodating additional electronic components.

3. Hybrid Power Systems

- Concept: Integrate a hybrid power system combining rechargeable batteries with solar panels and kinetic energy harvesters.
- Details: Solar panels on the helmet surface and kinetic energy harvesting from head movements can extend battery life and reduce the need for frequent charging.

4. Durable Encapsulation of Electronics

- Concept: Develop a durable encapsulation technique for electronic components to protect them from environmental factors.
- Details: Use waterproof and impact-resistant casings that can withstand moisture, dust, and shocks without adding significant weight.

5. Voice-Activated Control System

- Concept: Implement a voice-activated control system for hands-free operation of smart features.
- Details: Integrate a microphone and voice recognition software to allow users to interact with the helmet's functionalities without distraction.

6. Minimalistic HUD (Heads-Up Display)

- Concept: Design a minimalistic HUD that provides essential information without obstructing the user's field of view.
- Details: Use transparent OLED displays to show data like speed, navigation, and alerts directly on the visor.

7. Comprehensive Impact Testing Protocol

- Concept: Develop a comprehensive impact testing protocol specifically for smart helmets.
- Details: Create testing scenarios that account for the added weight and electronics, ensuring the helmet still meets or exceeds ECE 22.06 standards.

8. 3D Printing for Custom Fit

- Concept: Utilize 3D printing technology to create custom-fit helmets for each user.

- Details: Scan the user's head to design a helmet that offers maximum comfort and protection, then print using high-strength materials.

9. Cost-Effective Manufacturing Processes

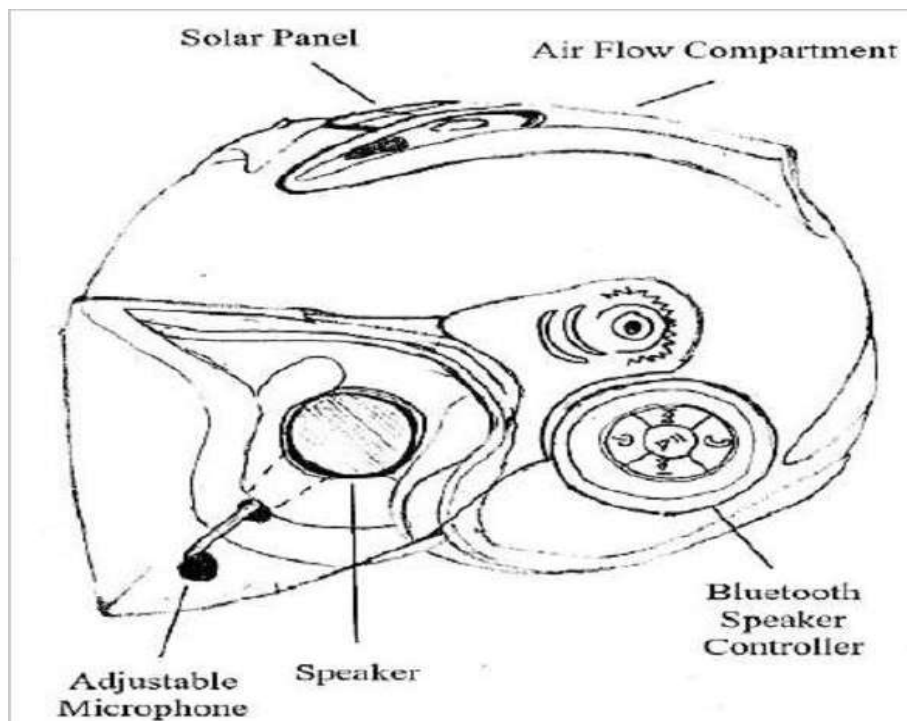
- Concept: Implement automated manufacturing processes such as robotic assembly and injection molding.
- Details: These methods can reduce production costs while maintaining high quality and consistency, making smart helmets more accessible.

10. Expanded ECE 22.06 Criteria for Smart Tech

- Concept: Collaborate with regulatory bodies to expand ECE 22.06 criteria to include smart technology.
- Details: Develop guidelines and standards for integrating electronics in helmets, ensuring safety and functionality are both addressed in certification processes.

These concepts aim to address the key research gaps in designing and fabricating smart helmets, ensuring compliance with **ECE 22.06** standards while enhancing safety, functionality, and user experience.

Our main work is that we fabricate the helmet with ECE22.06 standard



The concept design shown in Figure 1 is a half face helmet with basic equipment such as a helmet visor and an air flow channel. The additional components in the concept design include a pair of mini speakers, a Bluetooth speaker controller with quick access buttons, an adjustable microphone, and a solar panel on the top of the helmet as a power source.

The speakers will be installed inside the helmet near the ears of the user. They are fixed at the right distance from the ear and sponge pads will be fitted to it for comfort. The speakers will be connected to the waterproof Bluetooth speaker controller which will act as the main controller for the whole Bluetooth system of the helmet. It is located just outside of the helmet on the left side. The controller has five quick buttons to ease rider accessibility on this Bluetooth device. Moreover, there is an adjustable waterproof microphone on the right edge of the helmet positioned towards the mouth of the user. The stem of the microphone is pliable and its length can be adjusted accordingly, so that it does not become a distraction for the rider when in use. Furthermore, all the electrical components will be powered by the solar panel, which is located on the top of the helmet. The placement of solar panel is slightly towards the back, near the airflow compartments to reduce the heat produced by the solar panel. In addition to that, the slightly raised air flow channel acts as a protection for the solar panel to reduce damage if the helmet falls upside down. The wires and cables are routed behind the liners of the helmet for comfort. The solar panel is also coated with heat insulating materials on the inner part to prevent heat from the panel reaching the user's head. Lastly, sponge pads are inserted inside of the liner to ensure user comfort due to the additional components inside the helmet

2.5 Summary:

Past researches and their limitations have been discussed in this chapter. In perspective of Pakistan this system is very effective for the safety purpose of the user. User has to wear helmet to ride a bike and hence traffic rules will be followed by the rider. This system is under pocket control i.e. riding the two wheelers vehicle having safety in hand and in budget. This system has easy functionalities. It provides a better security to the biker.