Smart Helmet

B.E SENIOR DESIGN PROJECT REPORT

Electronics Specialization

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2023

COMPLETION CERTIFICATE

DEPARTMENT OF ELECTRICAL ENGINEERING
CERTIFICATE OF FINAL YEAR PROJECT SUBMISSION

This is to certify that the project titled: **Smart Helmet** has been submitted on DD/MM/Year: 01/06/2023 to the Department of Electrical Engineering in partial fulfillment for the Degree of Bachelors in Electrical Engineering by the following students.

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Figure: Receiving an award from PEC.at a ceremony held in Multan, Nov. 24, 2022

KEYWORDS

Arduino-IDE, Force sensitive resistor, Global Positioning System, Infrared Radiation sensor, MCU, Smart helmet

List of Abbreviations:

IR: Infrared Radiation

FSR: Force Sensitive Resistor

GPS: Global Positioning System

MCU: Microcontroller Unit

SIM: Subscriber Identity Module

UNSDG: United Nations Sustainable Development Goals

NAE: National Academy of Engineering

ABSTRACT

The number of bike riders in Pakistan is increasing exponentially. Being economically feasible and convenient the lower middle class relies on motor bikes as the main mode of transportation. Unfortunately, the risk of road accidents due to bike-riders is much higher than drivers of other vehicles. Not wearing of helmet is an important factor resulting in fatality or head injuries. Usage of helmet and enforcement of road safety measures can prevent fatal head injuries. The occurrences of accidents is not in our control but taking preventive measures to avoid fatal injuries is in our hands. Mostly, the bikers don't wear helmet because they choose comfort over safety. We therefore need to solve this problem by inculcating the culture of wearing a helmet. This will reduce the risk of head injury to bike riders. This project aims at providing safety to the bike riders by adding the following features to the helmet:

- Identify when a rider is wearing the helmet;
- Speed Monitoring
- Route Monitoring via GPS device
- Be able to connect to the rider's phone for further updates
- Crash alerts
- GSM device with SIM
- Connection to a smartphone – to send SMS and GPS directions for location.
- Alert notifications to the preferred emergency contacts in case of any mishap;

This project also includes an application that indicates a red helmet incase a rider is not wearing a helmet, while a green helmet in the app indicates that the rider is wearing the helmet.

We have used components that are locally available in the market at a much affordable cost. The design provides safety and all features of a smart helmet with various types of sensors embedded in the circuit. In case of any mishap, Force-Sensitive Resistor detects and sends alert to family members about accident. GPS Module sends location. This is beneficial for the companies which have a vast scale of bike ridership. They can ensure safety measures of their employees and can check that their employee is wearing his/her helmet or not.

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CHAPTER - 1

1.1 Introduction:

The concept of helmet was born in 1914, by a British Physician Dr. Eric Gardner who designed it for head protection of motorcyclists in the Isle of Man TT, the premier motorcycle race of the day. His idea was successful and the race organizers made head protection compulsory, which brought a dramatic decrease in head concussions amongst racers. However, this did not make the civilians excited. They felt discomfort wearing a shell on their head while riding. But everything changed when the famous national hero of Britain, aka 'Lawrence of Arabia' died tragically in a road accident some miles from his home. This tragic turn of events made the public realize the dangers of motorcycle riding and how to prevent further accidents. This moved him to promote helmets for the British Army. As during those days, motorcycle mounted 'dispatch riders' were widely used for reconnaissance and communication. His efforts made the Army issue an order for all its military riders to wear helmets made of rubber and cork [1]. Figure 1-1and Figure 1.2 shows the changes in the design of helmet from 1920 to 1960.

Figure 1.1: Changes in design of helmet with time from 1920 to 1960 [1]

The colorful plastic helmet of today with its web suspensions and protective face bars is a far cry from the leather crown and earflaps of 1920. In 1922, the ''reinforced'' crossbands and forehead piece were added. From this came the ''old helmet'' – 1923 that Grange wore, which remained more or less standard for 15 years. In the middle Thirties the first face guards appeared, and in the late Forties the molded leather hat was popular and is still used by some today[1].

Figure 1.2: Helmet in 1950

Figure 1.3: Not wearing of helmet caused head injured

1.1.1 Helmet Culture in Pakistan:

Pakistan is an under-developing country lies in the central Asia. Among all road users group motorcyclist have especially poor safety record. Approximately more than 50% of those who die in the road side crashes are cyclists, pedestrian and two wheelers motorcyclists. These deaths and injuries are affecting every social and cultural society of Pakistan. In Pakistan, the use of smart helmets is very low and those who are using the smart helmet is not up to the national safety standards and quality. According to motor vehicle ordinance which was implemented in 1965 urged the motorcyclists to wear smart helmets but still this is a challenge for law enforcement agencies [2]. As far as the trends of wearing a helmet are concerned, Pakistan's status is no different from the global trends. Conferring to surveys carried out in countries with low GDP, 50% of the fatal accidents were reported to be of motorcyclists[3]. Amongst the registerd vehicles in Pakistan, 75 % are motorcycles [4]. Figure 1.3 shows head injury due to not wearing the helmet.

1.2 Objective:

- To ensure that the a person is wearing a helmet via App.
- To monitor the speed of the motorcyclist to ensure he does not perform over speeding.
- To detect crash incidents and inform the relevant people about the details of person's location, date and time.

1.3 Scope:

This Smart Helmet can be used in different sectors and environments which are mentioned below:

- Insurance companies
- Logistics companies
- Colleges and Universities
- Bike riders of MNCs

This project report comprises five Chapters. Chapter 1 is the introduction, followed by literature review in Chapter 2. Methodology is described in Chapter 3, while Results are discussed in Chapter 4 followed by Conclusion in Chapter 5.

CHAPTER - 2

2.1 Literature Review:

The basis of this research project stems from this suggestions provided by medical journals, emphasizing the significance of wearing a helmet during motorcycle rides. If the motorbike gets stolen, the user can receive information about the bike's current wherabouts through the utilization of a GSM/GPS communication module.[5]

The 2016 research paper 'Smart Helmet' aimed to promote helmet usage among riders as its main objective. It addresses rising death tolls caused by the motorcycle accidents, particularly emphasizing that a significant portion of these casualties resulted because of not wearing of helmets. Due to limitations faced by the traffic police in monitoring remote roads within cities, the primary focus was to establish mandatory helmet usage for two wheeler riders. [6].

According to the Research paper in 2015 titled 'Smart Helmet'. In this project the author has proposed the smart helmet because of growing bike accident. People get injured or might be dead because of not wearing helmet. Continuously no one follows road rules. In order to overcome these problems, this smart helmet has been designed. [7].

Yet, the suggested prototype needs further improvements to make sure the helmet remains in contact with riders' head throughout the journey to protect him in case of any accidents [8]. When a rider wears the helmet, head injuries can go as low as 80%, thus saving lives from accidents. New technologies such as Internet of things have helped avert hazardous situations in preventing bike accidents. An alert system is integrated in the model to alert the rider and relevant personnel by transmitting SMS via cell phone. Wearing of helmet should be made mandatory during the journey. Recent surveys have shown deaths of 4 people per hour daily resulting in 70% due to not wearing a helmet [9].

The consequences of a motorcyclists being involved in accidents due to over speeding are mainly due to not wearing helmet, are extremely perilous and can result in fatalities. Making it a habit to wear a helmet during bike riding will mitigate the effects of severity and potentially protect lives. Numerous countries, including Malaysia, have implemented regulations mandating helmet usage for motorcycle riders. Thus, this project has been specifically developed to enhance the safety of motorcycle riders. It

incorporates an alert system that activates when the speed limit is exceeded. Detection of the rider's head is accomplished using a Force Sensing Resistor (FSR), while the motorcycle's speed is monitored through GPS technology. [10]. Motorcycle will only start when the rider buckles the helmet, An LED will light up indicating the bike speed exceeding 100 km/hour [11].

Below is the table in which a total of 81 studies have investigated various applications of smart helmets for motorcyclists focusing on start control, accident prevention, and rescue request and convenience improvement. These studies have reported several key findings. In terms of start control, smart helmets have been developed to ensure that motorcyclists are wearing helmet and are not under the influence of alcohol. By checking these conditions, the smart helmet prevents the motorcycle from starting if any of the requirements are not met. This feature aims to enhance safety and compliance with the helmet usage and prevent accidents related to alcohol consumption. [13]

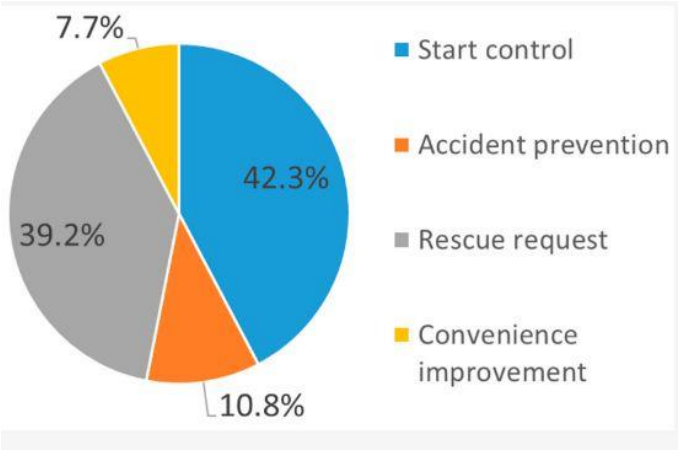

Figure 2.1: Pie chart showing percentage of smart helmet studies

Our project is a form of shielding head covering utilized by riders to enhance motorcycle safety. Its primary objective is to ensure the rider's well-being. This helmet incorporates advanced functionalities such as detection of alcohol, recognition of accident, tracking of location, hands free operation, and crash detection. Consequently, it serves not only as an intelligent helmet but also as a feature of a smart motorcycle. Wearing the helmet is mandatory, as the ignition switch will not activate without it. A wireless RF module can establish communication between the transmitter and receiver. If the rider is intoxicated, the ignition system automatically locks, and a message containing the rider's current location is transmitted to the registered number. In the event of an accident, the helmet utilizes a GSM module and GPS technology to send a

message containing the accident location. The project's notable feature is its ability to detect falls; incase a biker drops from the bike, an SMS alert is sent accordingly.

Table 2.1. Breakdown of Road Accidents Deaths [15]

Road Deaths	**Percentage**
Motorcycle Riders	53%
Pedestrians	19%
4-wheeled vehicle drivers	14%
4-wheeled vehicle passengers	11%
Cyclists	2%
Others	1%

Table 2.2. Functionality selected by motorcycle riders needed most in a smart helmet

Gadget	**Functionality**
Smart Motorcycle Helmet	GPS Tracking Crash Detection SMS Notification / Alert to first responders and to the family

CHAPTER – 3

3.1 Methodology:

The methodology of developing the smart helmet is comprised of four phases as shown in 3-1. The whole procedure of creating this smart helmet was divided into four phases. First phase was the purchasing of the components in which controller, sensors and battery were purchased. Testing was done in the second phase and all the components and circuit was assembled in the third and fourth phase.

Figure 3.1: Methodology

3.1.1 Phase 1:

In phase 1, we did literature review related to smart helmets. Many scientists have published in journals and websites about the smart helmet which they developed. In order to have the best selection of the components, we studied the papers which helped us in selecting the components which is our phase 2. Literature review was done in order to get more knowledge related to smart helmet requirements.

3.1.2 Phase 2:

Components were selected and purchased after research and study about what kind of controller would be used for the project. What kind of sensors would be most suitable and feasible for the smart helmet to work and function properly? Components which are being used for the smart helmet are locally available in the market. In the smart helmet, we used ESP32 SIM Microcontroller which is powered by a 3.7 LiPO battery. Other components of the smart helmet include IR sensor, Force Sensitive Resistor and GPS which are connected to the ESP32 as well. Force Sensitive Resistor to the controller. IR sensors is used in the smart helmet so that identification can be made that either a person is wearing a helmet or not.

3.1.3 Phase 3:

This is the third phase where the components were tested as shown in Figure 3-2 and Figure 3-3. After testing they were assembled in the form of a circuit to be mounted inside the helmet. Circuit is placed inside the smart helmet and it is covered with black strips for its protection against any element or exposure which can damage the circuitry. The size of the circuit is compact and consists of sensors, battery, controller, jumper wires etc.

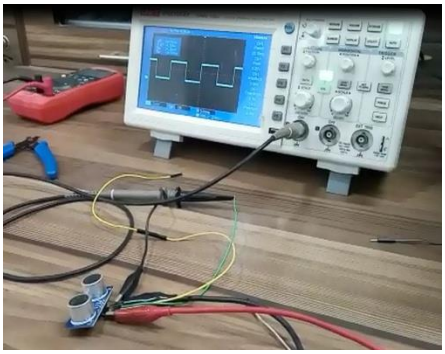

Figure 3.2: An ultrasonic sensor is being tested

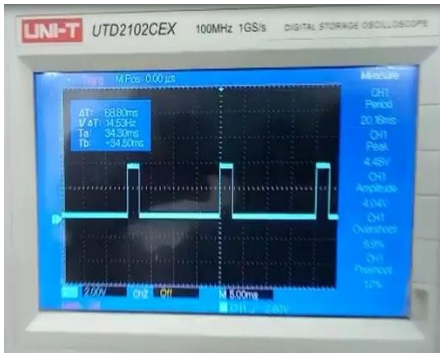

Figure 3.3: Waves are generated indicating response of the sensor

3.1.4 Phase 4:

Phase 4 was the final phase in which all the features of the helmet were checked. Their functionalities were checked and demonstrated for crash detection alert, wearing of helmet detection and sending time and location details to the relevant personnel in case of an accident.

All the four phases were done in the IoBM research Lab and tested in the campus. The final shape of the figure is shown in figure 3.4.

Figure 3.4: Smart Helmet structure

In the smart helmet, we used ESP32 SIM Microcontroller which is powered by a 3.7V Lithium ion battery. Other components of the smart helmet include IR sensor, Force Sensitive Resistor and GPS which are connected to the ESP32 as well. Force Sensitive Resistor gives crash detection information to the controller which further sends the details of the incident to the relevant contacts. IR sensors is used in the smart helmet so that identification can be made that either a person is wearing a helmet or not. Following are the details of the components used in the circuit.

3.2 Components List:

3.2.1 FSR (Force Sensitive Resistor):

A force sensitive resistor (FSR) shown in Figure 3-5, is a material which changes its resistance when a force or pressure is applied. Conductive film is an example of such force resistance material. In other words, force sensitive resistor it's a sensor that allow you to detect physical pressure, squeezing and weight.

Non-Actuated Resistance. 10M W Size. 18.28mm diameter.

Figure 3.5: Force sensitive resistor [16]

3.2.2 IR Sensor:

IR sensors shown in Figure 3-6, are now widely used in motion detectors, which are used in building services to switch on lamps or in alarm systems to detect unwelcome guests. In a defined angle range, the sensor elements detect the heat radiation (infrared

radiation) that changes over time and space due to the movement of people. It detects whether a person is wearing a helmet or not and updates the status accordingly.

Operating Voltage: 3.3-5 VDC

Distance Measuring Range: 2~30cm

Weight: 15cm

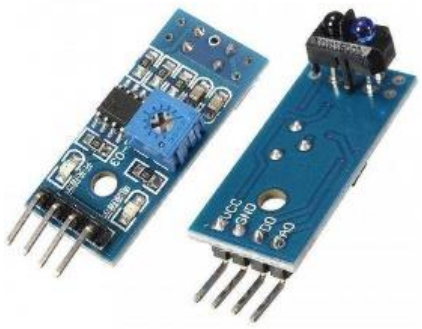

Figure 3.6: IR sensor

3.2.3 ESP32 Microcontroller:

The ESP32 SIM800L wireless communication module features 802.11 b/g/n wifi protocol and Bluetooth v4. 2BR/EDR and BLE standard protocol. This wireless communication module supports cloud server development and SDK for user firmware development. Package Includes 1 x Sim800L ESP32 Wireless Communication Module.

SIM800L supports Quad-band frequency its works on frequencies 850MHz, 900MHz, 1800MHz, and 1900MHz, it can transmit and receive voice, SMS, and data information with low power consumption. The operating voltage of this chip is from 3.4V to 4.4V which makes it ideal to operate by a Li-Po battery supply.

Figure 3.7: ESP32 Microcontroller [15]

3.2.4 NEO GPS:

The NEO-6M GPS module shown in Figure 3.8 is a well-performing complete GPS receiver with a built-in 25 x 25 x 4mm ceramic antenna, which provides a strong

satellite search capability. With the power and signal indicators, you can monitor the status of the module.

- Power Supply: 3V-5V.
- EEPROM.
- LED Indicator.
- Backup battery.
- Baud Rate: 9600.
- Mounting Holes: 3mm.
- Module Dimensions: 23mm x 30mm.
- Antenna Dimensions: 25mm x 25mm.

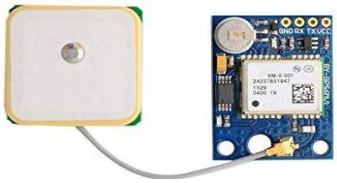

Figure 3.8: GPS Module

3.2.5 Battery:

In this smart helmet a 3.7v battery shown in figure 3.9 is used which has the following specifications.

Dimensions Size	18.5 x 70 mm
Max Operating Voltage	2.75V – 4.2V
Maximum Charging Voltage	4.2+- 50mV
Maximum charging current	2A

The whole procedure of creating this smart helmet was distributed into four phases. First was the purchasing of the components in which controller, sensors and battery were purchased. Testing was done in the second phase and all the components and circuit was assembled in the third and fourth phase.

Figure 3.9: 3.7V lithium ion battery

3.3 Schematic Diagram:

Figure3.10 depicts the schematic diagram of circuitry used in smart helmet. In this diagram, it can be seen that Force sensitive resistor (FSR), Infrared Sensor (IR), GPS are connected to the ESP32 microcontroller and a 3.7V Lithium ion battery. These sensors are responsible for the various features of the helmet to execute properly.

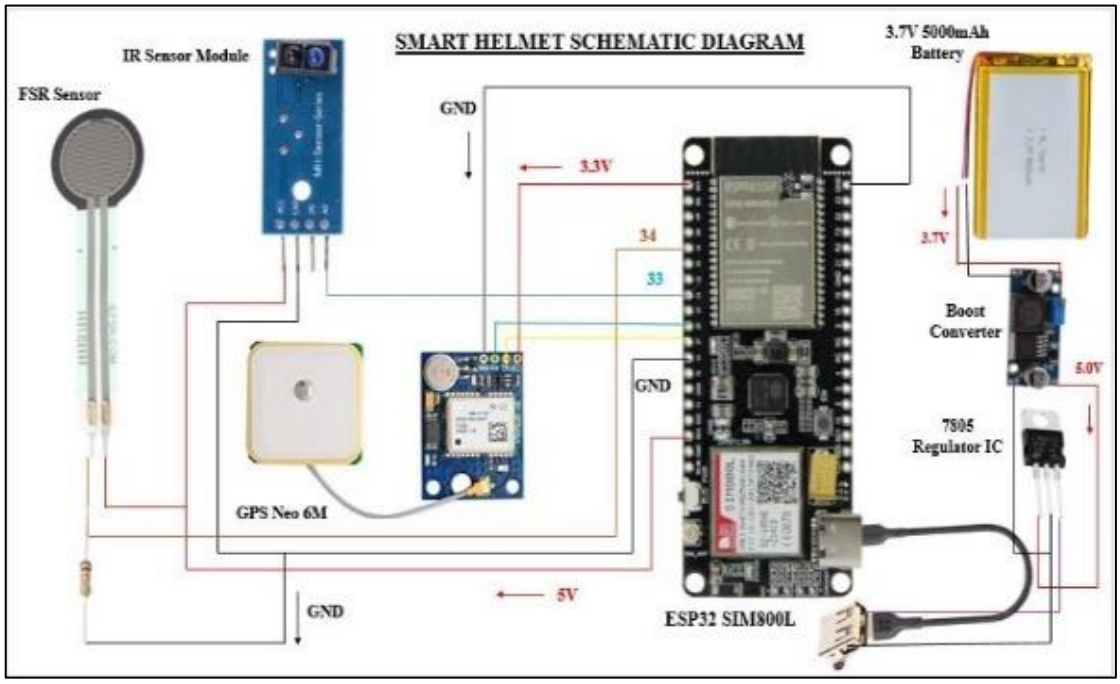

Figure 3.10: Circuitry of Smart helmet

3.3.1 How It Works:

ESP32 controller is main component of this circuit. Other components are connected with ESP32 controller's pins. IR sensor is connect with pin # 33. When rider wears helmet, it detects and analog output is sent to controller. FSR sensor is connect with pin # 34. FSR sensor is Force Sensitive Resistor when force applied to this sensor then it changes its resistance. Controller detects this change and sends output as SMS via Sim 800l module. The NEO-6M GPS module has four pins: GND, Tx, Rx, and VCC. The Tx and Rx pins are used to communicate with the controller. Pin # 12 is used as Tx and Pin # 14 is used as Rx. This GPS performs two types of work. It gives the location of rider in SMS and speed of rider.

3.3.2 ESP32 Sim800L:

ESP32 controller is main component of this circuit. Other components are connected with ESP32 controller's pins. Controller has total 38 pins. It has 23 I/O pins. All

components are connected with these I/O pins. The controller is programmed according to the requirements of the smart helmet using C++ language.

3.3.3 IR Sensor:

IR sensor is connected with pin # 33. When rider wears helmet, it detects and analog output is sent to controller. Controller sends output to mobile phone via Wi-Fi.

```
IRvalue = analogRead (IRSensor);
Serial.print ("IR Value =");
Serial.println (IRvalue);
```

3.3.4 FSR Sensor:

FSR sensor is connected with pin # 34. FSR sensor is Force Sensitive Resistor when force applied to this sensor then it changes its resistance. Controller detects this change and sends output as SMS via Sim 800l module.

```
FSRvalue = analogRead (FSRSensor);
Serial.print ("FSR Value =");
Serial.println (FSRvalue);
```

3.3.5 GPS Neo 6M:

The NEO-6M GPS module has four pins: GND, Tx, Rx, and VCC. The Tx and Rx pins are used to communicate with the controller. Pin # 12 is used as Tx and Pin # 14 is used as Rx. This GPS performs two types of work. It gives the location of rider in SMS and speed of rider.

```
Serial.print ("latitude: ");
Serial.println (latitude);
LONGITUDE = gps.location.lng (), 6;
Longitude = double_string_con (LONGITUDE);
Serial.print ("longitude: ");
Serial.println (longitude);
speed = gps.speed.kmph ();
Serial.print ("speed: ");
```

CHAPTER - 4

4.1 Results:

We designed this helmet to enhance safety and reduce hazardous risks of the bike riders. It is equipped with various sensors and technologies that help bike riders stay safe and avoid accidents.

The specific results of a smart helmet depend on the features and technologies included in the helmet. The unique features of smart helmet which includes the following results are displayed:

4.1.1 Feature 1: Identification whether person is wearing a helmet or not.

When a person is not wearing a helmet, a red helmet symbol is displayed on the application shown in figure 4.1:

Figure 4.1: Red Helmet Symbol

As soon the person wears a helmet, red helmet symbol changes into green helmet indicating that person has now worn the helmet. This is shown in figure 4.2.

Figure 4.2: Green helmet

4.1.2 Feature 2: Crash and Speed Alert Notification

When a rider is travelling and undergoes an accident, the smart helmet sends an emergency alert via an SMS to the rider's immediate contacts so that they can be notified about the incident. The details include location, time and date at which the

incident took place. The results are shown in the following SMS screenshots received from the rider's helmet, as shown in figure 4.3 and figure 4.4.

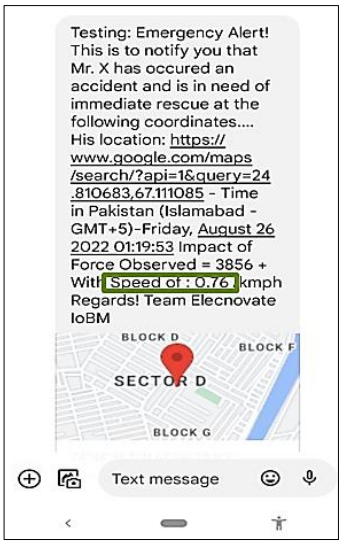

Figure 4.3: Speed Alert

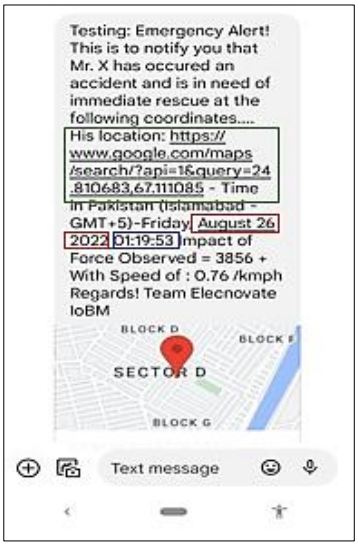

Figure 4.4: Crash Alert

Smart helmets can be equipped with communication devices, such as radios or Bluetooth, allowing to stay in contact with each other and receive instructions from supervisors. Smart helmets can record and document safety-related incidents, such as falls or collisions, providing valuable data for accident investigations and safety assessments. Overall, smart helmets can help improve safety, increase efficiency, and reduce the risk of accidents in various industries

CHAPTER - 5

5.1 Conclusion:

Smart helmet is a new and innovative approach to ensure safety of the bike riders during the journey. It is equipped with various sensors and devices that can detect many other important information identifies wearing of helmet or not, crash detection alerts, monitor the speed of the bike rider to provide real time feedback to improve safety.

From the literature review and other research information gathered, following conclusion was derived.

The aim of designing this helmet was to provide support to motorcyclist against head injuries in case of accidents. The helmet is cost effective and feasible. further enhancement can be made by adding advanced features to the helmet in future. The product will be commercialized and patented soon.

All components used in the smart helmet are locally available in the market at a much affordable cost. The design provides safety to the bike riders and all features of a smart helmet with various types of sensors embedded in the circuit. An insulation will protect the circuit from heat and from rain water. In case of any mishap, Force-Sensitive Resistor will detect and alert about accident. GPS Module will send location. Flash memory will be used for data acquisition and storage. In places with no internet or Wi-Fi services, the data can be stored offline and then uploaded or transmitted once the Wi-Fi is available.

The number of bike riders in Pakistan is increasing exponentially. Being economically feasible and convenient the lower middle class relies on motor bikes as the main mode of transportation. Unfortunately, the risk of road accidents due to bike-riders is much higher than drivers of other vehicles. Not wearing of helmet is an important factor resulting in fatality or head injuries. Usage of helmet and enforcement of road safety measures can prevent fatal head injuries. In Pakistan 80% of the motorcycle accidents result in deaths or head injuries of the motorcyclist, due to not wearing helmets. The occurrences of accidents is not in our control but taking preventive measures to avoid fatal injuries is in our hands. Mostly, the bikers don’t wear helmet because they choose comfort over safety. We therefore need to solve this problem by inculcating the culture of wearing a helmet. This will lessen the hazard of injuring the head of bike riders.

Nevertheless, some points may be taken into consideration for future progress, research and development. They are mentioned below:

5.2 Strengths of Design:

- Economically cheaper and reliable than its competitors.
- Focuses on safety and health factor rather than the entertainment purpose.
- It's made with components which are locally and easily available.
- It would provide speed monitoring, helmet wore or not alert, and would provide location of the helmet to the database monitoring control center.

5.3 Weaknesses of Design:

- As our design aim is to provide safety and health assurance to its consumer with maximum efficiency, though there are few things which can decrease the efficiency rate of our design.
- Training the customers to provide technical details frequently could be difficult.
- If contract procured, Mass production would require vast space.

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Appendix A
GANTT CHART

Task ID	TASK Description	Task Duration	Week-1	Week-2	Week-3	Week-4	Week-5	Week-6	Week-7	Week-8	Week-9	Week-10	Week-11	Week-12	Week-13	Week-14
01	Presentation SDP 1	1 week														
02	Controller coding and other programming installation	2 weeks														
03	Assembling the helmet	2 weeks														
04	Interconnecting the circuit with ESP32 and other components	2 weeks														
05	Working on Design of helmet	2 weeks														
06	Running & error finding	2 weeks														
07	Finalizing the project	2 weeks														
08	Report Writing	2 weeks														

Appendix B

Bill of Material (BOM) with Estimated Cost for the Helmet				
S. #	Component	Price/Item	Quantity	Total Cost (PKR)
1	Helmet	2500	1	2500
2	Re-chargeable Battery	450	1	450
3	Force Sensitive Resistor	1800	1	1800
4	ESP32- connectivity	3000	1	3000
5	GPS NEO 6M	750	1	750
6	Ultrasonic sensor	150	1	150
7	Miscellaneous: Acrylic, Waterproof sheet; Insulation sheet			1000
		TOTAL COST-PKR		9,650

Appendix C
Complex Engineering Problems

Work Package	Characteristic	Features	Score	Compliance (Please add remarks and mark for related preamble)
WP1 *	Depth of Knowledge required	Resolved with **forefront in-depth** engineering knowledge (WK3, WK4, WK5, WK6 or WK8) which allows a fundamentals-based, first principles analytical approach.	**3/3**	To gain the basic knowledge of sensor and other components used in the smart helmet, rigorous research was concluded about each item's details, functions and coding during the first phase of our research project. IoT technology was used to observe real time data monitoring including helmet status, crash alert notification and speed monitoring. The aim was to ensure safety of the bike riders.
WP2	Range of conflicting requirements	Involve **wide-ranging or conflicting** technical, engineering and other issues.	**1/1**	No conflicting issues involved in the project.
WP3	Depth of analysis required	Have **no obvious solution** and require abstract thinking, originality in analysis to formulate suitable models.	**1/1**	The smart helmet has unique features. The circuitry is embedded inside the padding of the helmet with protection layers. The components and helmet performance was checked and tested using testing devices in the lab such as function generators used for testing sensors and other equipment. The project will be commercialized as companies have already shown in interest. Mass manufacturing of the helmet would require vast space, manpower and more equipment.
WP4	Familiarity of issues	Involve **infrequently encountered** issues	**1/1**	We have used new technology, not used by others in the making of smart helmet. Coding issues occurred in the transmission of alert notification but was resolved.
WP5	Extent of applicable codes	**Beyond codes** of practice	**1/1**	Coding was involved in enabling all three features of the helmet. C++ was used. All features are functioning properly.
WP6	Extent of stakeholder involvement and level of conflicting requirements	Involve **diverse groups of stakeholders** with widely **varying needs**.	**1/1**	Stakeholders include 80%, bike riders who use bikes for going to work. Unilever Pakistan workers, Food Panda staff, MNCs, students of HEIs and delivery boys are the major stakeholders.

				The helmet can be made based on customised requirement.
WP7	Interdependence	Are **high level problems** including **many component** parts or sub-problems?	**1/1**	The project is designed using layered approach, hence no interdependence.
EP1	Consequences	Have **significant consequences** in a range of contexts.	**1/1**	In case of accidents, the helmet sends timely alert notification with time, date, and location to the family members for timely help, thus saving lives.
EP2	Judgement	Require judgement in **decision** making	**1/1**	Due to modular designed approach each feature responses as per requirement for decision making. For example if the helmet is not worn, the App developed sends an alert with a red helmet icon asking to wear the helmet, and turns green when the helmet is worn.
Aggregate: The smart helmet designed for the safety of bike riders to prevent head injuries was successfully made. Its unique features functions properly. The circuits for each feature were assembled independently and embedded inside the helmet with protective layer for providing protection to the head. The project was awarded 3rd prize in the Unilever Hackathon, where 130 universities all over Pakistan participated. It was also awarded grant by PEC in the ceremony at PEC Multan. The project was recently displayed in the 2nd Sindh HEC project Exhibition at Expo Centre Karachi.			**11/11 100%**	The components were tested thoroughly ensuring safety measures of the group member in the R&D lab.

Complex Engineering Activities

Preamble	**Complex activities** mean (engineering) activities or projects that have **some or all** of the following characteristics listed below	Score	**Compliance (Please add remarks and marks for against relevant preamble)**
Range of resources	**Diverse resources** (people, money, equipment, materials, information and technologies). EA1	**1/1**	**Unilever and Pakistan Engineering Council**
Level of interaction	Require resolution of significant problems arising from interactions between **wide ranging** or **conflicting** technical, engineering or other issues.EA2	**1/1**	Smart helmet uses new technology and there is no conflict.
Innovation	Involve creative use of engineering principles and **research-based** knowledge in **novel** ways. EA3	**1/1**	Smart helmet uses IoT based state of the art components which ensures functionality of its key features.
Consequences to society and the environment (* UN SDGs)	Have **significant consequences** in a **range of contexts**, characterised by **difficulty** of prediction and mitigation.EA4	**1/1**	It can reduce the head injuries by a vast quantity and ensure safety of the bike riders.
Familiarity	Can extend **beyond previous** experiences by applying **principles-based** approaches.EA5	**1/1**	All the functions are easy to use.
Aggregate: 1. The helmet is Unique, as it is smart and can send real time information alerts to international and local recipients in case of over speeding, and bike crash. 2. It identifies whether rider is wearing a helmet or not. It can send location, time and date of the incident to the nearest contacts.		**5/5 100%**	The smart helmet ensures safety of the bike riders through its unique features.

Appendix D

National Academy of Engineering (NAE) Grand Challenges for Engineering

Grand Challenges	CHARACTERISTIC	
GC1	Make Solar Energy Economical	☐
GC2	Provide Energy from Fusion	☐
GC3	Develop Carbon Sequestration Methods	☐
GC4	Manage the Nitrogen Cycle	☐
GC5	Provide Access to Clean Water	☐
GC6	Restore and Improve Urban Infrastructure	☐
GC7	Advance Health Informatics	✓
GC8	Engineer Better Medicines	☐
GC9	Reverse-Engineer the Brain	☐
GC10	Prevent Nuclear Terror	☐
GC11	Secure Cyberspace	☐
GC12	Enhance Virtual Reality	☐
GC13	Advance Personalized Learning	✓
GC14	Engineer the Tools of Scientific Discovery	✓

Comments:

The project is designed to reduce fatal head injuries especially for bike riders; ensuring low cost and availability in the market.

Supervisor's Signature: _____

Appendix E
UN SDGs Mapping

UN SDGS	CHARACTERISTIC		GOALS AND TARGETS (FROM THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT) & INDICATORS
SDG1	No Poverty	☐	
SDG2	Zero Hunger	☐	
SDG3	Good Health and Well Being	●	**Goal 3: Each year, road traffic crashes cause nearly 1.3 million preventable deaths and an estimated 50 million injuries** **Target 3.5:** The 2030 horizon for road safety: securing a decade of action and delivery"
SDG4	Quality Education	☐	
SDG5	Gender Equality	☐	
SDG6	Clean Water and Sanitation	☐	
SDG7	Affordable and Clean Energy	☐	
SDG8	Decent Work and Economic Growth	☐	
SDG9	Industry, Innovation and Infrastructure	●	**Goal 9: Inculcate culture of wearing smart helmet to ensure safety and wellbeing of the bike riders of industries. State of the art microcontroller is used for the smart helmet.** **Target 9.5**. By 2030, reduce the number of fatal accidents caused by head injuries of the bike riders and educate about the importance about safety over comfort.
SDG10	Reduce Inequality	☐	
SDG11	Sustainable Cities and Communities	●	**Goal 11: Usage of Smart helmet will reduce the amount of accidents and injuries.** **Target 11.5** 50% reduction in road traffic accidents and injuries by 2030 is an ambitious but achievable target.
SDG12	Responsible Consumption and Production	☐	
SDG13	Climate Action	☐	
SDG14	Life Below Water	☐	
SDG15	Life on Land	☐	
SDG16	Peace, Justice and Strong Institutions	☐	
SDG17	Partnership for the Goals	☐	

Comments:

80% of the head injuries in Pakistan occur due to not wearing of helmet during the journeys. 42% of the fatal deaths also occur because of this reason. We therefore need to solve this problem by inculcating a culture of wearing smart helmet so that not just only locally, it will also have impact globally.

Supervisor's Signature: _____