IoT Based Smart Helmet and Solar Analyzer

Final Year Project Report

Presented

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In Partial Fulfillment

of the Requirement for the Degree of

Bachelor of Science in Electrical Engineering

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

COMSATS UNIVERSITY ISLAMABAD

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DECLARATION

We hereby declare that this project, neither whole nor as a part has been copied out from any source. It is further declared that we have developed this software and accompanied a report entirely based on our efforts. If any part of this project is proved to be copied out from any source or found to be a reproduction of some other. We will stand by the consequences. No portion of the work presented has been submitted of any application for any other degree or qualification of this or any other university or institute of learning.

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COMSATS UNIVERSITY ISLAMABAD
July 2023

IoT Based Smart Helmet and Solar Analyzer

An Undergraduate Final Year Project Report submitted to the Department of

ELECTRICAL AND COMPUTER ENGINEERING

As a Partial Fulfillment for the award of Degree

Bachelor of Science in Electrical(Computer) Engineering

by

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Dedication

This project is dedicated to our parents for always gearing our energy up and giving their full support, time, and efforts on our studies, our teachers who've always been there to guide and help us in every situation, the group mates who had always made equal efforts. Also to all efforts and hard work we did in the time of university life. We appreciate each of our families and friend for encouraging, believing, and motivating us.

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Muhammad Shuja Ur Rehman Khan
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Abbreviations

SA	Solar Analyzer
SH	Smart Helmet
GSM	Global System for Mobile
GPS	Global Positioning System
IOT	Internet of Things
PV	Photo Voltaic
ML	Machine Learning
RDM	Real-time Difference Measurement
MBDM	Module Based Difference Measurement
AI	Artificial Intelligence
RBFN	Radial Bases Functional Networks
WAAS	Wide Area Augmentation System
EGNOS	European Geostationary Navigation Overlay Service
BMS	Battery Management System

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Abstract

With each passing day, mankind is brainstorming to improve technology in every field to bring comfort to their lives. IoT has now become the most significant technology of every innovation. Similarly, this project is based on IoT and a Smart helmet is been designed along with a solar analyzer. A smart helmet is a type of protective headgear using which rider will be more comfortable and secure while riding his/her bike. The Smart Helmet provides, emergency location updates, emergency notifications via SMS, bike theft protection and integrated Bluetooth speakers and mic. To make this project work even better a solar analyzer has been added with the smart helmet. Solar analyzer is a solar power meter that measures the power generated by the solar panels. These measurements are used to calculate the overall energy usage and power efficiency of the installed solar panels. Using IoT technology, the power generation can be greatly influenced by means of its performance, monitoring and maintenance. The smart helmet is introduced as an economical solution for the riders. With the advancement of technology, everything is integrated with Internet. The Smart Helmet is the protective headgear that has been integrated with an on-board computer. This on-board computer will bring a change in society. People will feel more secured wearing the helmet while riding. The live-feed of the rear view will help the rider to have a more joyous ride and the rider will continuously get smart helmet charged with sunrays as well.

Chapter 1

1 Introduction

We live in a world where most people would want surveillance usually at public places where chances of tragic incidences would be high. It is hard for a human to inspect many people at a gathering or some terminals. Due to the rapid changes in the demographic structure of the world, there arises a dire need to bring vital changes in conventional methods. With each passing day, mankind is brainstorming to improve technology in every field to bring comfort to their lives. [1]

An IOT-based smart helmet is a type of protective headgear using which rider will be more comfortable and secure while riding his/her bike. With the back camera mounted on the cap rider will most likely observe rearward on the screen of the visor [2]. Moreover, a solar analyzer is mounted in the smart helmet because solar energy is one of the most promising renewable sources of energy currently being used globally for meeting rising demands of electric power. The sunlight is collected either directly by using photovoltaics cells or indirectly using concentrated solar energy. The solar photovoltaic (PV) energy system directly converts the sun photons energy to electricity through the solar cells. Solar cells are made from light sensitive semiconductors that use photon energy to dislodge electrons to drive an electric current. [3]

IoT provides ways for preventing errors and flaws. The user will be able to connect his smart helmet to an android application. The smart helmet is introduced as an economical solution for the riders. Its solar analyzer is a machine that is used to measure or analyze current situations of the smart helmet. The idea behind designing the solar analyzer is to measure the efficiency of the system. It is a portable device. Therefore, a nonprofessional can handle it easily. A simple current-voltage analysis method was proposed for the IOT based solar analyzer to be integrated with smart helmet where the electrical signature of each faulty modules and array was fixed by considering the deformations induced on the I/V curves. [4]

1.1 Intro to Smart Helmet:

In an emerging country like Pakistan, motorcycles are a popular and efficient mode of transportation but also pose a high risk for accidents. The lack of help for riders after an accident and difficulty in recording the event can lead to fatal consequences. To mitigate these risks, a solution is needed to provide assistance and protection to riders during their trips.

We are proud to introduce our ground-breaking Smart Helmet, a unique piece of protective headgear that seamlessly combines cutting-edge technical breakthroughs to guarantee the highest level of safety and convenience. This cutting-edge headgear is equipped with a number of advanced features, such as meticulously designed sensors, an integrated camera, solar panels for renewable energy production, and a complex communication system based on a potent microprocessor. The Smart Helmet gives motorcyclists greater control and a greater sense of awareness by utilizing the possibilities of these ground-breaking components.

This amazing helmet's capacity to create seamless connection with the rider's motorcycle is one of its most impressive features. Riders can easily communicate with their bikes, accessing essential data and carrying out tasks with ease, through a seamless connection. The Smart Helmet also offers users a live, real-time broadcast of their surroundings through a specially crafted visor, giving them a thorough view of the road in front of them as well as the crucial capability to monitor any risks from behind.

The Smart Helmet has a clever feature that protects against theft since it understands the value of security in all areas. Forcefully removing the helmet activates a security feature that immediately turns off the bike's power source. This guarantees that the rider's two-wheeler is always secure and offers unmatched protection against potential theft.

Along with its innovative features, the Smart Helmet was created with sustainability in mind. As a result of the solar panel integration, the battery of the helmet may be kept charged for longer periods of time, reducing the need for regular recharging and encouraging environmentally beneficial habits.

We aim to improve motorcycle safety with the innovative Smart Helmet by enabling riders to confidently navigate the busy streets of Pakistan while taking use of the unrivaled benefits provided by this innovative headgear. We work to create a safer and more secure environment for everyone who chooses to use this thrilling means of transportation by putting the safety of riders first and addressing the inherent dangers connected with motorbikes.

1.2 Intro to Solar Analyzer:

The effectiveness of solar panels can decrease for a number of reasons, including the buildup of dirt, shade from neighboring objects, changes in temperature, and more. These problems may significantly affect the overall effectiveness of solar panel installations. Regrettably, the traditional approaches to tracking solar panel performance are frequently labor-intensive and yield scant data.

We have created a cutting-edge tool called the Solar Analyzer to address these issues. This state-of-the-art tool is intended exclusively to track the efficiency of solar panel installations and provide real-time data monitoring of electricity generation. The Solar Analyzer gives users useful information and alerts via a user-friendly smartphone application, ensuring they have complete control and visibility over their solar panel systems.

The solar analyzer is a portable device with IoT connectivity and wireless technology. As a result, there is no need for difficult wiring or installation procedures and the gadget and the user's mobile application may communicate seamlessly. The Solar Analyzer provides simplicity and accessibility by utilizing wireless connectivity, making it simpler for consumers to stay updated about the condition of their solar panel installations.

The Solar Analyzer's capability to identify any problems or anomalies that could reduce the effectiveness of the solar panels is one of its main advantages. For instance, the device will immediately detect any accumulation of dirt or debris on the surface of the panels and notify the user. Similar to this, the Solar Analyzer will issue a warning if adjacent objects are blocking sunlight. This will remind the user to take the appropriate actions, such as cutting trees or changing the panel's orientation.

By keeping track of temperature differences, the Solar Analyzer also helps users maximize the efficiency of their solar panel systems. It includes advice for preserving ideal conditions and significant insights into how temperature swings may affect the performance of the panels. Users can take proactive steps to reduce power losses and guarantee their solar panel systems run as efficiently as possible by anticipating potential problems in real-time.

Maximizing the lifespan and performance of solar panel systems requires routine maintenance. Unfortunately, a lot of consumers frequently ignore this feature. By giving timely reminders for maintenance activities like cleaning the panels or evaluating the system's components, the Solar Analyzer allays this worry. These prompts assist customers in staying on top of their solar panel maintenance needs, ensuring that their systems continue to provide the best possible amount of power over the long haul.

The Solar Analyzer transforms the operation and upkeep of solar panel installations. This portable gadget gives consumers the power to manage their solar panel systems efficiently, reducing efficiency losses and assuring rapid maintenance. It does this through real-time data monitoring, notifications, and wireless communication. The Solar Analyzer uses technology to improve the efficiency and lifetime of solar panel installations, making renewable energy more widely available and effective. It offers a variety of cutting-edge functionality in addition to its monitoring and maintenance tools to further improve the user experience. Users may monitor the functioning of their solar panels at any time using the mobile application's comprehensive dashboard, which offers real-time data on electricity generation.

Users can examine trends and patterns in the performance of their solar panel system over time using the Solar Analyzer's historical data analysis features. Users can discover long-term efficiency problems, optimize energy use, and make wise decisions about system improvements or expansions with the use of this useful information. It also offers remote access, enabling users to keep an eye on their solar panel installations at any time and from any location. Owners of solar panel systems who frequently travel or have many installations will find this to be especially helpful. Users can feel secure knowing that they can keep track of their solar energy production no matter where they are thanks to the ability to remotely monitor and operate their systems.

The Solar Analyzer is made to work with a variety of system configurations and manufacturers to ensure easy integration with current solar panel systems. The Solar Analyzer can adapt and offer precise monitoring and analysis whether it's a small-scale commercial setup or a large-scale residential rooftop installation.

The Solar Analyzer also encourages consumers to make informed decisions, which promotes sustainability and energy efficiency. Based on the information obtained from the solar panel system, the mobile application can offer tailored recommendations and advice. For instance, it can advise reducing energy use during periods of peak generation or offer suggestions for possible energy-saving measures the user could take in their home or facility.

By promoting data exchange and cooperation, the Solar Analyzer also helps the development of renewable energy as a whole. Users have the option to anonymously share performance data from their system with a larger network, enabling more extensive investigation and evaluation of solar energy production on a global scale. The adoption of renewable energy solutions can be advanced by using this aggregate data to enhance solar panel technology and spot regional trends.

In conclusion, the Solar Analyzer is a ground-breaking solution that gives owners of solar panel systems access to thorough monitoring, real-time data analysis, and preventative maintenance tools. The Solar Analyzer revolutionizes how we oversee and optimize solar energy generation by tackling the issues of efficiency losses, routine maintenance oversight, and constrained monitoring capabilities. The Solar Analyzer is an essential instrument for maximizing the performance and efficiency of solar panel systems, contributing to a more sustainable and renewable energy future. It has a user-friendly interface, wireless connectivity, and cutting-edge functionality.

1.3 Overview:

In an ever-evolving world, humanity continues to strive for technological advancements across various domains, aiming to enhance the quality of life and bring convenience to everyday activities. One prominent technology driving innovation is the Internet of Things (IoT), which has transformed numerous industries. Building upon this trend, we worked on two distinctive products known as the solar analyzer and the smart helmet, each with a distinct focus but united in their aim to revolutionize their respective fields.

The Solar Analyzer is a portable tool designed to monitor the performance of solar panel systems in real time. Traditionally, monitoring solar panels was a tedious and time-consuming task, providing limited information to users. However, the Solar Analyzer introduces a transformative solution by leveraging wireless technology and IoT connectivity. Through a mobile application, users can easily access crucial data on power generation and receive notifications about any noteworthy events. By utilizing real-time monitoring and proactive maintenance, the Solar Analyzer mitigates power losses, ensuring that solar panel systems operate at peak efficiency. This innovative approach optimizes power generation and enhances the overall effectiveness of solar energy systems. On the other hand, the Smart Helmet heralds an evolution in the world of riding helmets that provide protection. This innovative helmet incorporates a variety of cutting-edge parts, such as sensors, a built-in camera, solar panels, and an intricate communication system. Its major goal is to make riding safer and more convenient for passengers. The Smart Helmet transforms into an essential tool for addressing safety issues by seamlessly integrating the rider with their motorbike. It provides real-time information like speed and navigational instructions while also offering a live view of the surroundings thanks to the integrated camera. With the help of this live broadcast, motorcyclists may increase their safety by becoming more knowledgeable about potential risks and making wise judgements. The Solar Analyzer and the Smart Helmet both improve output and security in their respective fields. The Smart Helmet transforms motorcycle safety by successfully minimizing the dangers that come with riding and giving users a full range of functions that improve their riding experience. It creates a frictionless and safe environment for riders by integrating cutting-edge technologies, wireless connection, and IoT integration. On the other side, the Solar Analyzer guarantees that solar panel systems operate at their peak efficiency, allowing consumers to fully use renewable energy. The limits of conventional monitoring approaches are addressed by adopting real-time monitoring, preventative maintenance, and wireless connectivity, enabling users to maximize the effectiveness of their solar energy systems.

Both products focus on user safety, promote environmental sustainability, and make it possible for people to live in environments that are safer and more protected. The Solar Analyzer and the Smart Helmet provide customers with special and unrivalled benefits by combining cutting-edge innovation, wireless networking, and IoT integration. We are getting closer to a world that is safer, more sustainable, more connected thanks to these ground-breaking technologies that pave the way for a day when technology is effortlessly integrated into our daily lives.

1.4 IMPACT OF UN SDGs:

1.4.1 SDG 9: Industry, Innovation, and Infrastructure:

Our project focuses on leveraging IoT technology to enhance the functionality and safety of smart helmets. By incorporating IoT capabilities into traditional headgear, our project introduce innovation in the field of protective equipment for riders. The smart helmet integrates various features such as a back camera and connectivity with an Android application, providing real-time monitoring and improved visibility for the rider. This technological innovation improves the overall user experience and contributes to the advancement of the industry. Moreover, the project explores the integration of a solar analyzer, further enhancing the innovative aspects by innovating another device of renewable energy into the design. By combining technology, safety, and sustainability. Our project promotes advancements in the industry, driving innovation in the field of smart helmet development.

1.4.2 **SDG 11: Sustainable Cities and Communities**:

Our project contributes to creating safer urban environments by incorporating smart helmet technology. Smart helmets provide riders with enhanced safety features and real-time monitoring capabilities, promoting road safety and accident prevention in cities. The integration of back cameras in the helmet allows riders to have a clear view of the road behind them, reducing blind spots and improving situational awareness. By leveraging IoT technology, the smart helmet can also connect to an Android application, providing riders with vital information and alerts regarding potential hazards or unsafe road conditions. This proactive approach to road safety helps to create a safer and more secure urban environment for both riders and pedestrians. Additionally, the project's focus on innovation and technology advancements in the field of smart helmet development contributes to the overall sustainability and progress of cities and communities.

1.4.3 SDG 13: Climate Action:

The integration of a solar analyzer along with the smart helmet which highlights the project's commitment to climate action. By incorporating renewable energy sources, such as solar power, along with the the smart helmet, our project promotes sustainable and climate-friendly electric power generation. The solar analyzer within the helmet allows for the measurement and analysis of solar energy efficiency. This emphasis on solar power showcases a shift towards cleaner and more sustainable energy alternatives, reducing reliance on fossil fuels and mitigating greenhouse gas emissions. By harnessing solar energy through photovoltaic cells, the smart helmet contributes to the adoption of renewable energy in daily activities, aligning with global efforts to combat climate change. The use of solar power also offers the potential for energy independence and resilience, as it is a renewable resource with virtually unlimited potential. Overall, your project's integration of a solar analyzer in the smart helmet supports SDG 13 by promoting climate action through the utilization of sustainable and clean energy sources.

1.4.4 SDG 16: Peace, Justice, and Strong Institutions:

The smart helmet, equipped with back cameras and IoT technology, plays a significant role in promoting peace, justice, and strong institutions by enhancing surveillance capabilities and improving security measures. By incorporating back cameras into the helmet, it enables real-time monitoring and surveillance of the surrounding environment. This enhanced surveillance helps to deter potential criminal activities and ensure public safety in various settings, such as public spaces, gatherings, or terminals. The IoT technology integrated into the helmet enables seamless connectivity and data transmission, providing authorities with valuable information for quick response and efficient decision-making. By enhancing surveillance capabilities, your project contributes to the creation of safer communities, prevents potential incidents, and promotes a sense of security among individuals. It aligns with SDG 16's objective of promoting peace, justice, and strong institutions by leveraging technology to enhance public safety and security. Additionally, the project encourages the cooperation and collaboration between stakeholders, including law enforcement agencies, urban planners, and policymakers, in building safer and more secure environments.

Chapter 2

2 Background:

Some of the recently published works on IoT based smart helmets and solar analyzer have been reviewed as under:

This research intended to protect bikers from accidents by ensuring their security and safety. Without a helmet, the bike won't start because of the circuit's design. With the ideal helmet usage prior to riding, it introduced a security system on the rider. This system does not utilize Microcontroller 8051-based circuitry or advanced Java programming techniques simple operating and operation based on RF link. The motorcycle can be moved using an RF transmitter and receiver if it receives a signal from the helmet. Here, improving motorcycle safety is our key goal as we create the course. [5]

One of the past research on solar analyzer provides an alternate electricity source. It aimed to prototype a tiny smart off-grid solar cell system. In order to detect and monitor the voltage of solar cell charging, the current flowing from the solar panel into a battery, and the current flowing from the battery to the irrigation systems, this research used IOT with voltage and current sensors. A cloud service for IOT devices called was created to process voltage and current data. In this study, voltage and current sensors, relay modules, DC sprinklers, and fog pumps were employed as equipment and tools. [6]

The main algorithm for the working of the Helmet suggested an algorithm that solves the discrepancy by efficiently managing the sensor's x, y, and z axes while accounting for the passage of time. The method can be used in a variety of real-world circumstances thanks to this strategy. The system distinguishes between driving mode and parking mode to reduce false crash detection events and needless inconvenience. In doing so, it improves crash detection's precision. And by evaluating the performance of the suggested algorithm across different scenarios, it is observed that it can successfully distinguish between driving and parking modes. Additionally, it adapted crash detection events based on the specific scenario at hand. This adaptability ensures that the algorithm can adjust its response accordingly, improving the overall effectiveness. [7]

A prototype was made to detect accidents by incorporating a vibrator sensor for crash detection in the system. Upon detecting a crash, the circuit is activated, triggering an S.O.S message to be sent to the nearest hospital, police station, fire brigade, and the emergency contact of the user. This ensures that injured individuals receive emergency treatment as quickly as possible. [8]

A system was made by utilizing a parabolic antenna and gyro sensor to precisely locate moving vehicles. By replacing the stepping motor with a BLDC motor, the system addresses issues of noise and slow response speed. Implementation of a two-axis control system and a separate encoder enhances accuracy. The system is capable of tracking the desired antenna angle effectively, with minimal errors in six degrees of freedom motion. [9]

Increasing number of deaths due to the rise in traffic collisions caused by motorbike riders who do not wear helmets. It highlights the significance of taking action to improve rider safety and suggests using a smart helmet as a viable remedy. In order to promote compliance with helmet-wearing rules, the smart helmet is particularly made to detect whether the user is wearing a helmet or not. It has an ignition mechanism that only works when the user is wearing a helmet, making sure that only riders who value safety may operate the motorbike. The smart has cutting-edge components including GPS and GSM technology. Users may share their location with their family and friends in the case of an accident, giving them the information they need to request aid right away. Additionally, the IoT capabilities of the helmet make it possible to gather and send user data to the cloud. This information may be used for activity tracking, helmet wear trends, and accident analysis, providing a thorough picture of the elements influencing motorcycle accidents. [10]

A WHO study quoting about the traffic accidents discussed about the death ratio occurred due to traffic accidents. A solution was proposed for it by using the piezoelectric sensors built into a helmet to measure the degree of trauma sustained by the wearer. These sensors translate the level of stress into electrical impulses, which are analyzed to ascertain if the damage is severe and exceeds a specific threshold. It should be emphasized that this system is capable of detecting trauma brought on by different kinds of accidents. The research presents a detecting system that automatically sends an SMS to the wearer's family members and the emergency department, seeking quick aid, to ensure fast assistance. The longitude and latitude information from the SMS allow for accurate monitoring of the accident's location. [11]

In another study we have examined current developments in the Smart Helmet system in this study. The usage of the smart helmet system helps to reduce motorcycle accidents and quickly identify those that do occur in order to protect human health. Additionally, the smart helmet system examined in this research is employed in the mining sector to protect miners from dangerous situations in the mine and to warn them of dangerous gas emissions there. The study also sheds light on how the smart helmet system has changed over time and how it functions today using cutting-edge innovations like the Internet of Things (IoT). This work also discusses the intelligent motor cycle helmet system that warns the rider of approaching large trucks or buses in order to prevent crashes. [12]

The applications of smart helmets were investigated for their potential to improve the safety and convenience of motorcycle riders in a thorough assessment of 81 research. Start control, accident prevention, rescue requests, and convenience enhancement were the four main topics of these investigations. The functionality of the smart helmet's start control system was created to guarantee that the biker complied with safety regulations. This was done by making sure the cyclist was wearing a helmet and looking for symptoms of intoxication. When one of these requirements wasn't satisfied, the smart helmet took over and stopped the motorcycle from starting. Another important area that smart helmets are addressing is accident prevention. These helmets have sophisticated sensors that could identify a range of possible threats. The smart helmet might quickly recognize dangerous conditions by keeping an eye on variables including speed, blink patterns, and sleepiness. In these situations, the helmet sent the motorcyclist warning warnings, thereby lowering the possibility of accidents. Additionally, smart helmets provided a useful capability for rescue calls. These helmets were equipped with clever technology that could detect car accidents. The smart helmet instantly began a rescue request through text or phone call after an accident was detected. [13]

Similarly for the Solar Analyzer a recent article has provided a comprehensive study of several advanced fault detection approaches in PV systems. The study has divided fault detection approaches into model-based difference measurement (MBDM), and real-time difference measurement (RDM). A PV module can be modeled electrically with a one-diode or two-diode model. However, modeling a real PV system is very complex because electrical parameters vary largely between PV systems due to variations in the construction of PV modules (dimension, material, and ground connection), site, and physical layout. Especially in large-scale power generation systems, modeling a system comes with a special technical challenge. In this study, we have limited our work to detect only electrical faults [14].

The use of reflectometry methods have also been used for fault detection in PV systems. A time domain reflectometry (TDR) method was used to detect short circuit and insulation defects, and recently, a spread spectrum TDR (SSTDR) method was investigated to detect ground faults and aging-related impedance variations in a PV system. [15]

The different types of faults that can occur in the PV panels are Environmental faults include soiling and dust accumulation, bird drops, and temporary shading. Permanent environmental faults include permanent shading due to the poor choice of installment location. Hotspot faults in the PV modules can be caused by both permanent and temporary shading. Lastly, electrical faults include open circuit, line-line, and ground faults, either in PV modules, arrays, or whole systems. Open circuit faults are caused by the disconnection of wires in single or multiple branches of a PV circuit [16].

The types of faults that can occur due to the wires which are connecting the panels. If any fault occurs such as a ground fault, open circuit, short circuit, or partial shading of panels can reduce the efficiency of the system. These types of faults must be addressed in time. Prevention maintenance cost is better than Breakdown maintenance cost. To do this, we have to go for the manual process which is costly and time taking as well [17].

The information about the collaborative initiative which led to the creation of sophisticated SMDs, accompanying algorithms, and software that enable thorough monitoring, problem diagnosis, and PV array optimization can be improved which results in the better performance of the panels [18]. The Monitoring utility-scale solar arrays that is essential for lowering maintenance costs and improving array performance under a variety of circumstances. In this in-depth study report, we outline the complex layout of a cutting-edge testing facility with a powerful 18 kW power capacity. This cutting-edge facility has a staggering 104 solar panels, each precisely outfitted with modern smart monitoring technology. These advanced monitoring systems are made up of a variety of intricate parts, such as sensors, wireless transceivers, and relays. The devices are enabled by this combination of cutting-edge technology to continuously monitor the solar panels, identify issues in real-time, and even enable dynamic connection topology modifications as and when necessary.

These devices' seamless integration with the facility guarantees a strong monitoring infrastructure, enabling thorough and accurate data collecting under a variety of scenarios. In this in-depth study report, we outline the complex layout of a cutting-edge testing facility with a powerful 18 kW power capacity. This cutting-edge facility has a staggering 104 solar panels, each precisely outfitted with modern smart monitoring technology. This experimental facility's capacity to create networked data exchanges with a variety of entities is one of its primary characteristics. The facility's monitoring equipment and dedicated servers, fusion and control centers, as well as mobile devices, can all communicate with one other without interruption thanks to wireless data sharing capabilities. This interconnected environment promotes effective data flow, enabling quick analysis and decision-making for the best possible array management. [19]

Chapter-3

3 Project Introduction and Motivation

3.1 For SH:

The helmet project incorporates a comprehensive range of sophisticated and innovative features that are specifically designed to revolutionize rider safety and elevate the overall functionality of the helmet. At its core, the gyro sensor (accelerometer) assumes a pivotal role in meticulously monitoring abrupt changes in motion, encompassing impacts or falls, with the primary objective of promptly detecting and identifying potential accidents. In parallel, the integration of the cutting-edge GPS module (Neo6M) equips the helmet with unparalleled capabilities for providing exceptionally accurate and real-time location tracking. This intrinsic feature enables the helmet to constantly and seamlessly monitor the precise position of the rider, offering a critical advantage during emergency situations by facilitating the rapid and precise location of the rider in need. In tandem with the gyro sensor and GPS module, the helmet's GSM module (SIM800L) harnesses the power of cellular networks to establish seamless and instantaneous communication channels. Leveraging this capability, the helmet can expediently transmit emergency alerts, which include precise location information, to pre-determined contacts or emergency services. This seamless and rapid exchange of information ensures that necessary assistance can be dispatched swiftly and efficiently. To further bolster safety measures, the helmet integrates an intuitive and immediate alarm system in the form of an integrated buzzer. In the event of a crash or accident, the buzzer instantaneously activates an audible alarm, effectively notifying the rider and individuals in close proximity, thus significantly increasing the likelihood of immediate assistance. In order to empower riders with enhanced situational awareness, the helmet incorporates an LCD display that seamlessly integrates a rear view camera. This dynamic integration enables riders to have an unobstructed view of the road behind them, significantly augmenting their ability to detect potential hazards and proactively ensure their safety. Additionally, the helmet boasts Bluetooth connectivity, enabling riders to engage in hands-free communication without the need to remove the helmet. This feature facilitates seamless integration with compatible devices, such as smartphones, and enables riders to effortlessly make or receive calls, thereby minimizing distractions and optimizing their focus on the road ahead. Furthermore, the incorporation of HC-12 transmitters equips the helmet with exceptional wireless communication capabilities, enabling seamless and reliable transmission of signals related to crash detection or the reception of commands from external sources or systems. In terms of power management, the helmet is fortified with a boost converter and Battery Management System (BMS), which effectively regulate the power supply to the various components and diligently monitor battery levels. This intelligent and robust power management system ensures optimal utilization of the helmet's battery, effectively preventing overcharging or excessive discharge and contributing to prolonged battery life. Finally, the helmet's compatibility with the Arduino Nano allows for extensive data logging and in-depth analysis. This empowers users to capture and store crash-related data, such as impact intensity and timestamps, fostering comprehensive post-incident analysis and documentation for future reference, research, or safety improvement initiatives. Through the synergistic integration of these cutting-edge features, the helmet project sets a new standard in rider safety, offering a holistic and technologically advanced solution that aims to safeguard riders' lives and enhance their overall riding experience. Furthermore, the helmet project also incorporates an advanced power management system to ensure efficient usage and protection of the battery. The boost converter and Battery Management System (BMS) work together to regulate the power supply to the various components of the helmet and closely monitor battery levels. This intelligent system prevents overcharging and excessive discharge, thereby extending the battery life and ensuring reliable performance throughout the rider's journey. The helmet do all this offers data logging and analysis capabilities through the integration of the Arduino Nano. This allows for the collection and storage of crash-related information, including impact intensity and timestamps. Such data can be further analyzed for research purposes, documentation, or to identify patterns and improve safety measures.

3.2 IMPLEMENTATION:

3.2.1. Expected Outcomes for Smart Helmet:

Our project contains multiple features. The main focus of our project is:

- Improved road safety.
- Collision detection & SOS Alert via SMS.
- Live Location of the rider.
- Reasonable Cost.
- Compatible with all bikes.

3.2.2 Expected Outcomes for Solar Analyzer:

- It gives clear information about various solar parameters, extracted energy, fault detection, historical analysis of the solar plant, and associated energy loss.
- It can easily measure our solar production ratings and the saving on our monthly electricity bill.
- It can track all the important parameters of the solar PV system.
- Consumers will be able to monitor their runtime ratings of installed solar panels.
- It will display data on screen as well as on smartphones.

- Fault tracing would be possible.
- IOT-Based Solar Analyzer would be of reasonable cost.

When compared to other costly single-included items that contribute to the success of our operation, all of these bundles come at almost no expense.

3.3 SENSORS AND PIN CONFIGURATION

3.3.1. GPS

PIN D8 and D9 will be used for RX and TX respectively. The system's NEO 6M module's function is to calculate the precise longitude and latitude coordinates based on the location of the object on Earth. The NEO 6M module is able to calculate these coordinates precisely by utilizing cutting-edge satellite technology, which can subsequently be used for various purposes within the system. The NEO 6M module delivers the longitude and latitude data to the Arduino microcontroller after obtaining it. The data is received by the Arduino, which serves as the main processing unit, and can then display it on the serial monitor. This facilitates real-time monitoring and analysis of the system's location-based functionality by enabling users or developers to conveniently inspect the generated longitude and latitude values. By providing current and accurate geographic data, the NEO 6M module's connection to the Arduino expands the system's possibilities. This information may be used by a wide range of applications, such as tracking devices, mapping systems, and location-based services. Additionally, by displaying the longitude and latitude on the serial monitor, the system's other components may seamlessly connect with it and have easy access to them.

3.3.2. GSM

The PIN D2 and D3 pins will be connected to the RX (receive) and TX (transmit) pins of the SIM 800L module. Communication between various functional modules is made possible via the SIM 800L module, which also makes it possible to send messages to a family or a hospital. The SIM800L module will get the necessary information from the system functional module when it wants to send a message. The communication interface, which is a SIM card in the SIM800L module, enables messages to be delivered to the intended recipients, such as hospitals or family members. This module, in addition to relaying messages, may also offer important position information through GPS. The module may establish its precise geographical coordinates and integrate this data with the transmission information by including GPS capabilities. This allows hospitals and family members to not only receive messages but also determine the sender's location.

3.3.3. Dht-11 (Temperature & Humidity Sensor):

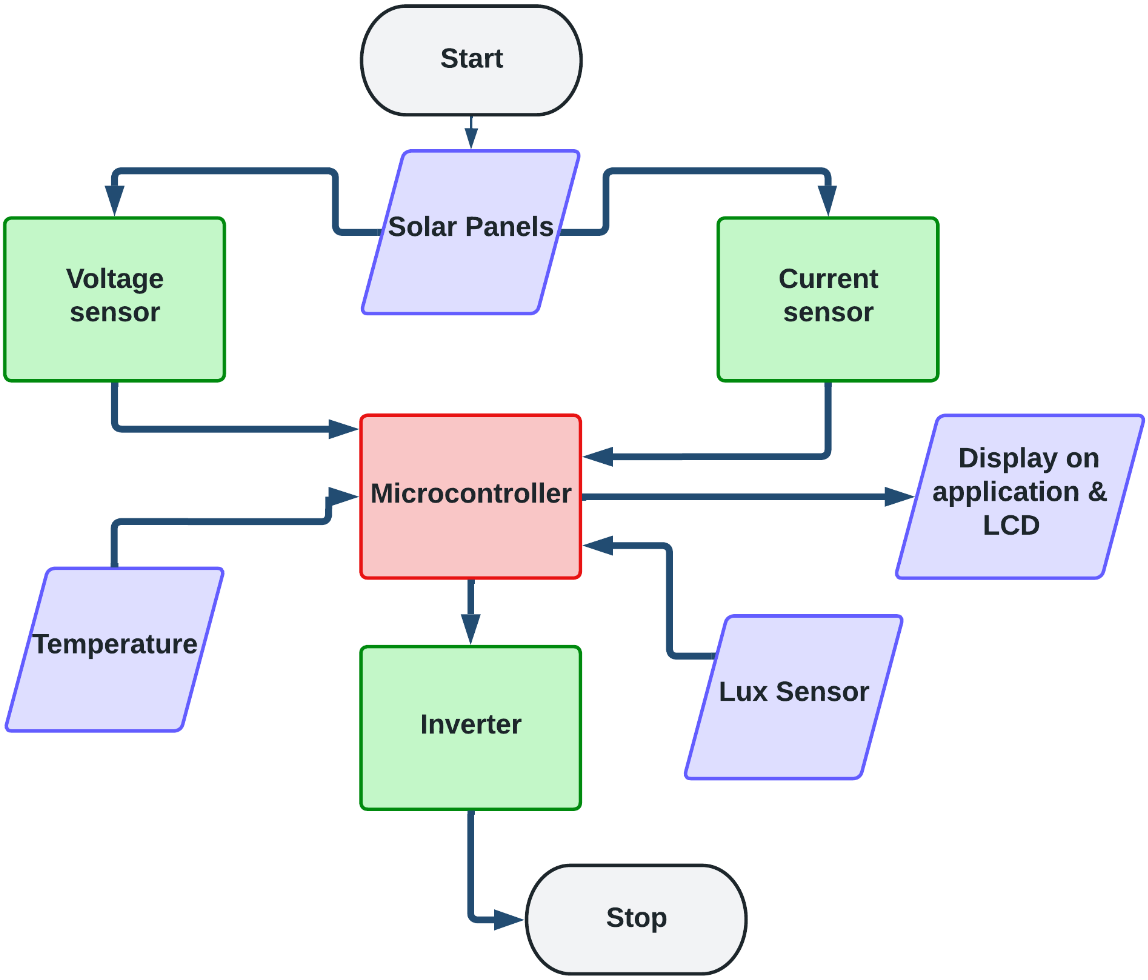
PIN SDA and SCL will be used to connect Dht-11 to microcontroller through I2C respectively. A quick and affordable solution to keep track of the temperature & humidity in the area and improve the efficiency of our solar power system is to use a DHT11 temperature & humidity sensor. We use a DHT11 temperature and humidity sensor in our solar analyzer to measure the ambient temperature & humidity of the surrounding environment.

The DHT11 is a widely used low-cost sensor for monitoring temperature and humidity in a range of applications, including solar analyzers. It is frequently used in DIY electronics projects. We utilize a digital input pin to link the DHT11 sensor to our microcontroller in order to use it in our solar analyzer. In order to read data from the sensor on our microcontroller, we download and install a DHT library. We have used the library functions to read the temperature & humidity information from the DHT11 sensor once it is attached to our microcontroller and the library has been installed. Depending on how the library is set up, the DHT11 sensor produces temperature values in either Celsius or Fahrenheit and humidity in percentage.

Our solar analyzer can track the ambient temperature & humidity of the area where the solar panels or system are installed using the temperature & humidity information from the DHT11 sensor. This information can be helpful for evaluating the solar system's performance and locating any elements that might be reducing its effectiveness.

3.4 Block Diagram:

3.4.1 For Solar Analyzer:



<u>Fig 1: Block Diagram for Solar Analyzer</u>

In fig 1, we explore the complexities of the solar analyzer and its flawless operation in this illuminating block diagram. The micro-controller, a key component in charge of coordinating the actions of all the sensors attached to it, is at the center of this effective system. The solar analyzer's brain, this clever micro-controller, ensures efficient coordination and data processing.

One of the most important parts, the voltage sensor, is responsible for monitoring the voltage produced by the solar panels. This sensor precisely measures the voltage levels by utilizing the voltage divider rule. The ACS-712 current sensor powers the current sensor, which simultaneously and accurately monitors the electric current moving through the system. The analyzer can determine the generated power using the straightforward yet effective formula P = VI, where P stands for power, V for voltage, and I for current. This is made possible by the simultaneous readings. A temperature sensor is included into the micro-controller system to increase the solar analyzer's capability. This temperature sensor does two tasks: it records the ambient temperature and compares it to the ideal circumstances for that particular moment and other environmental characteristics that are recorded in the database. This thorough temperature study enables a deeper comprehension of the system's functioning and offers insightful information for optimization. The solar analyzer has a user-friendly 16x2 LCD display that is seamlessly integrated for improved user engagement and data visualization. This display acts as an educational interface by giving the user real-time ratings of the solar panels. The LCD display enables users to easily monitor the system's health and efficiency by giving them fast access to critical performance information. Additionally, the micro-controller is essential to the solar analyzer system's data handling and transmission. It gathers information from the numerous sensors, analyses it, and stores it for further study. This information may be used to monitor the efficiency of the solar panels over time, spot any anomalies or deviations, and come to wise maintenance or optimization choices. The micro-controller makes it possible to communicate easily with systems or devices outside the system. The exchange of data, remote monitoring, and even integration with more comprehensive energy management systems are all made possible by this connectivity. The solar analyzer may send real-time data to servers, fusion and control centers, or even mobile devices for thorough monitoring and analysis by creating a dependable network interface. In short the block diagram for the solar analyzer offers a comprehensive analysis of the system's operation. As the brain of the system, the micro-controller effectively controls the sensors to provide accurate measurements of voltage and current. These observations then make it possible to calculate power using a simple formula.

3.5 SOLAR POWER GENERATION MONITORING:-

This is done by using the solar analyzer in which the different sensors measure the voltage, current, temperature and light intensity respectively.

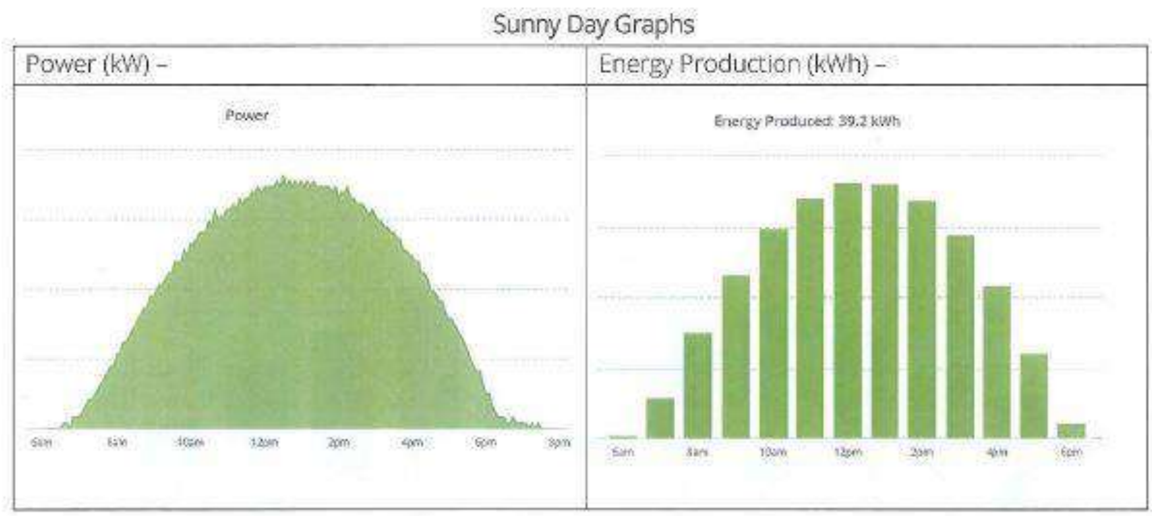


Fig 2: Power Generation Graph

Figure 2 is essential in order to clearly depict the complex power generation patterns that develop during the course of a day. It highlights the various time periods. This vast amount of priceless information is painstakingly collected and entered into the database, where it plays a vital function as a point of reference for comparing the measurements for electricity generation at different times of the year. The real-time power statistics of the solar panels are compared to historical data on power generation as a standard, making it easier to spot abrupt or unexpected swings. The solar analyzer system carefully examines these comparisons to identify any significant variations in power generation and instantly alerts the user to these deviations. This real-time alert system serves as a preventative strategy by enabling users to act promptly in response to abnormalities and improve system performance. The solar analyzer system provide users a greater grasp of the dynamics of the array's performance over various timeframes by exploiting the extensive database of power generation patterns. This historical view helps with trend analysis and aids in spotting possible performance problems or administrative inefficiencies. With this information, users are better equipped to make choices that will increase system output, reduce any possible losses, and guarantee optimum performance over the long run.

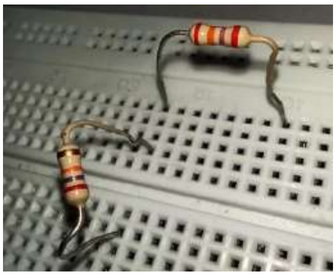


Fig 3: Voltage Divider Circuit

In fig 3, a voltage divider circuit is shown through which the voltage output of a solar panel or system can be measured simply and accurately by using a voltage divider circuit as a voltage sensor. We can measure the voltage precisely and utilize the results to improve the efficiency of our solar power system with the proper configuration and calibration. A simple circuit called a voltage divider can be used to split a voltage into smaller amounts that a microcontroller or other device can measure. Once the voltage divider circuit is constructed, you can use it to measure the output voltage by connecting it to a microcontroller's analog input pin. Once the voltage data has been processed, the microcontroller can analyze it to determine how well the solar panel or system is working.

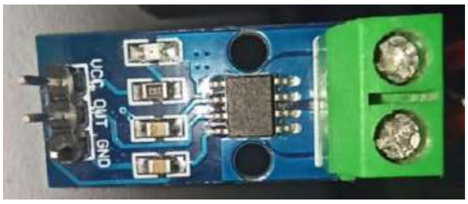


Fig 4: Current Sensor (ACS-712)

A current sensor is used to gauge the amount of electrical current flowing through a circuit. Current sensors are in two main categories: invasive and non-invasive. For this we are using ACS-712 which is a non-invasive current sensor. These current sensor does not require direct physical contact with the circuit to measure the current because it is a non-invasive sensor. This is useful for solar analyzer devices when physical access to the solar panel or system may be difficult or prohibitive. For monitoring the efficiency of a solar panel or system, the ACS712 current sensor offers a high degree of accuracy in detecting current. To reduce mistakes in current measurements, the sensor includes a low offset voltage and a linear response. And with all that the ACS712 current sensor uses relatively little power, which is crucial for solar analyzer devices that are powered by solar panels or batteries. The device's operating life is increased by the low power consumption, which also helps to conserve energy.

Fig 5: ESP-32

The ESP32 is a highly versatile microcontroller-based system-on-chip (SoC) that has gained significant popularity in the field of Internet of Things (IoT) and embedded systems. It offers a powerful processing unit with dual cores and clock speeds of up to 240 MHz, providing ample computational power for complex tasks. Additionally, it features built-in Wi-Fi and Bluetooth connectivity, making it suitable for a wide range of IoT applications. With its rich set of peripherals, including GPIO pins, SPI, I2C, and UART, the ESP32 enables easy interfacing with external devices and sensors. It provides ample memory and storage capabilities, allowing for the efficient storage of data and firmware. Moreover, the ESP32 can be programmed using popular development environments such as the Arduino IDE, Micro-Python, or the official ESP-IDF, providing developers with flexibility and convenience.

The main controlling element for the whole implementation was the ESP-32 microcontroller. It played a crucial part in synchronizing the actions of the current sensor and voltage sensor as well as in handling the data gathered. The ESP-32 enabled smooth connection and data exchange between the sensing devices and the mobile application thanks to its powerful processing capability and many input/output pins. In addition to being utilized for real-time monitoring, the sensor data was also used to present the results on a mobile device. Users will easily be able to see and comprehend the gathered data thanks to the integration of a mobile application. Users may access and thoroughly analyze the electrical characteristics using this mobile interface's user-friendly and straightforward platform.

3.6 Solar Readings Rate pattern under normal condition:

The recorded voltage values obtained under typical temperature and lighting circumstances are depicted in the graph. This specific collection of data was acquired to investigate the electrical potential variations in a regulated setting. We attempted to exclude any outside influences on the voltage readings by sustaining a constant temperature and light level throughout the experiment.

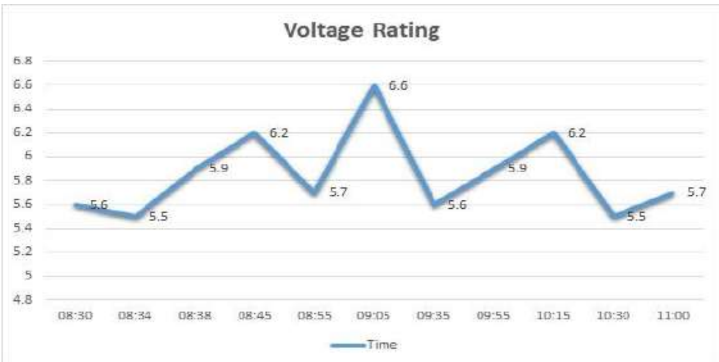


Fig 6: Voltage Time Graph

The y-axis of the presented graph signifies the corresponding voltage levels measured at each time interval, while the x-axis indicates the amount of time that has passed since the data gathering procedure began. A continuous line connecting the data points on the graph enables visual study of the observed voltage trends. The voltage readings reveal a pattern of changes under the defined standard temperature and light conditions. These changes imply that the system being examined has internal electrical activity. It is significant to highlight that these oscillations are within a range that previous studies and theoretical models have predicted.

Fig 7: Current Time Graph

The y-axis in the graph indicates the corresponding current values that were recorded at each time interval, while the x-axis in the graph reflects the amount of time that has passed since the data gathering procedure began. A continuous line connecting each data point on the graph allows for visual study of the observed current trends. The current measurements show observable patterns and variations under the set standard load, temperature, and light conditions. These changes imply that the system being observed has inherent electrical activity. It is important to recognize that these oscillations fall within the range that previous studies and theoretical models have predicted.

3.7 Factors affecting the efficiency of Solar panels:

3.7.1 High Temperature:

The effectiveness of solar panels is negatively impacted by high temperatures. A decline in total panel performance is caused by higher heat losses, decreased voltage output, increased resistance, and decreased energy conversion. Particularly in areas with hot climates, employing efficient thermal management techniques, optimizing panel installation, and investigating innovative materials can help reduce these impacts and increase the effectiveness of solar panels.

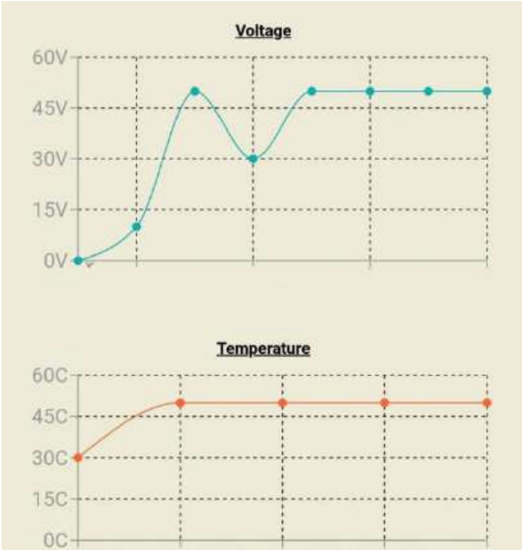


Fig 8: Comparison of Voltage and Temperature Graph

3.7.2 Poor Light Availability:

Sunlight is used by solar panels to produce power. The quantity of electricity produced by the solar panels diminishes when light is scarce, such as on overcast days or in shadowed places. Lower energy output occurs as a result of less sunshine since there are fewer photons available to excite electrons in the solar cells. The quantity of sunshine that solar panels get directly affects how much power they can produce. The power output of the panel's declines when there is insufficient light available. This may have an effect on a solar power system's overall performance, particularly if the system depends largely on the energy produced by the panels. The percentage of sunlight that solar panels can convert into useable power is measured by their conversion efficiency. The conversion efficiency decreases when light is scarce. Lower light intensities may cause the materials used in solar cells to perform less well, decreasing the total efficiency of energy conversion. For solar panels to work, either natural or artificial light is needed. The effectiveness of solar panels may be seriously hampered in conditions when light supply is constantly insufficient, such as in areas with extended periods of cloudy weather. The dependability and efficiency of solar energy systems in such conditions may be constrained by their reliance on outside light sources.

3.8 For Smart Helmet:

Methodology:

The Smart Helmet consist of three main features: accident prevention, rear- view camera and emergency alert.

3.8.1 Rear-view Camera and heads up display:

The addition of live streaming rearview technology to automobiles offers a substantial improvement in terms of improving driver convenience and safety. This novel function makes use of a helmet-mounted camera to record the scene directly behind the car in real time. The camera stream is then sent to a 2.5-inch heads-up display (HUD) mounted on the visor, giving the driver a clear picture of the surroundings behind him or her. This cutting-edge device successfully removes blind spots, which have long been an issue for drivers, by removing the dependency on conventional side mirrors. With the HUD, drivers may retain a clear and thorough awareness of the traffic and things behind them. The HUD functions as a virtual rearview mirror. This real-time rearview display improves situational awareness greatly, enabling safer lane changes, maneuvering in small areas, and managing challenging traffic situations. The HUD itself has a number of benefits. Its small size and location on the visor guarantee that the driver's attention is always on the road, minimizing distractions and eliminating the need to switch between various mirrors or screens. The rearview feed is projected into the driver's line of sight via the heads-up display technology, ensuring that they may quickly access important information without having to take their eyes off the road. The inclusion of this technology to the helmet also offers more convenience and flexibility. A natural and intuitive viewing experience is provided by the camera's direct helmet mounting since it travels along with the driver's head motions. This dynamic feature of the system improves the capacity of the driver to properly and swiftly analyze their surroundings and make judgements while driving. The live streaming rearview function improves overall driving safety by lowering the likelihood of crashes and accidents. Drivers can proactively identify possible risks, such as oncoming cars, pedestrians, or bicycles, by having an unobstructed view of the surroundings behind them. The system may also include cutting-edge capabilities like object identification and collision alerts, which would increase the safety advantages even further.

3.8.2 Block Diagram For SH:

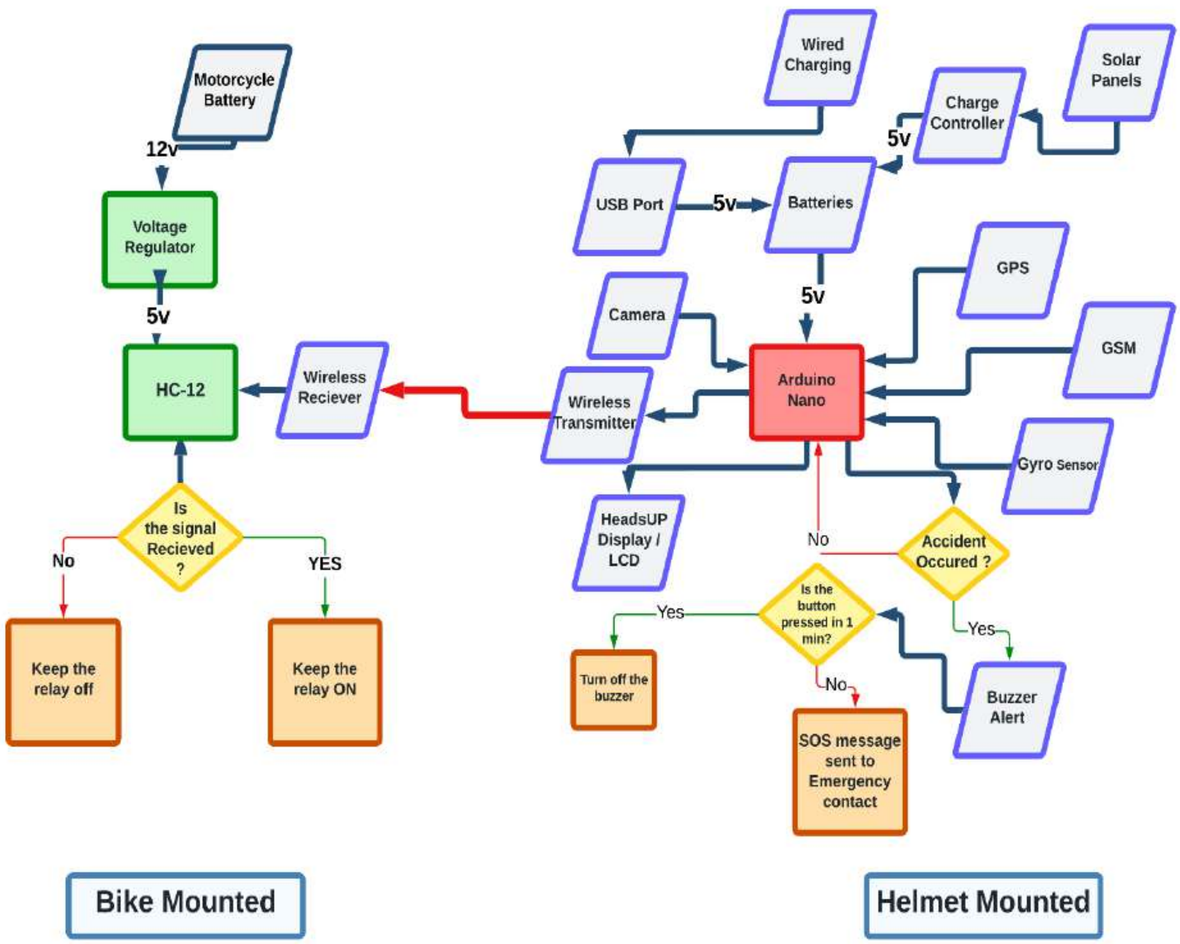


Fig 9: Block Chart For Smart Helmet

3.8.3 Detection:

Our solution depends on the embedded GYRO sensor, which is connected to the microcontroller and sets off an alarm whenever an impact happens. This sensor's purpose is to identify abrupt axis shifts that signify a sizable change in motion. It works by monitoring the sensor's signal continuously and starting a timer when an impact is detected. The timer starts and waits for the user's reaction for one second after activation. The microcontroller reads a response from the timer that occurs inside this window as a low signal, which rules out an intruder or an emergency. Such circumstances result in no GSM module activation and no alarm transmission. The microcontroller reads a timed failure to get a response within one second as a strong signal, suggesting a potential emergency. The GSM module is then turned on once the microcontroller issues a command to it. The timer is turned off at the same moment that the microcontroller starts figuring out the collision time and range. When these numbers are calculated, the microcontroller provides a low signal if the resulting collision time is below a set threshold. This causes the aforementioned procedure to be repeated, enabling ongoing monitoring and evaluation. The collision time must surpass the threshold value to indicate a major effect, though. In certain circumstances, the alarm is set off and a signal is sent to the user's emergency contact by the microcontroller and GSM module.

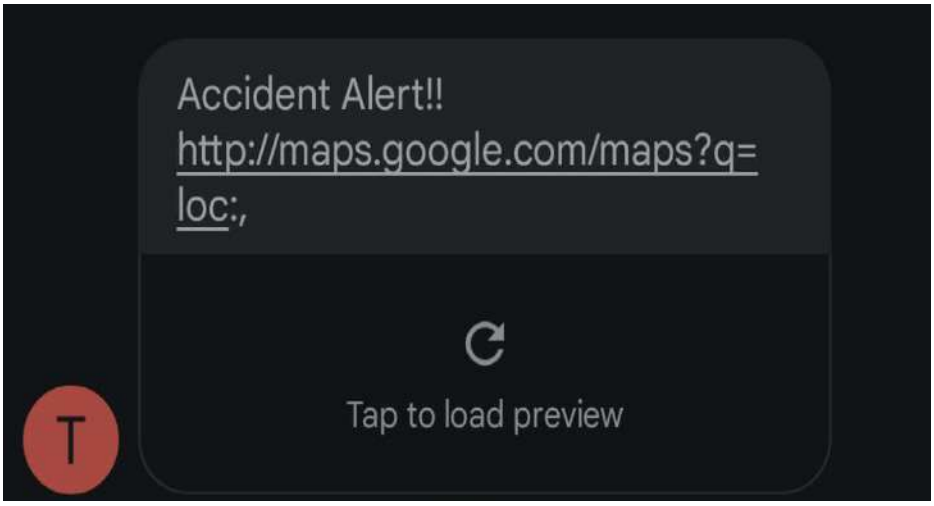


Fig 10: Notification Alert

3.8.4 Transmission of Information:

The microcontroller immediately reacts to the interrupt signal generated by the GYRO sensor by transmitting a high value signal to the GSM module. This signal acts as an instruction to turn on the GSM module and start the required processes. The GSM module gets into work right away and uses its capabilities to send an SMS to a pre-specified phone number. The recipient of this SMS will be informed of the exact location of the event thanks to the inclusion of important information in it, such as the GPS coordinates of the accident site. The SMS also contains an alert message that informs the intended recipient of the urgency and importance of the issue. Our solution makes it possible to quickly send this information to a preset contact using the GSM module's SMS capability, which allows quick and effective sharing of crucial facts. Because of this, timely action may be made to deploy emergency personnel to the scene or alert someone who can provide on-the-spot help.

3.8.5 Gyroscope Sensor:

A gyroscope sensor is essential for sensing the rate of rotation or angular velocity along the three axes in an IoT-based smart helmet. Its integration into the helmet system offers a number of useful capabilities that improve user experience overall while also boosting safety and navigation. Head movement tracking is one of the main reasons a gyroscope sensor is used in a smart helmet. The wearer's head is precisely tracked by the gyroscope sensor, enabling a variety of applications. In augmented reality programs, for instance, where the wearer's head motions are used to operate virtual objects or interact with digital information, it can track head movements to provide feedback. The gyroscope sensor can also operate other helmet features that depend on head orientation, such changing the visor or pausing music. The smart helmet system's balance and stabilization are also aided by the gyroscope sensor. The sensor is able to identify any potential loss of balance by continuously scanning for jerky movements or tilts of the helmet. To stabilize the helmet or start remedial measures to stop mishaps or injuries, use this information. For instance, the internal systems of the helmet can be adjusted if the gyroscope sensor detects a sudden tilt or imbalance in order to preserve stability and assure the wearer's safety. A smart helmet's gyroscope sensor can also be an essential part of the fall detection system. The sensor can detect unexpected falls or collisions by continuously monitoring the helmet's orientation and angular velocity. The gyroscope sensor can quickly warn the central control system or launch emergency response procedures in the event of a fall. The safety of helmet wearers is considerably improved by this feature, especially in situations where prompt aid or action is necessary. An IoT-based smart helmet that includes a gyroscope sensor offers a number of capabilities that improve user experience, increase safety, and help with navigation. The sensor offers accurate head movement tracking, making it easier to engage with augmented reality apps and manage different helmet features. Additionally, it aids in stabilization and balance, offering a secure and comfortable wearing experience. Additionally, the fall detection feature of the gyroscope sensor adds an extra layer of security by instantly spotting and reacting to probable mishaps or collisions.

Fig 11: GYRO Sensor

3.8.6 GPS :

The Global Positioning System (GPS), which was first created for military use, has experienced an amazing metamorphosis and is now widely available and essential for civilian usage. Its vast range of applications includes transportation, mapping, surveying, outdoor leisure, agriculture, logistics, and emergency response. The way we navigate, track assets, and pinpoint our exact location on Earth has been revolutionized by GPS, which has become into a necessary instrument.

A distinct collection of data, continuously transmitted by each GPS satellite, gives its exact orbital location and time information. These satellites' synchronisation makes sure that their signals are broadcast at the same time. These signals do, however, come at somewhat varied times because of the changing distances between the receiver and the various satellites. The receiver can precisely identify its distance from each satellite by carefully monitoring the time it takes for signals from several satellites to reach the receiver, a procedure known as trilateration. The receiver uses advanced algorithms to compute its accurate three-dimensional position using this essential information, taking latitude, longitude, and altitude into account. The National Marine Electronics Association (NMEA) - 0183 protocol is used by the GPS system to provide standardised communication between GPS devices. In order to ensure interoperability and easy integration within larger systems, this protocol specifies the structure and format of the data sent between GPS receivers and other devices. The GPS receiver, which acts as the main sensor for location detection in this system, is a crucial part. A GPS receiver must have excellent sensitivity and accuracy when obtaining and tracking GPS signals to ensure peak performance. Modern GPS receivers are equipped with cutting-edge features like parallel channels and large search bins. Even when a receiver has lost its prior location information (cold start), these characteristics enable quick collection of satellite signals and cut setup time to just a few seconds. Furthermore, even in difficult circumstances like congested metropolitan areas where satellite signal reception may be hampered, these receivers' extraordinary tracking sensitivity, which can reach levels as low as 159 dBm, enables precise navigation performance. The potential for GPS in the future is really promising. Constant improvements in satellite technology, like the creation of the newest GPS satellites, promise wider coverage, better signal quality, and greater accuracy. Further enhancing the precision and dependability of GPS location is the widespread use of augmentation systems like the Wide Area Augmentation System (WAAS) and the European Geostationary Navigation Overlay Service (EGNOS). We should expect more advancements in GPS technology as it continues to develop, opening up new opportunities and uses

Fig 12: GPS

3.8.7 GSM :

The GSM modem, which resembles a featureless mobile devoid of a display, keyboard, or speakers, is essential to the system for preventing accidents and reporting them. A SIM card may fit into this specialized gadget, which needs a mobile network operator subscription to function. Surprisingly, more than 690 mobile networks provide GSM services throughout 213 nations, making GSM the technology of choice with 82.4% of all mobile connections worldwide. GSM offers practical features like short message services (SMS) and General Packet Radio features (GPRS) for effective data transfer in addition to voice communication. In order to enable simultaneous communication, GSM technology is excellent at digitizing and compressing information before delivering it across channels that can handle two separate streams of user data. Although there are two more frequency bands available, this technology only uses the 900 MHz or 1800 MHz frequencies. The aforementioned bands, however, are the most often used ones. Data transport is dependable and quick with GSM because to its 270 kbps transmission rate. The GSM network's modem is used as the conduit by which the accident's position is sent. The microcontroller's ability to operate it makes for easy incorporation into the system for reporting and preventing accidents. The GSM modem has capacitors and resistors to guarantee correct performance, which contribute to its dependable operation. In addition, LEDs are used to show the network status. When the circuit is turned on, the network status pin specifically offers instant input on network accessibility. A green LED is used to show this condition; it blinks quickly throughout the network acquisition stage and slowly after the network assessment is finished. Expanding on the GSM technology and GSM modem subject allows us to examine a number of factors that contribute to its widespread use and efficiency. People may communicate and connect easily regardless of where they are because to the wide-ranging GSM network coverage across the world. Additionally, the addition of SMS and GPRS services broadens GSM technology's capabilities beyond voice communication, enabling effective data transfer and supporting a variety of applications and services.

Fig 13 : GSM module

3.8.8 HC-12 Trans receiver:

A typical wireless communication component found in Internet of Things (IoT)-based smart helmet systems is the HC-12 transmitter. The goal of this communication channel is to create a trustworthy, extensive line of contact between the smart helmet and a centralized control or monitoring system. The helmet can send and receive data from the central system thanks to the two-way communication provided by the HC-12 transmitter. The HC-12 transmitter's long-range capacity, which makes it suited for applications where the smart helmet may be positioned at a great distance from the central system, is one of its main advantages. This makes communication possible even when the person wearing the helmet is a long range from the monitoring or control station. Another key advantage provided by the HC-12 transmitter is wireless communication. By doing away with the necessity for physical cable connections, the smart helmet system is more flexible and mobile. The smart helmet's integrated sensors can send sensor data more easily thanks to the HC-12 transmitter. Data from sensors that measure variables like temperature, humidity, acceleration, or heart rate are included in this. This information can be sent to the central system, which can then use it for monitoring, analysis, or to take the appropriate actions in response to the sensor readings. Additionally, the smart helmet can receive commands or instructions from the central system thanks to the HC-12 transmitter. These commands offer a method of remote control and can be used to activate particular features or abilities of the helmet. The HC-12 transmitter enables continuous real-time monitoring, enabling the central system to keep track of the condition and functionality of the smart helmet. This makes it possible for quick replies to be given in situations requiring remote control, such as emergencies, departures from usual operating protocols, or other such situations. The HC-12 transmitter makes it possible to record data from the smart helmet and transfer it to the central system, which makes data logging and analysis easier. This information can be used to evaluate performance, look back at historical patterns, or learn more about how people use helmets, behave, and other safety-related matters.

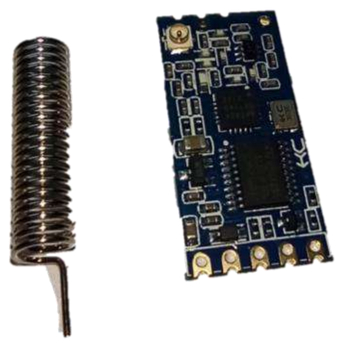
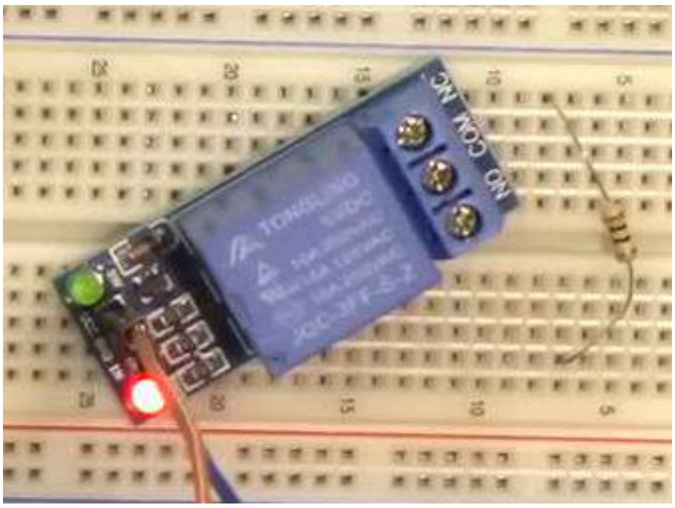


Fig 14: HC-12 Trans receiver module

3.8.9 Single Channel Relay:

A 5V single-channel relay can be activated by the HC-12 Transmitter when the receiver unit detected a loss of signal. Upon activation, this relay served as a switch to cut off the bike's power source, guaranteeing an automatic power-off. Relay control was put in place as a failsafe to deal with circumstances when the helmet was outside the specified range or when the communication link between the helmet and the bike was broken. The receiver device may detect signal loss by continually monitoring signal strength. The receiver device started taking the appropriate steps to activate the 5V single-channel relay as soon as it noticed a loss of signal. The 5V single-channel relay was crucial to how the bike turned off. The relay switched from its default state as soon as it received the activation signal from the receiver unit. The result of this state transition was that the electrical connection within the bike's power system was broken. As a consequence, the bike's power source was essentially cut off, which caused the bike to turn off on its own. When this system evolved, the relay control mechanism showed its importance in maintaining the security and safety of the bike and its user. The method offered a dependable and effective way to power off in cases when the communication link between the helmet and the bike was impaired by adding the relay as a vital component. This proactive method reduced possible dangers and avoided unauthorized usage of the bike or mishaps that may occur if the bike's engine continued to run even while the helmet was out of range.



<u>Fig 15: Single Channel Relay module</u>

3.8.10 Control Unit:

As the main element of our control unit and the key component of our identification architecture, the Atmel ATMega328 microcontroller performs a crucial role. This microcontroller is in charge of receiving data from the GPS module, processing all pertinent information, and pinpointing the location of the accident using the processed data. The microcontroller is also in charge of notifying the proper parties of the accident's location. With 8 k-bytes of in-system programmable flash memory, the ATMega328 microcontroller is a high-performance, low-power gadget. Because of its on-chip flash memory, the program memory may be easily updated either within the system itself or using a conventional non-volatile memory programmer. This feature offers flexibility and simplifies any required software upgrades or adjustments for the control device. The ATMega328 microcontroller provides a flexible and affordable solution for a variety of embedded control applications thanks to its robust features. It is the perfect fit for our identification framework, where effective operation and appropriate power management are vital due to its performance and low power consumption. We can create a stable and sturdy control system for our identification framework by utilizing the ATMega328 microcontroller. Since it is flexible and may be programmed in-system, the control unit can adjust to changing requirements and updates as necessary. Overall, our embedded control system has a great foundation thanks to the ATMega328 microcontroller, which also supports the efficient and effective operation of our identification framework.

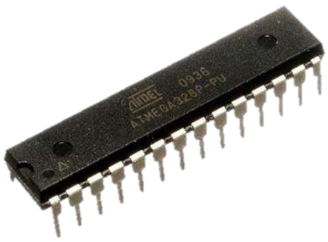


Fig 16: Atmel ATMega328

Chapter 4

4 SOFTWARE

4.1 Software

Mainly two software are used to take make this project completely. Arduino IDE was used to do the coding for the microcontroller. Android Studio was used to make the mobile application

4.1.1 Arduino IDE:

The Arduino IDE (Integrated Development Environment) is an open-source tool used to generate software for Arduino microcontroller boards. It has a simple user interface that makes developing and uploading programs to the Arduino board straightforward.

The Arduino IDE is built on the Processing programming language, which is a simplified version of Java that is easy to learn for novices. It provides a simple code editor with syntax highlighting, auto-completion, and error checking to help programmers write code faster.

The integrated programming environment (IDE) has a library manager that allows users to rapidly search and install libraries that have pre-written code for various sensors and modules, such as sensors for temperature, humidity, and motion detection, among others.

Fig 17: Arduino IDE

4.1.2 Android Studio:

The Android Studio Integrated Development Environment (IDE) is used to build applications for the Android operating system. It is a comprehensive software development environment that includes a number of tools for creating Android applications.

Android Studio's code editor, which includes features like syntax highlighting and code completion, provides an easy method to develop code. A visual layout editor is also available, allowing programmers to construct their applications' user interfaces by dragging and dropping widgets, views, and components.

Real-time error checking and debugging is one of Android Studio's key features since it enables programmers to quickly identify and fix errors in their code. Along with support for real Android devices for testing and debugging, it also includes an emulator that enables developers to test their apps on a simulated Android smartphone.

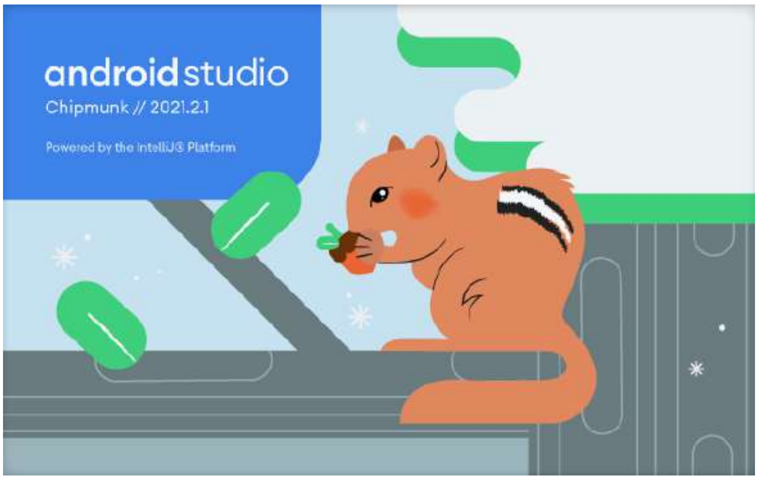


Fig 18: Android Studio

4.1.3 Code Explanation:

4.1.3.1 WiFiMulti.h:

The Wi-Fi-Multi library is a library used in Arduino programming for handling multiple Wi-Fi network connections. It provides a convenient way to manage and connect to multiple Wi-Fi networks using a single Arduino sketch. The library simplifies the process of connecting an Arduino board to a Wi-Fi network. It abstracts away the complexities of managing Wi-Fi connections, making it easier to switch between different networks. Using this library we can define and store the credentials (SSID and password) of multiple Wi-Fi networks in the Arduino sketch. This allows the Arduino board to attempt connecting to different networks in case the primary network is not available. It automatically scans and connects to available Wi-Fi networks based on the defined credentials. It tries to connect to networks in the order they are defined, switching to the next network if the previous connection fails.

4.1.3.2 LiquidCrystal_I2C.h:

The LiquidCrystal_I2C library in Arduino IDE is a library used for interfacing with Liquid Crystal Displays (LCDs) that communicate using the I2C (Inter-Integrated Circuit) protocol. It provides functions and methods to control and display information on the LCD module using the I2C communication interface. This library allows the user to initialize the LCD module by specifying the I2C address of the display and the number of columns and rows. This initialization sets up the communication between the Arduino board and the LCD module.

4.1.3.3 Firebase_ESP_Client.h:

The Firebase_ESP_Client library facilitates communication between Arduino boards and the Firebase Realtime Database. It allows us to connect to a Firebase to project, read and write data to the database, and authenticate access using Firebase authentication methods. This library enables the integration of Arduino-based projects with the powerful cloud-based data storage and synchronization capabilities of Firebase.

4.1.3.4 Adafruit_AM2320.h:

The Adafruit_AM2320 library is specifically designed for interfacing with the AM2320 sensor. This sensor is capable of measuring temperature and humidity. The library provides functions for initializing the AM2320 sensor, reading temperature and humidity data, and handling any errors that may occur during the process.

4.1.3.5 addons/TokenHelper.h:

The "TokenHelper" library, mentioned with the "addons/TokenHelper.h" inclusion, likely provides functions and utilities to assist in generating and managing authentication tokens for accessing APIs or secure services. The specific functionalities and processes involved in token generation can be found within the library documentation or examples.

4.1.3.6 addons/RTDBHelper.h:

The "RTDBHelper" library, referenced by the "addons/RTDBHelper.h" inclusion, is likely tailored for working with Realtime Databases, such as the Firebase Realtime Database. It may offer functions and helper methods for handling Realtime Database payloads, including printing data, data manipulation, error handling, and potentially authentication and security-related tasks. For detailed information on the library's specific functionalities, it is advisable to refer to the library's documentation or associated resources.

4.1.3.7 AltSoftSerial.h:

The AltSoftSerial library is an alternative software serial library that provides a non-blocking serial communication interface. It allows you to create additional software serial ports on Arduino boards that do not have multiple hardware serial ports. This is useful when you need to communicate with multiple serial devices simultaneously.

4.1.3.8 TinyGPS++.h:

The TinyGPS++ library is a lightweight GPS library that simplifies parsing NMEA (National Marine Electronics Association) GPS data. It provides functions and methods to extract useful information such as latitude, longitude, altitude, speed, and course from GPS modules. The library handles the parsing of raw GPS data, making it easier to work with GPS modules and integrate GPS functionality into your Arduino projects.

4.1.3.9 SoftwareSerial.h:

The Software Serial library is a built-in Arduino library that enables serial communication on any digital pins of the Arduino board. It allows you to create additional software serial ports, similar to the hardware serial ports, for communication with external devices. This is useful when the hardware serial ports are already in use or not available on the Arduino board.

4.1.3.10 math.h:

The math.h library is a standard library in C and C++ programming languages. It provides a wide range of mathematical functions, including trigonometric functions (sin, cos, tan), logarithmic functions, exponential functions, and more. This library allows you to perform complex mathematical calculations in your Arduino sketches.

4.1.3.11 Wire.h:

The Wire library is a built-in Arduino library that provides functions to communicate with I2C (Inter-Integrated Circuit) devices. I2C is a popular communication protocol used for interconnecting multiple devices in a system.

Chapter 5

5 Results

The successful implementation of the IoT-based Solar Analyzer exemplified its remarkable capabilities in providing invaluable insights into the comprehensive performance and optimal efficiency of solar energy systems. Through the utilization of the ESP-32 device, the Analyzer ensured precise and reliable measurements of essential parameters such as voltage, current, power, temperature, and light intensity, resulting in meticulous and extensive data collection. Seamless integration with Firebase enabled efficient transmission of the collected data to the Android application, granting users immediate and uninterrupted access to visually captivating graphs that presented each parameter individually. The introduction of a groundbreaking condition-based mechanism revolutionized proactive system monitoring, triggering a precisely calibrated one-hour timer whenever the voltage level failed to meet the predetermined threshold alongside specific light and temperature conditions. This intelligent feature significantly enhanced the Analyzer's usability, empowering users to promptly identify, address, and rectify potential complications, ultimately optimizing the performance of solar energy systems. The implemented IoT-based Solar Analyzer showcased astounding efficiency in monitoring, analyzing, and adeptly managing the vital parameters inherent in solar energy systems, making a significant contribution towards the widespread adoption and seamless implementation of efficient solar energy utilization.

5.1 Login Screen:

Fig 19: Android App Login Screen

The login screen of our Solar Analyzer mobile app plays a crucial role in enhancing user security and providing controlled access to the application. By implementing a login feature, we establish an additional layer of protection, ensuring the safeguarding of sensitive data and maintaining the integrity of solar system information. This feature acts as a gatekeeper, granting access only to authorized individuals, thus ensuring that only designated users can utilize the app and access its comprehensive performance insights. Prioritizing user security, our login screen fosters trust and confidence in our Solar Analyzer, assuring users that their data is well-protected and that they have exclusive control over monitoring and managing their solar systems.

5.2 Monitoring Screen:

In the monitoring, we have multiple parameters to monitor:

5.2.1 Voltage:

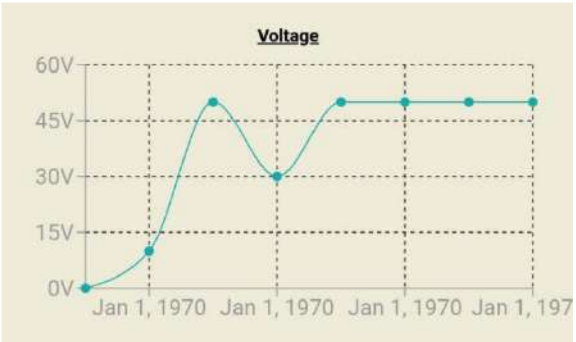


Fig 20: Android App Voltage Graph

The voltage production of solar panels over time is summarized as follows: Initially, at time zero, the solar panels exhibit no voltage output, possibly due to insufficient sunlight or unfavorable conditions. However, as time progresses, the voltage production gradually increases. At the end of the first hour, the voltage output reaches 13 volts, indicating improved sunlight intensity and energy conversion. During the second hour, the voltage production further rises to 30 volts, signifying enhanced efficiency. After three hours, the voltage production stabilizes at 50 volts, demonstrating the panels' capability to sustain energy generation.

5.2.2 Current:

Fig 21: Android App Current Graph

The current time graph provides real-time insights into the performance and behavior of solar panels. It visualizes patterns, such as peak production periods and fluctuations in current output, which are influenced by factors like sunlight intensity, temperature, and shading. Comparing the current time graph with historical data allows us to identify deviations or anomalies in current production. This analysis helps detect potential issues or abnormalities that may impact overall panel efficiency. For instance, a sudden drop in current during peak sunlight hours could indicate a fault or shading problem. Furthermore, the current time graph assists in system optimization. It identifies periods of high current production, enabling users to schedule energy-intensive tasks during these peaks for maximum self-consumption of solar energy. Conversely, it also highlights periods of low current production, prompting users to adjust energy usage or investigate potential causes for underperformance.

5.2.3 Power:

Fig 22: Android App Power Graph

Analyzing the power time graph allows us to observe the performance and behavior of the solar panels in real-time. It helps identify patterns, such as peak power production periods and fluctuations in power output, which can be influenced by factors like sunlight intensity, temperature, and shading. By comparing the power time graph with historical data, we can detect any deviations or irregularities in power production. This analysis enables the identification of potential issues or anomalies that may impact the overall efficiency of the solar panels. For example, a sudden drop in power output during optimal sunlight conditions might indicate a malfunction or shading obstruction. Additionally, the power time graph provides valuable information for system optimization. It allows users to identify periods of high power production, enabling them to schedule energy-intensive tasks during these peaks to maximize the utilization of solar energy. Conversely, it also highlights periods of low power production, prompting users to adjust their energy usage or investigate potential causes for decreased output.

5.2.4 Temperature:

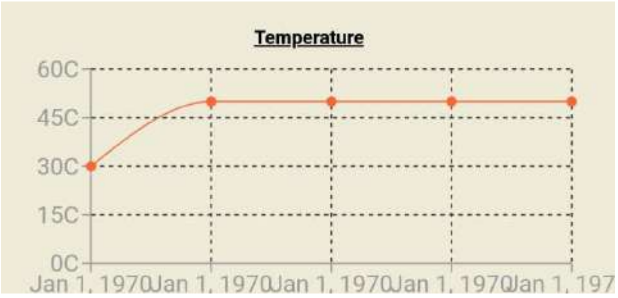


Fig 23: Android App Temperature Graph

Analyzing the temperature time graph allows us to observe the temperature patterns and fluctuations that impact the performance of the solar panels. Factors such as sunlight intensity, weather conditions, and panel heat dissipation can influence temperature variations. By comparing the temperature time graph with historical data, we can identify any significant deviations or irregularities in temperature. This analysis enables us to detect potential issues or abnormalities that may affect the overall efficiency of the solar panels. For instance, a sudden spike in temperature could indicate excessive heat buildup or poor ventilation around the panels. Additionally, the temperature time graph provides valuable information for system optimization. It helps identify periods of high or low temperatures, allowing users to assess the impact on panel performance and take appropriate measures. For example, during periods of high temperature, users may consider implementing cooling mechanisms or adjusting panel positioning to mitigate efficiency losses.

5.3 Automation Screen:

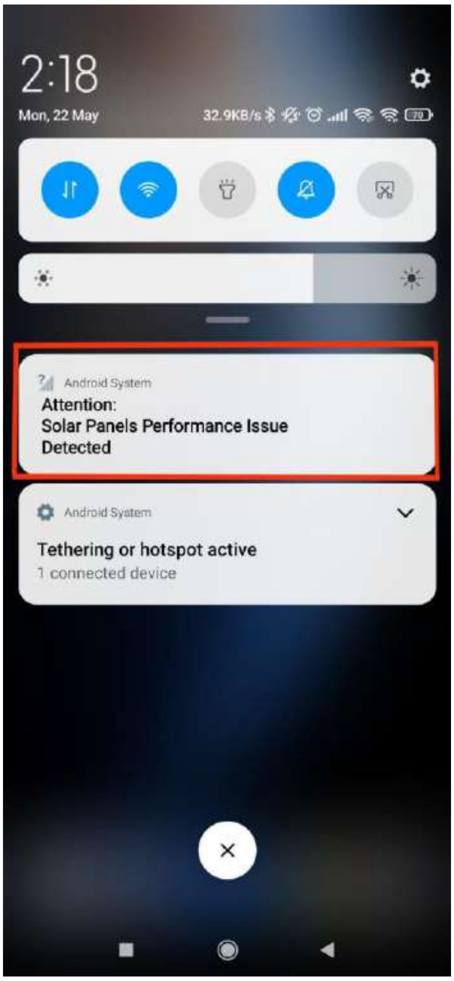


Fig 24: The Display of Emergency alerts

This message serves as a sample notification sent due to the abnormal power production observed in the solar panels. After comparing the actual power generation with the ideal parameters, it has been determined that the power production did not meet the expected standards. In response to this deviation, a prompt notification was dispatched to the user, aiming to promptly inform them about the abnormality of the solar panels. This proactive approach ensures that users are swiftly alerted to any irregularities in power generation, empowering them to take necessary actions and effectively address potential issues. By promptly notifying users about the abnormality, our system facilitates the maintenance of optimal solar panel performance and the maximization of energy efficiency. Ultimately, this contributes to the establishment of a more sustainable and reliable solar energy system.

5.4 Smart Helmet Outcomes:

Some of the multiple features of this project are listed below:

- Improved road safety.
- Collision detection & SOS Alert via SMS.
- Live Location of the rider.
- Reasonable Cost.
- Compatible with all bikes.

To assure the highest level of safety on the road, a rigorously planned and put into place accident prevention and warning system makes use of cutting-edge wireless technologies including the GYRO Sensor (accelerometer), GPS modem, and GSM. By identifying possible dangers and rapidly informing the relevant parties, the system seeks to avoid accidents. As we put the finishing touches on our paper and the creation of this system, we are still passionate about increasing the effectiveness of electronic hardware utilization using cutting-edge technology. A test carried out at two nearby places serves to illustrate the system's operation. Although the instructions and fractional latitude and longitude numbers may differ somewhat, the original measurements never change. Take, for instance, the first SMS message we received stating that a testing accident happened at 3232.50 North and 7149.68 East, similarly, the second SMS message we received stating that a testing accident happened at 3133.10 North and 7150.90 East specifying a latitude and longitude respectively. The device precisely pinpoints the rider's location after an accident by combining GPS, GSM, and GYRO technologies. Even while the location might not be exact, it will be near to where the rider is really standing, making efficient retrieval possible. Accident detection is the project's most important component. An important factor in determining if an accident has occurred is the GYRO Sensor. It recognizes any rapid changes in the axis' motion brought on by the rider's unneeded movements or unexpected jolts. The GYRO Sensor alerts the microcontroller with a strong signal when it detects a substantial change. The microcontroller then transmits the signal to the GSM module. The GSM module quickly delivers SMS notifications to the emergency contacts saved in its memory after receiving the coordinates from the GPS module, which is still accurately calculating the rider's position. We have put in place a threshold value mechanism to deal with false alerts brought on by little vibrations. The GYRO Sensor reevaluates the readings and compares them to the threshold value when it senses vibrations. The GYRO Sensor continues to provide a strong signal to the microcontroller even though the estimated value is below the threshold and indicates a little disturbance. The GPS module can then precisely pinpoint the rider's location thanks to the microcontroller's transmission of the signal to the GSM module. The emergency contacts then get SMS messages from the GSM module. The GYRO Sensor's potential to detect abrupt changes in the degree of motion along many axes also contributes to its capacity to identify accidents. The system's reaction mechanism is triggered by these changes, which point to a possible mishap situation. When the GYRO Sensor notices these alterations, it sends a strong signal to the microcontroller to alert it about an accident. Immediately after, the microcontroller sends this signal to the GSM module for further processing. In addition, the GPS module is put to use to precisely pinpoint the rider's position after an accident. The GPS module determines the precise coordinates of the rider's location by using satellite positioning data. The ability to conduct effective rescue operations and provide correct aid depends on this information. The GSM module receives these coordinates from the GPS module and incorporates them into the incoming SMS alerts. The system starts sending SMS notifications to the emergency contacts listed in its settings through the GSM module. The receiver phone numbers for the accident alerts are these people. The GSM module uses the established cellular network to communicate to guarantee that the messages are delivered quickly and reliably. A threshold value method is used to make sure the system can tell the difference between real accidents and minor disturbances or vibrations. The GYRO Sensor recalculates the corresponding values when it notices vibrations and compares them to the predefined threshold value. The vibrations are negligible and not suggestive of an accident if the estimated value is below the threshold. Even under these circumstances, the GYRO Sensor continues to provide a strong signal to the microcontroller, guaranteeing that the system is alert and prepared to act in the event of a real disaster. This preventive technique keeps the system's ability to identify actual incidents intact while preventing needless false warnings.

Chapter 06

6 Future Work, Conclusion and COMPARISON:

6.1 Improvements:

IoT-Based Smart Helmet and Solar Analyzer" has been developed with great effort and attention to ensure that all important parameters are measured. However, with the continuous advancement in technology, there are opportunities for further improvements in this project. These improvements can be categorized into two main types: software improvements and hardware improvements.

6.1.1 Software Improvements:

In order to further enhance the functionality of the project, the Android application can be upgraded, as well as the development of a dedicated Android application for the smart helmet itself. These advancements aimed to provide users with additional features, such as access to previous alert warnings, the ability to change emergency contacts, and a map view for real-time rider location tracking. The integration of these enhancements would not only improve the overall user experience but also contribute to the project's overall effectiveness. To begin with, the Android application can undergo improvements in terms of its design and structure. By incorporating more visually appealing graphics and buttons, the researchers can enhance the user interface, making it more intuitive and user-friendly. This upgrade can involve optimizing the layout of the application, ensuring that users can easily navigate through its various functionalities and settings. One significant addition to the Android application can be the provision of access to previous alert warnings. By incorporating a log or history section within the application, users can review previous alerts and warnings received through the smart helmet. This feature would enable users to revisit important information and better understand the patterns or trends related to their riding behavior or potential risks encountered on the road. Moreover, the ability to change emergency contacts through the Android application would add another layer of flexibility and customization. Users could easily update and modify their emergency contact details based on their preferences or changing circumstances. This feature ensures that the right individuals are notified promptly in case of an emergency, enhancing the overall safety and response efficiency.

Additionally, the integration of a map view within the Android application would allow users to track the real-time location of the rider. By utilizing GPS technology, the application can display the rider's current position on a map interface. This feature provides added convenience and peace of mind, both for the rider and for others who may be concerned about their well-being. Another enhancement could involve implementing data visualization through graphs within the Android application. By presenting the collected data in a visual format, such as charts or graphs, users can gain a more intuitive representation of their riding patterns, potential risks, and overall performance. This visualization aids in easily interpreting and analyzing the information, empowering users to make informed decisions regarding their riding habits and safety precautions.

6.1.2 Hardware Improvements:

To further improve the project, the hardware design can be enhanced in several ways, focusing on factors such as sensor selection, performance optimization, and design ergonomics. By exploring alternative sensors that offer superior efficiency, increased robustness, and reduced costs, the researchers can elevate the overall functionality and accuracy of the system. One area of improvement involves selecting advanced sensors that outperform their predecessors. These upgraded sensors may utilize cutting-edge technologies and improved algorithms to provide more accurate and reliable data. In addition to sensor selection, optimizing the performance of the hardware design is essential. This can be achieved through meticulous calibration and fine-tuning of sensor parameters, such as sensitivity and response time. By refining these settings, the system can achieve optimal accuracy and responsiveness, ensuring that potential risks are promptly identified and appropriate warnings are issued. Furthermore, modifications to the shape and size of the hardware modules can enhance their integration within the helmet and analyzer. Consideration should be given to ergonomics, ensuring that the components seamlessly integrate with the existing helmet structure without causing discomfort or hindrance to the motorcyclist. By refining the design, the hardware can be more aesthetically pleasing and ergonomic, encouraging better user acceptance and compliance.

By implementing these software and hardware improvements, the "IoT-Based Smart Helmet and Solar Analyzer" project can leverage the latest technological advancements to provide a more advanced and user-friendly experience. The upgraded Android application will offer enhanced features and visualizations, while the hardware improvements will result in a more efficient and optimized system.

6.2 Conclusion

The development of IoT-based Smart Helmet and IoT-based Solar Analyzer projects has shown extreme potential in increasing safety and renewable energy services. The integration of Internet of Things (IoT) technology into these devices has paved the way for innovative solutions in their respective domains.

The IoT-based Smart Helmet system has demonstrated its ability to significantly improve rider safety. By incorporating advanced sensors and technologies, such as real-time monitoring of vital parameters, location tracking, and the integration of rear view cameras, this system provides riders with enhanced situational awareness and immediate alerts in case of emergencies. The automatic message containing the information of location to emergency contacts ensures timely assistance, reducing the risks associated with accidents and improving overall rider safety. Similarly, the IoT-based Solar Analyzer system has the potential to change the Renewable energy services.

By working on the IoT technology, this system enables continuous monitoring of various power generation parameters, such as temperature, voltage, current and other relevant metrics. The real-time data collection and analysis allow for the detection of abnormalities or complications, facilitating timely intervention and improved the power outcomes. However, to fully realize the benefits of these IoT-based systems, further research, development, and collaboration are necessary. Ensuring the accuracy, reliability, and security of the collected data is paramount. Collaborations with renewable energy professionals, regulatory bodies, and industry stakeholders will be essential to validate the effectiveness and safety of these systems. Additionally, ongoing advancements in software and hardware can contribute to the continuous improvement of these devices, providing users with even more advanced features and capabilities.

The IoT-based smart helmet and IoT-based small analyzer have the potential to make a significant impact on safety and healthcare. By leveraging the power of IoT technology, these devices open up new possibilities for improving the well-being and security of individuals. Continued research and innovation in this field will contribute to the widespread adoption of these systems, ultimately leading to a safer and healthier society.

6.3 COMPARISON:

PRODUCT	**DESCRIPTION**	**PRICE**
LIVALL MT1 smart helmet	**Mic, Bluetooth Speakers, Wireless Turn Signals Tail Lights , SOS Alert**	**$129.99**
COROS Omni smart helmet	**w/Bone Conducting Audio, LED Tail Lights & Removable Visor**	**$119.99 to $199.99**
Lumos smart helmet	**Wireless Turn Signal and Built-in Motion Sensor**	**$179.95**
Magic shine MJ-898 Commuter	**Arrow Turn Signal Lights | High Power Front Light | Speed Sensor Rear Light**	**$230.99 to $240.99**

smart helmet		
Sena smart helmet	**Bluetooth with HD Audio speakers and microphone**	**$169.99 to $199.00**
Smart Helmet	**GSM & GPS | Accident alert | Collision detection via Gyro| Back camera view on LCD | Bike on/off system via Transmitter | Bluetooth call receiver and entertainment system**	
Solar Analyzer	**Voltage and Current Reading | Fault Detection | Temperature and Humidity Measurement | Alert Notification**	

PARTICIPATED /QUALIFIED COMPETETIONS

- **COMPPEC 2023 (NUST | EME Campus)**
- **VISIO SPARK 2023 (COMSATS University Islamabad | Wah Campus)**
- **COMHEC 2022 (ZABIST | Islamabad Campus)**

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