VISVESVARAYA TECHNOLOGICAL UNIVERSITY
Jnanasangama, Macche, Santibastwada Road
Belagavi-590018, Karnataka

Internship Report

Real Time Smart Helmet

Submitted in Partial fulfillment for the award of Degree of
Bachelor of Engineering
in
ELECTRONICS AND COMMUNICATION ENGINEERING
19EC8ICINT

Submitted by
Narayan Kumar
1DS19EC725

Internship carried out

at
CELESTIAL V SOLUTIONS
Anam Plaza, 52-53, 2nd Floor, Anam Plaza, 8th F Main Rd, 3rd Block, Jayanagar, Bangalore.

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(An Autonomous College affiliated to VTU Belgaum, accredited by NBA & NAAC)
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(Accredited by National Assessment & Accreditation Council (NAAC) with 'A' grade)

CERTIFICATE

Certified that the internship work (19EC8ICINT) entitled, "*Real Time Smart Helmet*" is carried out by Narayan Kumar (1DS19EC725), is the bonafide student of ECE Department, Dayananda Sagar College of Engineering, Bangalore, Karnataka, India in partial fulfillment for the award of Bachelor of Engineering in Electronics & Communication Engineering , Visvesvaraya Technological University, Belagavi, Karnataka during the academic year 2022-23. It is certified that all corrections / suggestions indicated for internship work have been incorporated in the internship report deposited to the ECE department. The internship report (19EC8ICINT) has been approved as it satisfies the academic requirement in respect of internship work prescribed for the said undergraduate degree.

Internship Guide/Supervisor	Evaluator	Head of the Department
Name: Prof. Manasa R	Name:	Dr. T.C.Manjunath

Dr. B G Prasad
Principal

External Internship (to be signed by SEE examiners) Viva-Voce:

Name of the internship examiners

1: Signature & date: _____

2: Signature & date: _____

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Internship Certificate

This is to certify that **Mr. NARAYAN KUMAR** (USN: 1DS19EC725) student of **Dayananda Sagar College of Engineering**, Bengaluru, has successfully completed the Internship for the duration of **5 Weeks** in our company.

The Internship details as under:

Internship Domain : "IOT & Embedded"

Internship Period : 06-03-2023 to 08-04-2023

During this tenure he has shown keen interest in learning. He was also enthusiastic and proactive in understanding the concept.

We wish him all the success.

Yours Truly,
For ***Celestial V Solutions***

Authorized Signatory

CELESTIAL V SOLUTIONS Bangalore

Celestial V Solutions

52-53, 2nd Floor, Anam Plaza, 8th 'F' Main, 3rd Block, Jayanagar, Bengaluru – 560 011
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Declaration

Certified that the internship work (19EC8ICINT) entitled, "*Real Time Smart Helmet*" is a bonafide work that is carried out by me in the "**CELESTIAL V SOLUTIONS**" in partial fulfillment for the award of degree of Bachelor of Engineering in Electronics & Communication Engg. (Autonomous) of the Visvesvaraya Technological University, Belagavi, Karnataka during the academic year 2022-23 for the 4th year B.E. course. I hereby declare that the entire internship work has been done on my own in the company & is a novel work under the leadership of the industry / company guide. The results embedded in this internship report has not been submitted elsewhere for the award of any type of degree in any other university & is genuine related to the company aspects and the work done in the company/industry.

Student Name: Narayan Kumar Date : 19/05/2023

USN : 1DS19EC725 Place : Bengaluru -78

Sign : _____

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List of Acronyms & Abbreviations

- Arduino: A popular open-source electronics platform
- ESP8266: A low-cost Wi-Fi microchip used in IoT applications
- NodeMCU: A development board based on the ESP8266 chip
- GPS: Global Positioning System
- IoT: Internet of Things
- MQTT: Message Queuing Telemetry Transport (a lightweight messaging protocol for IoT devices)
- LCD: Liquid Crystal Display (a type of flat-panel display)
- API Application Programming Interface
- BLE Bluetooth Low Energy
- GPS Global Positioning System
- IOT Internet of Things
- IR Infrared
- MCU Microcontroller Unit
- RFID Radio-Frequency Identification
- SMS Short Message Service
- Wi-Fi Wireless Fidelity

Executive Summary

(Abstract of the internship)

IoT has been gradually expanding across different applications which brought a huge attention to the implementation of this project for the mining field, where environments can get a lot noisy and destructive. The project was carried out during an internship at CELESTIAL V SOLUTIONS company. The main objective of this project is to design and develop a smart helmet for mining industry application. The system will provide Realtime monitoring of the hazardous events such as increase in temperature and humidity, release of gasses like Methane, conscious and unconscious state of the miner, removal of helmet of the miner and obstacle damage to the helmet. The programming and troubleshooting will be conducted on mainly two sections, helmet section and control room section that means the system will have a transmitter to transmit necessary data and alerts to the control room or nearest manager and a receiver that can be used by the control room or the managers to grab the data and alerts from the transmitter. On the other side the system also syncs the data to the google firebase database. Apart from this the project also aims to create a system for alerts regarding water rise which is the primary cause of Flooding in mining industries. The above system includes the use of several sensors like IR sensor, Proximity sensor, Humidity Sensor, Gas sensor, and several other modules and microprocessors like node MCU and Arduino. Other problems like Ventilation issues and Haulage problems can be solved by changing the structural construction of mines. The above systems and designs will help stop several hazards and will increase a level of safety and health for the miners, which may attract more number of workers to this field and on the major side it will take an attempt to keep Realtime data for both managers and family members.

Keywords: Asynchronous Server, Google Firebase Database, Message Queuing Telemetry Transport, Piezoelectric Battery Charging, Realtime Monitoring.

Chapter 1

ABOUT THE COMPANY: CELESTIAL V SOLUTIONS

1.1 Company Profile

Celestial V Solutions is an IT Company, based in Bangalore, the silicon city of India. The company delivers IT solutions to a broad range of domestic and international level.

Celestial V Solutions is a provider of end-to-end IT services and solutions designed to help clients and improve efficiency. The specializing in outsourcing and offshore, the systems integration and application development, software and consulting, and quality assurance should be maintained.

The human resources training division turns out complete software professionals through specially designed instructors. The services model is simple. The company provide out of house expertise to the clients, who need to reach beyond their in-house capabilities or accelerate the progress of project under deadline, and the work to gain the clients confidence that the team or leased personnel will provide a rock-solid asset for planning and complete projects in time and on budgets.

To become the leaders in IT Solutions and sustain growth with quality, Innovation and Creativity is the vision of the company.

The mission is to provide highest and reliable quality of software solutions and services globally. Through innovation and creativity for professional satisfaction the company need to fulfil the organizational goals and societal needs.

The primary goal of Celestial V Solutions would be towards acquiring the technology and know-how for product development in the fields of wireless application, Internet/Intranet technologies, Client/Server, E-Commerce Solutions, Enterprise Resource Planning and the embedded technologies. The major player in this field would be ‘ERP’. Apart from the above it will also act as a customized solution provider and consulting firm.

Providing a fast and responsive service of the highest standards is what company thrive at working with start-ups as well as Fortune 500 companies. Development and management of both short term and long-term projects is ability to understand the real world of business and stretch to the maximum. Significant operations and IT experience in a range of industries. Get your projects done On-time and In-budget. The remaining committed to each other's welfare and success. Company do unto others as it expects others to do unto us.

The staffs at the company are an excellent blend of technical expertise and creative skills. The company have a team of professional web developers and designers who work to create attractive and functional web to make a website popular and make it rank well on the search engines. The KPO team has experienced industry professionals with high analytical and processing skills.

The team shares a passion to think ahead, innovate and work hard to achieve the set goals. They know that clients need one hundred per cent of the attention and work to ensure the same. This is what drives us to product high quality work that not only company but also you can be proud of.

1.2 Products

The products developed and delivered to the customers by the Celestial V Solutions are as follows:

Build Soft
Esybill
Esy2send
Esy2send mob app
RARS (Result and Attendance Retrieval system)

The working description of the above products is given below:

Build Soft

Web Based application which helps the construction companies to calculate the estimation cost for construction work and to maintain their Payment Transaction details. This system includes MIS Module with reports and graphs which help the management to understand the financial details of the company quickly.

Esybill

This application helps most of our retail customers. Using this they can easily generate bills, keeping track of their stocks, inventory, sales and purchase details. It also gives them an option to view the reports on daily, weekly and monthly basis.

Esy2send

Esysend is an application which helps us in sending SMS, bulk SMS, e-mail, bulk e-mail and both SMS and e-mail simultaneously. It is mainly developed targeting industries like marketing, schools, colleges, real estates, finance and other marketing industries.

Esy2send mob app

Esysend also has its mobile version, using this mobile application you can send SMS or bulk SMS with your mobile on the go when you are away from your system. All you need to use this mobile application is GPRS connection in your mobile and the mobile application of Esy2send which you can download from esy2send website. The biggest advantage in using this application is that you don't have to carry your laptop or system wherever you go and whenever you need to use esy2send application. By making a single click on your mobile application you can communicate in mass.

RARS (Result and Attendance Retrieval system)

It is another mobile from us, which servers at the most for schools and colleges. It helps the parents to know their children marks and results of the tests and examination. Once you download the mobile application on to your mobile, you can start using it and it's very easy to know your children curriculum on the go over the mobile. As soon as you place the request for details of your children, you will receive the message of the same within 5 seconds.

1.3 Services

Celestial V Solutions strive in providing the following services to the customers:

Software services
Web Services
Search Engine Optimizations
J2ME

Embedded system

The explanation of the above services is given in detail below:

Software services

Finding the right technologies for your growing business needs should not be a brain drain; after all, you have got more important things to think about – like running your business. The reality is that the scope of technology is growing rapidly, making it nearly impossible for you to be an expert for so many new hardware and software products. That is why the company are here. The company as pioneers of the software industry provide apt solutions for all your needs. The expert motto is to provide excellent quality of products for all the customer needs in timely manner.

Web Services

A website is like having global presence in the virtual market place, Internet. But just having a website deployed cannot get a business what it should from a website, thus it is important to get it done from experts and make it serve the purpose of having it. There are various aspects that need to be worked upon to make a website successful and create professional image of the business owing it. At Celestial V Solutions very well know how to accomplish this.

Search Engine Optimizations

Company provides with an excellent solution to the costumers' challenge in optimizing their property in search engines. With hands on experience with optimizing search results across various search engines, provide extensive reports and advice on how to improve costumers' property occupancy depending on various factors in different search engines.

J2ME

J2ME is a technology which helps us in developing mobile applications, that are not an excuse for mobile applications, and there is a team of skilled developers who have hand in experience, creating many mobile applications.

Embedded system

Embedded Systems Design and Development Services help company to achieve their product development and sustenance initiatives. The technologies committed to providing the highest quality of service to its customers, delivering advanced systems, solutions and services that benefit the businesses, the industry and the society.

Chapter 2

ABOUT THE DEPARTMENT

2.1 Research and Development

In the company, the research is being conducted in the field of networking, for efficient file transfer across the network, with greater security and speed. Research and development is one of the means by which the business of the company can experience future growth by developing new products or processes to improve and their operations. The activities that are classified as R&D differ from company to company, but there are two primary models, with an R&D department either being staffed by engineers and tasked directly with developing new products. In this company, the R&D department is staffed by the engineers.

R&D is an important means for achieving a future growth for the company, with the invention of the new technologies for the efficient growth of the company. The kind type of R&D being conducted in the company is basic research as well as applied research. When the research aims to understand a subject matter more completely and build on the body of knowledge relating to it, then it falls in the basic research category. This research does not have much practical or commercial application. The findings of such research may often be of potential interest to the company.

Applied research has more specific and directed objectives. This type of research aims to determine methods to address a specific customer/industry need or requirement. These investigations are all focused on specific commercial objectives regarding products or processes.

2.2 Processes Adopted for Software Developments

Software Development Life cycle (SDLC) was introduced to address the problems faced during the software development process. It is a disciplined and systematic approach that divides the software development process into various phases, such as requirements analysis, design, and coding. The SDLC aims to produce high quality software that meets or exceeds customer expectations, reaches completion within times and cost estimates. The phase-wise development process helps us track schedule, cost, and quality of the software projects.

There are six phases in SDLC:

Feasibility analysis

Includes analysis of project requirements in terms of input data and desired output, processing required to transform input into output, cost-benefit analysis, and schedule of the project. The feasibility analysis also includes the technical feasibility of a project in terms of available software tools, hardware, and skilled software professionals. At the end of this phase, a feasibility report for the entire project is created.

Requirement analysis and specification

It includes gathering, analysing validating, and specifying requirements. At the end of this phase, the Software Requirements Specification (SRS) document is prepared. SRS is a format document that acts as a written agreement between the development team and the customer. SRS acts as a input to the design phase and includes functional, performance, software, hardware, and network requirements of the project.

Design

Includes translation of the requirements specified in the SRS into a logical structure that can be implemented in a programming language. The output of the design phase is a design document that acts as an input for all the subsequent SDLC phases.

Coding

Includes the implementation of the requirements specified in the design document into executable programming language code. The output of the coding phase is the source code for the software that acts as input to the testing and maintenance phase.

Testing

Testing includes detection of errors in the software. The testing process starts with a test plan that recognises test-related activities, such as test case generation, testing criteria, and resource allocation for testing. The code is tested and mapped

against the design document created in the design phase. The output of the testing phase is a test report containing errors that occurred while testing the application

Maintenance

Include the implementation of changes that the software might undergo over a period of time, or implementation of new requirements after the software is deployed at the customer location. The maintenance phase also includes handling the residual errors that may exist in the software even after the testing phase.

The company is making use of the waterfall model approach for developing the projects.

2.2.1 Waterfall approach

The waterfall approach describes the software development process in a linear sequential flow. This means that any phase in the development process begins only if the previous plan is complete. The waterfall approach does not define the process to go back to the previous phase to handle changes in requirement. Therefore, different projects may follow different approaches to handle such situations.

The waterfall approach is the earliest approach that was used for software development. Initially, most projects followed the waterfall approach because they did not focus on changing requirements.

Every software developed is different and requires a suitable SDLC approach to be followed based on the internal and external factors. Some situations where the use of Waterfall model is most appropriate are:

- Requirements are very well documented, clear and fixed.
- Product definition is stable.
- Technology is understood and is not dynamic.
- There are no ambiguous requirements.
- Ample resources with required expertise are available to support the product.
- The project is short.

The advantage of waterfall development is that it allows for departmentalization and control. A schedule can be set with deadlines for each stage of development and a product can proceed through the development process model phases one by one. Development moves

from concept, through design, implementation, testing, installation, troubleshooting, and ends up at operation and maintenance. Each phase of development proceeds in strict order.

The disadvantage of waterfall development is that it does not allow for much reflection or revision. Once an application is in the testing stage, it is very difficult to go back and change something that was not well-documented or thought upon in the concept stage.

2.2.2 Version Control System

Version control system also known as revision system is used in the software development process for recording the changes to project done over time. A version control system is a repository of files, often the files for the source code of computer programs, with monitored access. A component of software configuration management, version control, also called as source control. It is the management of changes to documents, computer programs, large web sites, and other collections of information.

Changes are usually identified by a number or letter code, termed the “revision number”, “revision level”, or simple “revision”. For example, an initial set of files is “revision 1”. When the first change is made, the resulting set is “revision 2”, and so on. Each revision is associated with a timestamp and the person making the change. Revisions can be compared, restored, and with some types of files, merged.

Version control systems most commonly run as stand-alone applications, but revision control is also embedded in various types of software. Software developers sometimes use revision control software to maintain documentation and configuration files as well as source code.

As teams design, develop and deploy software, it is common for multiple versions of the same software to be deployed in different sites and for the software’s developers to be working simultaneously on updates, bugs or features of the software are often only present in certain versions (because of the fixing of some problems and the introduction of others as the program develops). Therefore, for the purposes of locating and fixing bugs, it is vitally important to be able to retrieve and run different versions of the software to determine in which version (s) the problem occurs. It may also be necessary to develop two versions of the software concurrently.

2.2.3 Bit Bucket

Bit Bucket is the git solution for professional teams. It is a distributed version control system that makes it easy for us to collaborate with the team. Bit Bucket is only collaborative Git solution that massively scales. The second wave of adoption will be moving the full software development workflow to the cloud for the same reason applications moved: accelerating business velocity. Bit Bucket server gives secure, fast, enterprise-grade controls, like fine-grained permissions and powerful management features.

2.3 Roles and Responsibilities of Individuals in the Department

Software Engineer

Software Engineer are also known as application programmer, software architect or system programmer/engineer.

The work of the software engineer typically includes designing and programming system-level software: operating systems, database systems, embedded systems and so on. They understand how both hardware and software function. The work involves talking to clients and colleagues to assess and define what solution or system is needed, which means there are a lot of interaction as well as full-on technical work.

System Analyst

System Analyst is also known as product specialist, systems engineer, solutions specialist, technical designer.

Systems Analyst investigate and analyse business problems and then design information systems that provide a feasible solution, typically in response to requests from their business or a customer. They gather requirements and identify the costs and the time needed to implement the project. The job needs a mix of business and technical knowledge, and good understanding of people. It’s a role for analyst programmers to move into and typically requires a few years’ experience from graduation.

Business Analyst

Business Analyst is also known as business architect, enterprise-wide information specialist.

Business Analysts are true midfielders, equally happy talking with technology people, business managers and end users. They identify opportunities for improvement to processes and business operations using the information technology. The role is project based and begins with analysing customers' needs, gathering and documenting requirements and creating a project plan to design the resulting technology solution. Business analysts need technology understanding, but don't necessarily need a technical degree.

Network Engineer

Network Engineer is also known as hardware engineer, network engineer.

Network engineering is one of the more technically demanding IT jobs. Broadly speaking the role involves setting up, administering, maintaining and upgrading communication systems, local area networks and wide area networks for an organisation. Network engineers are also responsible for security, data storage and disaster recovery strategies. It is a highly technical role and you'll gather a hoard of specialist technical certifications as you progress.

Web Developer

Web developer is also known as web designer, web producer, multimedia architect, internet engineer.

Web development is a broad term and covers everything to do with building websites and the entire infrastructure that sits behind them. The job is still viewed as the trendy side of IT years after it first emerged. These days web development is pretty technical and involves some hard-core programming as well as the more creative side of designing the user interfaces of new websites. The role can be found in organisations large and small.

Technical Consultant

Technical consultant is also known as IT consultant, application specialist, enterprise-wide information specialist.

The term consultant can be a tagline for many IT jobs, but typically technical consultants provide technical expertise to, and develop and implement IT systems for, external clients. They can be involved at any or all stages of the project lifecycle: pitching for a contract; refining a specification with the client team; designing the

system; managing part or all of the project; after sales support or even developing the code. A technical degree is preferred, but not always necessary.

2.4 Organization Structure

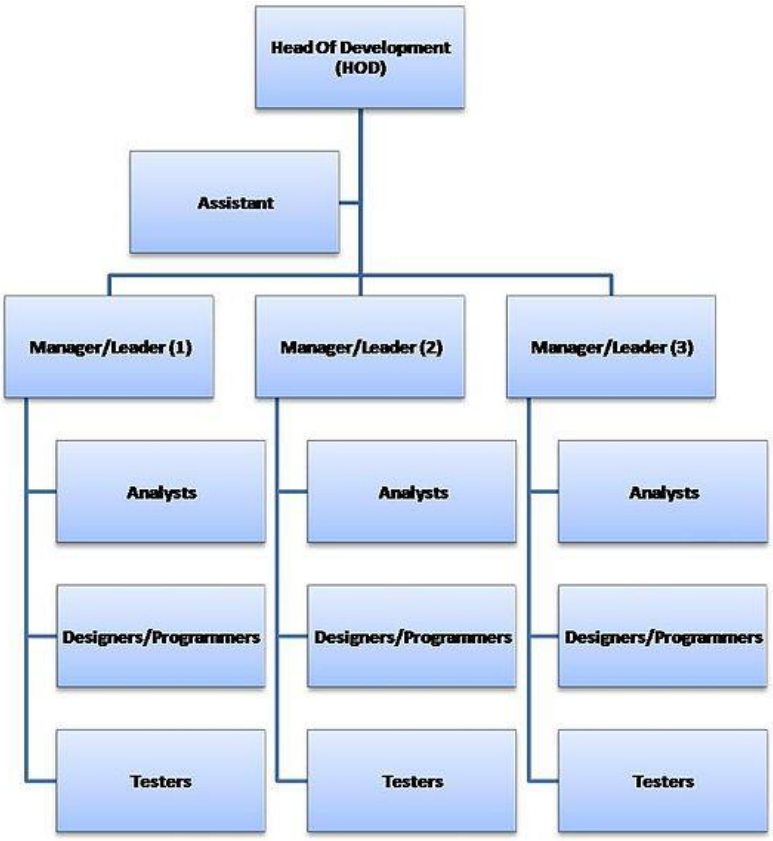


Figure 2.1 Organization Structure

The organisation structure is shown in Figure 2.1 where the manager of a software company is usually called the Head of Development who is also called as the Project Manager and reports to the stakeholders. He leads the sub-teams via the Team Leaders who in turn lead the group of analysts, programmers and testers. All the teams are fully independent and they work separately on the different projects. Like for the example in the company, one team is working on the networking projects, whereas the other team is working on the android projects.

The structure that is being followed in the is quite simple and all the employees' reports to one person, what make the situation quite clear however it is not a good solution in terms of knowledge exchange and optimal usage of human resources.

In this model there are dedicated managers/leaders for each main specialization, "renting" their people for particular projects led by product/project managers, who formally

or informally buy the people and pay for their time. This leads to each private employee having two bosses – the product/project manager and the specialized "resource" manager. On one hand it optimizes the usage of human resources; on the other hand, it may give rise to conflicts about which one manager has priority in the structure.

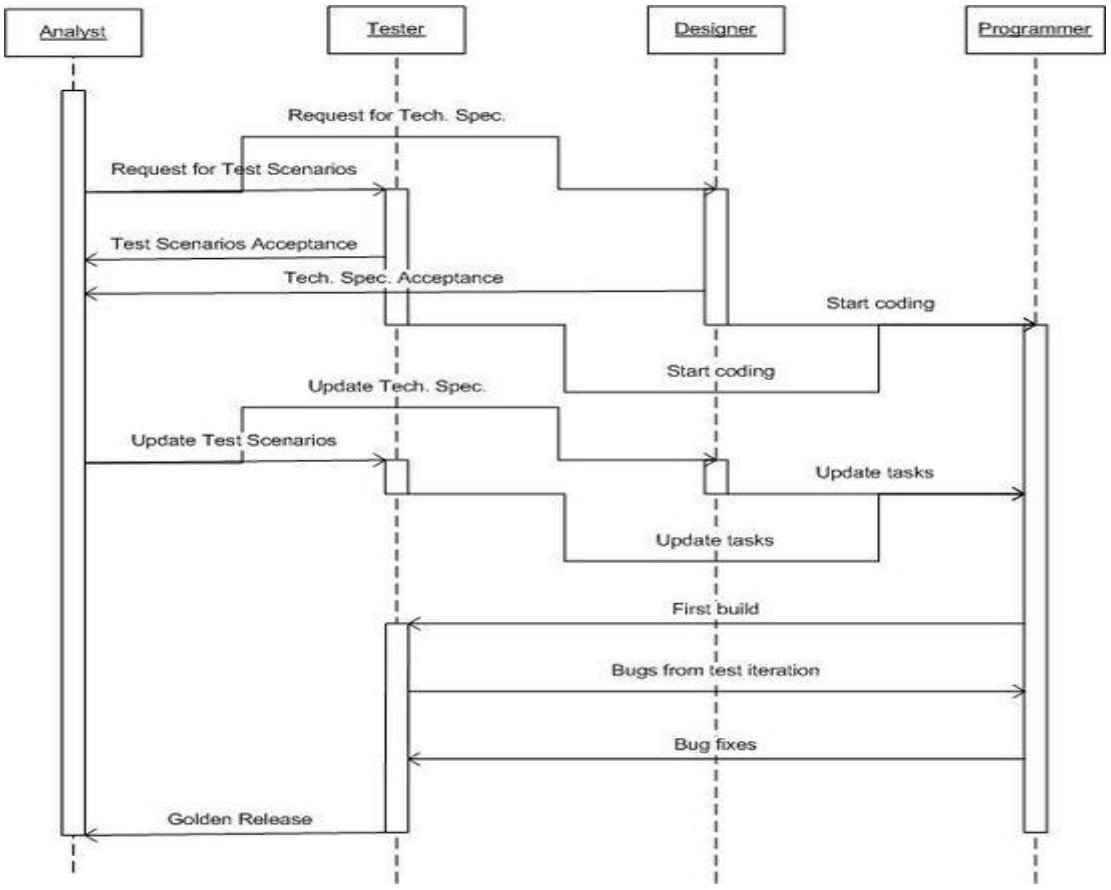


Figure 2.2 Interaction Diagram

The above Figure 2.2 shows UML diagram for the interaction between the groups in the software company, including the sequence of activities being carried out between the analyst, testers, designers and programmers.

2.5 On-going Project

The on-going project in the company is TechBus. The TechBus is school bus tracing and student tracking solutions. Almost every campus is looking to safeguard their campus environment protecting campus from cheating or to provide a safer campus environment. TechBus can help to make the campus environment safer using latest technologies. Convert your buses into smart-buses by using the state-of-the-art GPS tracking technology for the safety of the students. The schools enforcing such systems are preferred by parents for offering such distinguishing services.

School Bus fitted with TechBus GPS tracking device and RFID reader. The location detail is received from the satellite on TechBus GPS tracker module and the location Detail along with Student attendance from RFID is transmitted via GPRS or 3G from the TechBus GPS & RFID devices. Data from the TechBus device is received on our server through cellular network, which is stored for analysis. The alerts are sent via SMS and email to parents and transport managers. The viewing of live Bus location details, student attendance and other reports from anywhere using this TechBus cloud-based application.

Chapter 3

TASKS PERFORMED IN THE INDUSTRY

SL NO	WEEK	TASK COMPLETED
1	**Week1**	Introduction to IoT, Embedded System ,Firebase Database
2	**Week2**	Training on Sensors and Introductions
3	**Week3**	programming on Arduino &Android
4	**Week4 & Week 5**	Final Project & Presentation

3.1 INTRODUCTION

The rapid development of technology, particularly the Internet of Things (IoT), has the potential to revolutionize the mining industry by enhancing safety standards and improving overall efficiency. The hazardous and challenging working conditions in mines pose significant risks to the health and well-being of miners. Therefore, the implementation of a smart helmet and clothing system that leverages IoT capabilities can greatly contribute to addressing these challenges and ensuring a safer work environment.

The smart helmet and clothing system proposed in this project will integrate IoT technologies, such as asynchronous servers, Google Firebase Database, Message Queuing Telemetry Transport (MQTT), piezoelectric battery charging, and real-time monitoring. These technologies will work in synergy to create a comprehensive and efficient system for monitoring hazardous events in real-time.

The system will consist of two main sections: the helmet section and the control room section. The helmet section will be equipped with a suite of sensors and a transmitter for data collection and transmission. These sensors will monitor various factors, including temperature and humidity fluctuations, the release of harmful gases like methane, the conscious and unconscious state of miners, the removal of a miner's helmet, and potential helmet damage due to obstacles. The collected data and alerts will be transmitted to the control room section.

In the control room section, a receiver will collect and process the transmitted data, allowing mine managers to monitor the conditions within the mine in real-time. This enables them to take immediate actions to ensure the safety of miners. The system will also include a dedicated alert mechanism for monitoring water rise levels, addressing the risk of flooding. By incorporating sensors like IR sensors, proximity sensors, humidity sensors, and gas sensors, the system can effectively detect multiple risk factors and provide timely updates to relevant parties.

Furthermore, the collected data will be synced with the Google Firebase Database, providing real-time access to essential information for both mine managers and the family members of miners. This feature ensures that all relevant parties are informed about the safety and well-being of miners, allowing for prompt action in case of emergencies.

While the smart helmet and clothing system will significantly enhance safety standards, the project also acknowledges the importance of structural changes in mine construction. By optimizing the design and layout of mines, addressing ventilation and haulage issues, it is possible to create a safer and more efficient work environment for miners.

3.2 OBJECTIVES

The objectives of the project are to:

- Develop a smart helmet with sensors to monitor hazardous conditions in mines.
- Enable real-time transmission of data and alerts from the helmet to the control room.
- Create a control room section with a receiver to collect and process data from the helmets.
- Implement real-time monitoring of events like temperature, humidity, gas release, helmet removal, and damage.

- Sync data with Google Firebase Database for real-time access by mine managers and relevant parties.
- Develop an alert system for detecting and notifying about water rise levels in mines.
- Enhance safety and health standards in the mining industry.
- Facilitate efficient decision-making based on real-time data.
- Explore structural changes in mine design to improve ventilation and haulage.
- Promote the adoption and acceptance of the smart helmet for mining industry applications.

3.3 PROPOSED METHODOLOGY

The methodology for designing and developing the Smart Helmet Suit System for mining industry applications involves the following steps:

1. Requirement Analysis: Conduct a thorough analysis of the requirements and challenges faced in the mining industry to identify the key functionalities and features that the smart helmet and suit system should possess.
2. Sensor Integration: Select and integrate various sensors into the helmet suit system, such as gas sensors, IR sensors, pulse oximeter sensors, and thermal probes. These sensors will enable the detection and monitoring of hazardous events, including toxic gas presence, helmet removal, heart rate, blood oxygen saturation, body temperature, and environmental conditions.
3. Hardware Development: Design and develop the hardware components of the smart helmet suit system, including the helmet structure, sensor connections, microcontrollers, embedded modules (e.g., ESP32 MCU), and power management system. Ensure the hardware components are robust, lightweight, and suitable for mining environments.
4. Software Development: Develop the necessary software components for data collection, processing, and transmission. This includes programming the microcontrollers, implementing wireless communication protocols (such as WiFi), setting up a web server, and developing a mobile application for data access and control.
5. Real-time Data Transmission: Establish a connection between the smart helmet suit system and the control room through local transmission and real-time synchronization with the Google Firebase Database. Implement data transmission protocols and ensure secure and reliable communication.

6. Alert System Implementation: Integrate an alert system that generates notifications and alerts in response to hazardous events detected by the sensors. This includes sending alerts to the user, control room, and family members via email, ensuring timely response and necessary actions.

7. Testing and Evaluation: Conduct thorough testing of the smart helmet suit system to validate its performance, accuracy, and reliability in detecting and monitoring hazardous events. Evaluate the system's effectiveness in enhancing safety and health in mining environments.

8. Optimization and Improvement: Continuously optimize and improve the smart helmet suit system based on feedback and insights gathered during testing and evaluation. This may involve refining algorithms, enhancing user interfaces, or adding or removing sensors based on industry requirements.

3.3.1 CIRCUIT DIAGRAM

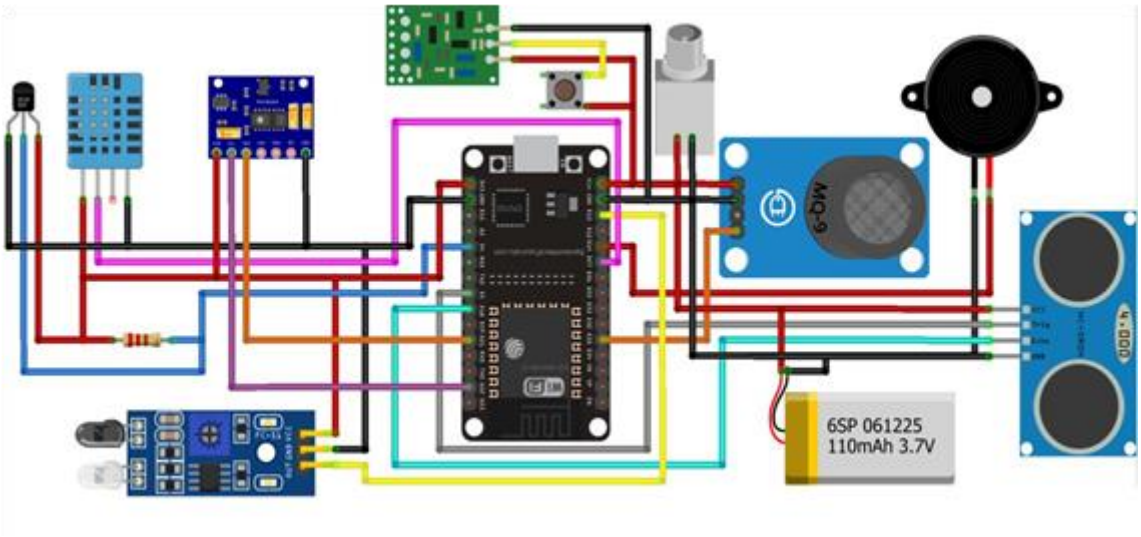


Fig. 3.1 Circuit Diagram

The architecture diagram of the smart helmet and clothing system for the mining industry includes two main sections: the helmet section and the control room section. The helmet section consists of various sensors such as an IR sensor, proximity sensor, humidity sensor, and gas sensor, along with a microprocessor such as Node MCU. These sensors will provide real-time data about the hazardous events, including temperature and humidity changes, gas releases, the conscious and unconscious state of the miner, removal of the helmet, and obstacle damage to the helmet. This data will be transmitted wirelessly using a transmitter to

the control room section. The control room section consists of a receiver that can receive the transmitted data and alerts from the transmitter. The data will be synced to the Firebase database, which will store the data and make it available for future reference. The control room section also includes a system to generate email alerts based on the received data, which will help in alerting the nearest manager or the control room about the hazardous events as shown in Figure 3.1.

3.3.2 Data Flow Diagram

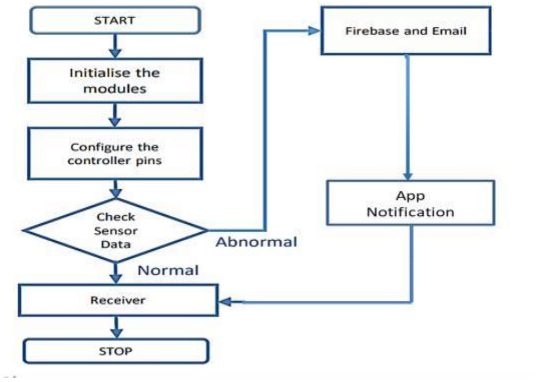


Figure 3.2: Data Flow

1. Data Collection: The starting point of the data flow diagram is the data collection process, which involves the use of various sensors embedded in the smart helmet and clothing as shown in Figure 4.2. These sensors include IR sensors, proximity sensors, humidity sensors, gas sensors, and others. They continuously collect data related to environmental conditions (temperature, humidity, gas levels), the miner's health (consciousness, physical state), and safety (helmet removal, obstacle damage).

2. Data Processing: Once the data is collected, it is sent to the microprocessors as shown in Figure 4.2 integrated within the helmet and clothing system. The microprocessors process the raw data, filtering out noise and converting sensor outputs into meaningful information.

3. Local Alert Generation: If the microprocessors detect any hazardous events or conditions, they generate local alerts for the miner. These alerts can include audio or visual signals as shown in Figure 4.2, such as beeping sounds or flashing lights, to warn the miner about potential dangers and guide them to take appropriate action.

4. Data Transmission: The processed and analyzed data, along with any generated and synced alerts, are transmitted from the helmet and clothing system to the control room via a

wireless communication module. This module may use Wi-Fi, Bluetooth, or other wireless communication technologies to ensure transmission as shown in Figure 3.2.

3.3.3 Use Case Diagram

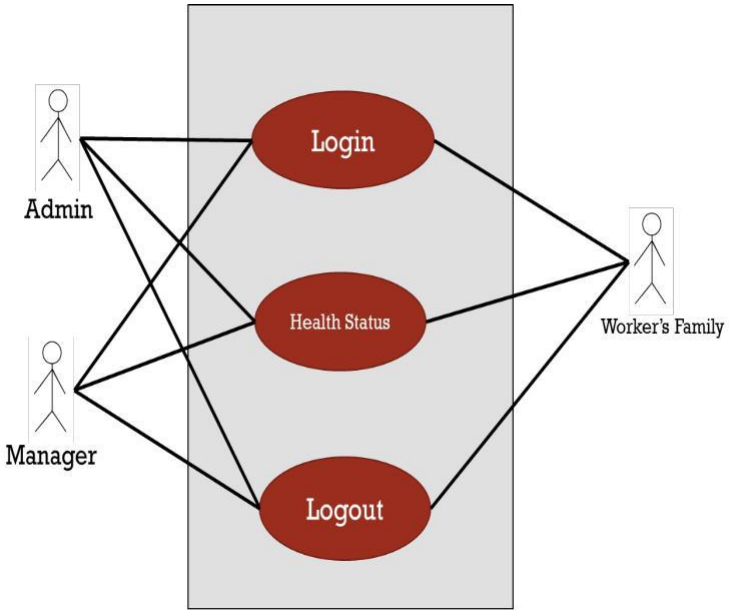


Figure 3.3: Activity Diagram

1. Actors:

Admin: Responsible for overall system management, such as user access, configuration, and data management.

Manager: Oversees mining operations, monitors workers' health status, and takes necessary actions in case of hazardous events.

Worker's Family: Family members of the miners who can access the health status information of their loved ones.

2. Use Cases:

Login: This use case represents the authentication process for each actor. Actors need to provide their credentials (e.g., username and password) to access the system. Health Status: This use case represents the real-time monitoring of workers' health status, including temperature, humidity, gas levels, and helmet status.

Logout: This use case represents the process of securely logging out of the system, ensuring the protection of sensitive data as shown in Figure 3.3.

3.3.4 Steps to RUN and EXECUTE the project

Step 1: Assemble hardware components Assemble the hardware components, including the sensors (IR sensor, proximity sensor, humidity sensor, gas sensor), microprocessors (NodeMCU and Arduino), and wireless communication mod-ules, into the smart helmet and clothing.

Step 2: Develop software Develop the software required for data collection, processing, and transmission. This includes programming the microprocessors to process the sensor data, detect hazardous events or conditions, and generate local and remote alerts.

Step 3: Configure communication settings Configure the wireless communication module to establish a connection with the control room receiver or remote monitoring application. Ensure the secure and reliable transmission of data be-tween the smart helmet and clothing system and the control room or manager's device.

Step 4: Integrate with Google Firebase Database Set up a Google Firebase Database account and configure the system to sync the collected data with the database. This step enables remote data access and management, as well as data redundancy and availability.

Step 5: Test the system Perform thorough testing of the smart helmet and cloth-ing system to ensure proper functionality, performance, and reliability. This includes testing the sensors' accuracy, the microprocessors' processing capabil-ities, the communication module's data transmission, and the alert generation mechanisms.

Step 6: Train miners and control room staff Train miners and control room staff on how to use the smart helmet and clothing system effectively. This includes understanding the system's features, interpreting the data and alerts, and taking appropriate action in response to hazardous events or conditions.

Step 7: Deploy the system in the mining environment Distribute the smart helmet and clothing system to miners and install the control room receiver or remote monitoring application on the manager's device. Ensure that the system is operational and ready for real-time monitoring and alert generation.

Step 8: Monitor and maintain the system Regularly monitor the system's performance and maintain the hardware and software components as needed. This includes updating the microprocessor firmware, calibrating the sensors, and troubleshooting any communication or connectivity issues.

Step 9: Analyze data and optimize operations Analyze the collected data to identify trends, patterns, and potential issues in the mining environment. Use this information to optimize mining operations, improve safety measures, and enhance overall productivity.

Step 10: Iterate and improve Continuously evaluate the smart helmet and clothing system's effectiveness and identify areas for improvement. Implement new features, advanced sensors, or machine learning algorithms to enhance the system's capabilities and further improve miner safety and health as shown in Figure 3.4.

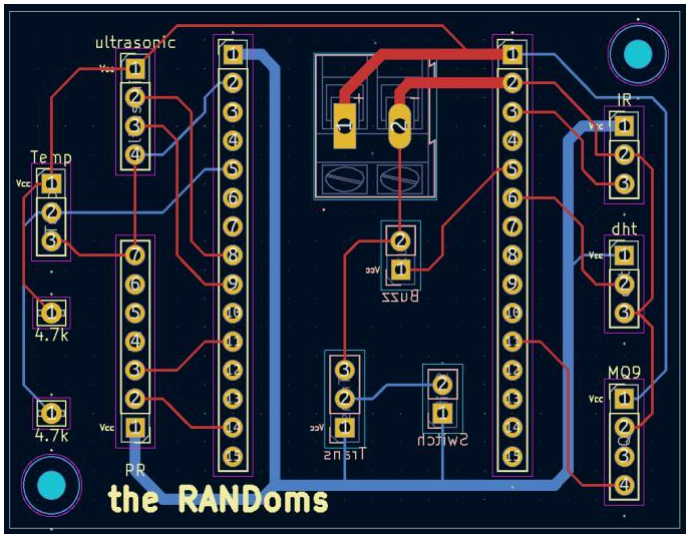


Figure 3.4: PCB Design

3.4 Block Diagram

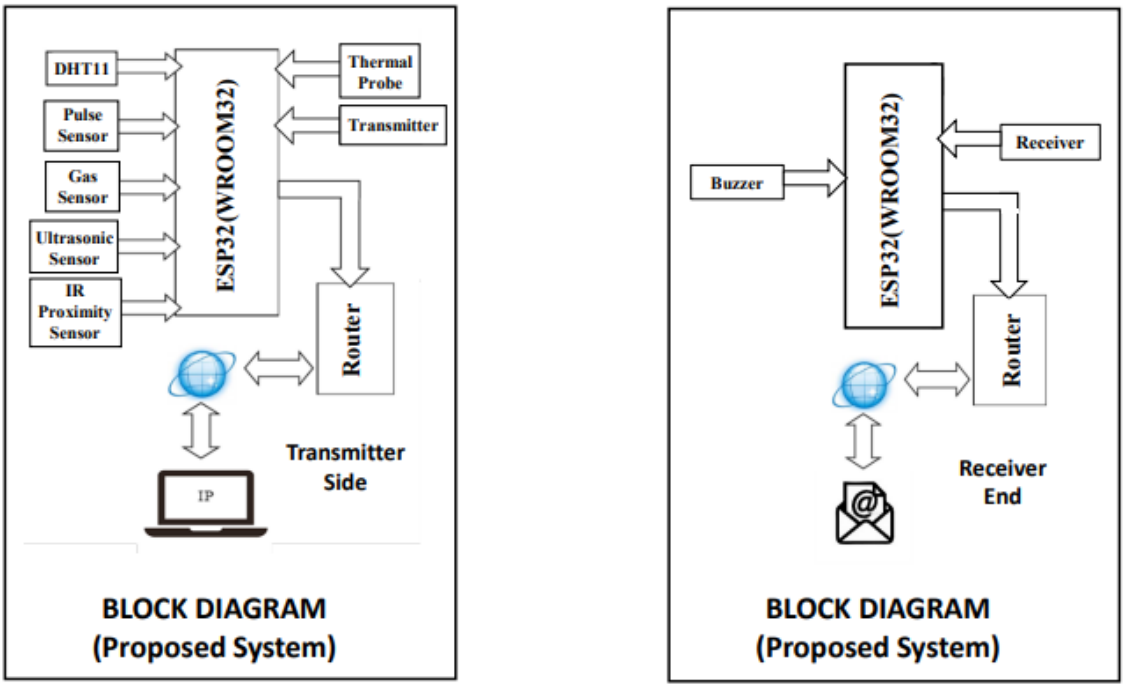
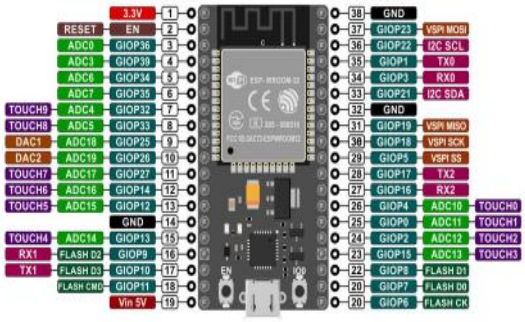


Fig. 3.5 Block Diagram

3.5 Tools Used

- **Hardware Components**



ESP32 (WROOM32)

It is the main component of the whole system and a powerful, generic Wi-Fi + BT + BLE MCU module with a dual core processor which makes the system much effective and faster.

The sleep current of the ESP32 chip is less than 5 µA, making it suitable for battery powered and wearable electronics applications.

The module also has a built in web server which can be accessed through any web browser using is IP address.

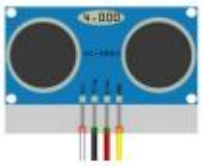
It serves as a controller to the rest of the components.

Humidity Sensor (DHT11)

- Low cost
- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data) Good for 20-80% humidity readings with 5% accuracy
- Good for 0-50°C temperature readings ±2°C accuracy
- No more than 1 Hz sampling rate (once every second)
- Body size 15.5mm x 12mm x 5.5mm 4 pins with 0.1" spacing

MQ-9 Gas Sensor

- **Detection Gas**: Carbon Monoxide, Methane, LPG
- **Concentration**: 0.4mg/L – 4mg/L
- **Supply Voltage**: <24V
- **Heater Voltage**: 5.0V ± 0.1V (High), 1.4V ± 0.1V (Low)
- **Load Resistance**: Adjustable
- **Heater Resistance**: 33Ω ± 5Ω
- **Heater Consumption**: <340mW

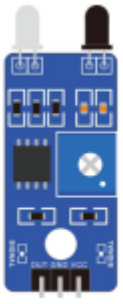


HC-SR04 Ultrasonic Sensor

- **Operating voltage**: +5V
- **Theoretical Measuring Distance**: 2cm to 450cm
- **Practical Measuring Distance**: 2cm to 80cm
- **Accuracy**: 3mm
- **Measuring angle covered**: <15°
- **Operating Current**: <15mA
- **Operating Frequency**: 40Hz

DS18B20 Thermal Probe

- Usable temperature range: -55 to 125°C
- Unique 64 bit ID burned into chip
- ±0.5°C Accuracy from -10°C to +85°C
- Temperature-limit alarm system
- Query time is less than 750ms
- Usable with 3.0V to 5.5V power/data



IR Proximity Sensor

- IR transmitter
- Ambient light protected IR receiver
- 3 pin easy interface connectors
- Indicator LED & Power LED
- Distance 2cm to 30cm
- Active Low on object detection
- 3.3 to 5V operation

- **Software Used:** -Arduino IDE, Google Firebase database, Embedded C

3.6 OVERALL WORKING

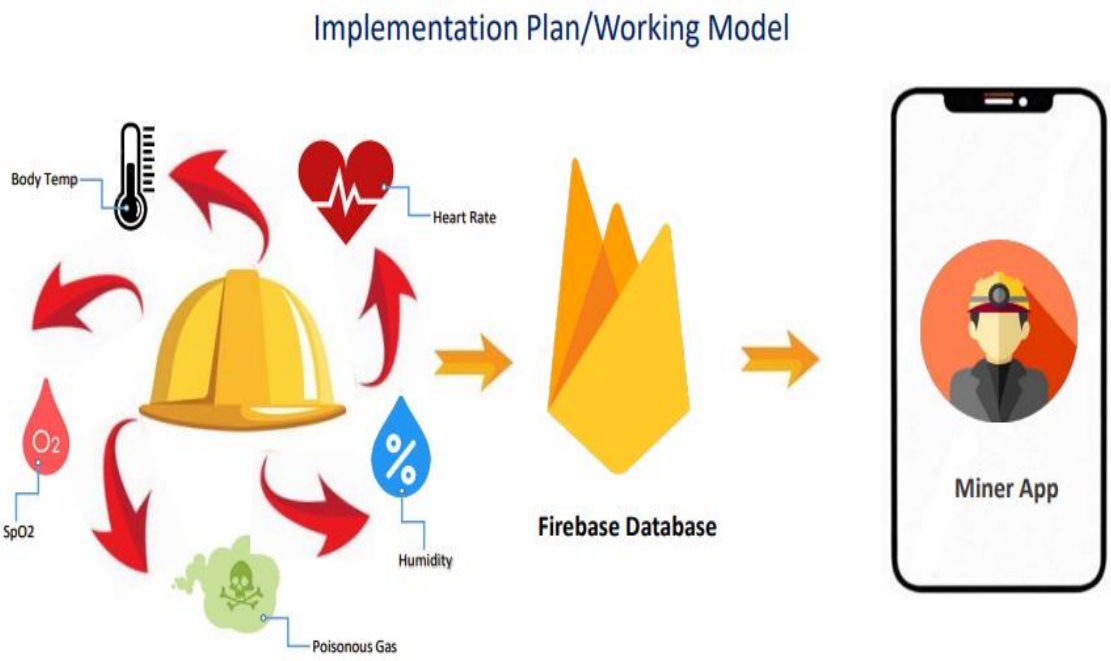
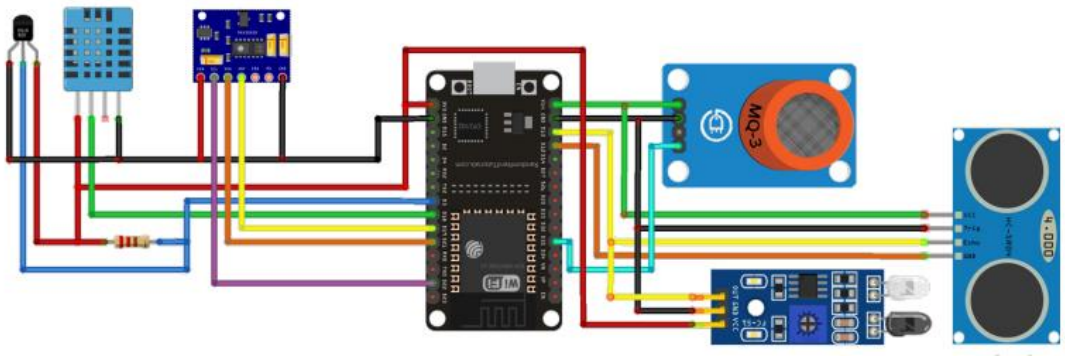


Fig 3.6 Working Model

The programming and troubleshooting will be conducted on mainly two sections, helmet section and control room section that means the system will have a transmitter to transmit necessary data and Alerts to the control room or nearest manager and a receiver that can be used by the control room or the managers to grab the data and alerts from the transmitter. Below is the Proposed Transmitter Circuit.



The system gets activated when the following conditions are triggered: • Pulse Oximeter Heart Rate Sensor-this sensor constantly monitors the heart rate of the miner and the Arduino program gives the alert once it exceeds the limit of 130 bpm. • Similarly the other sensors like Humidity Sensor, Gas Sensor, IR Proximity, Ultrasonic Sensor, Thermal Probe, etc. gets triggered when they undergo certain constrains according to the IDE program.

3.7 RESULTS

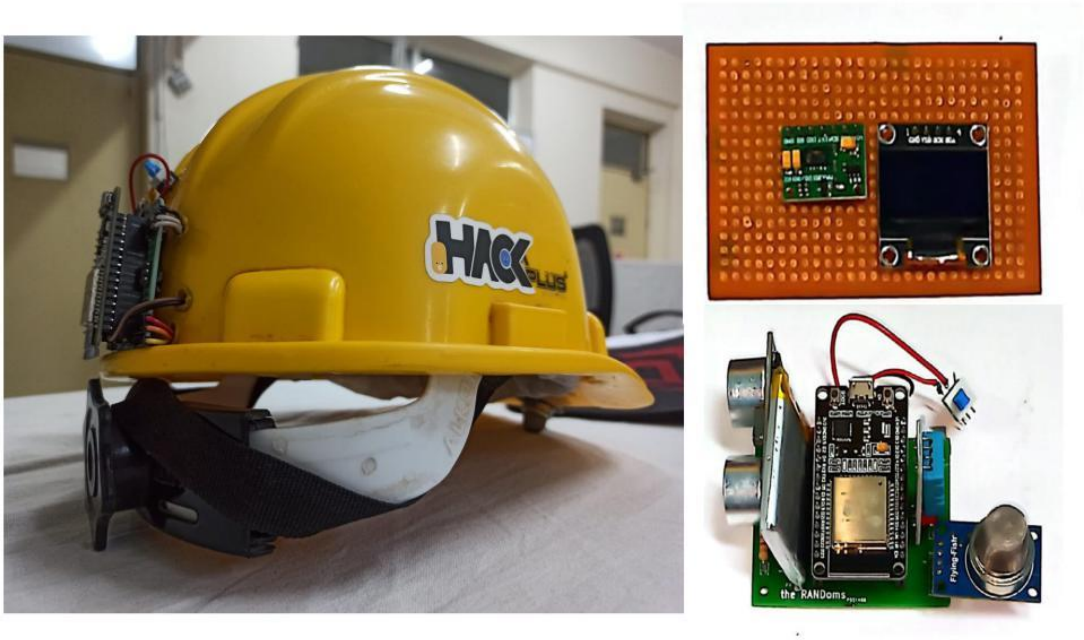


Fig 3.7 The Prototype

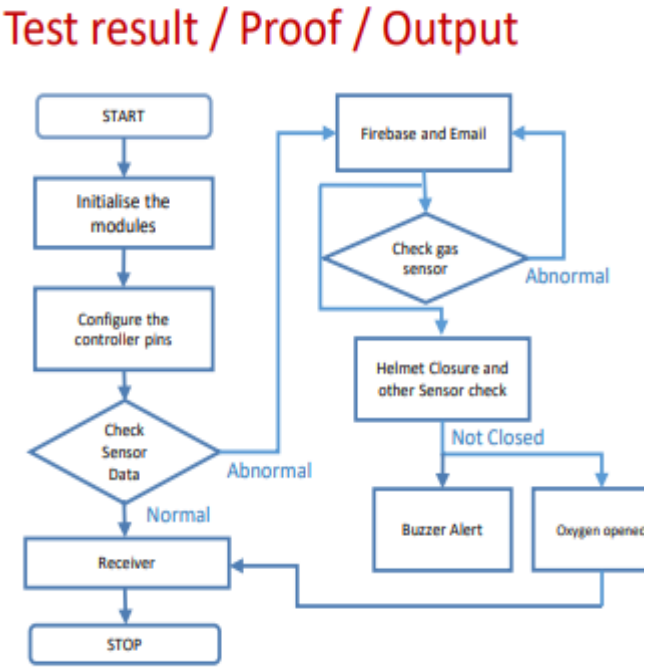


Fig 3.8 Flow Chart

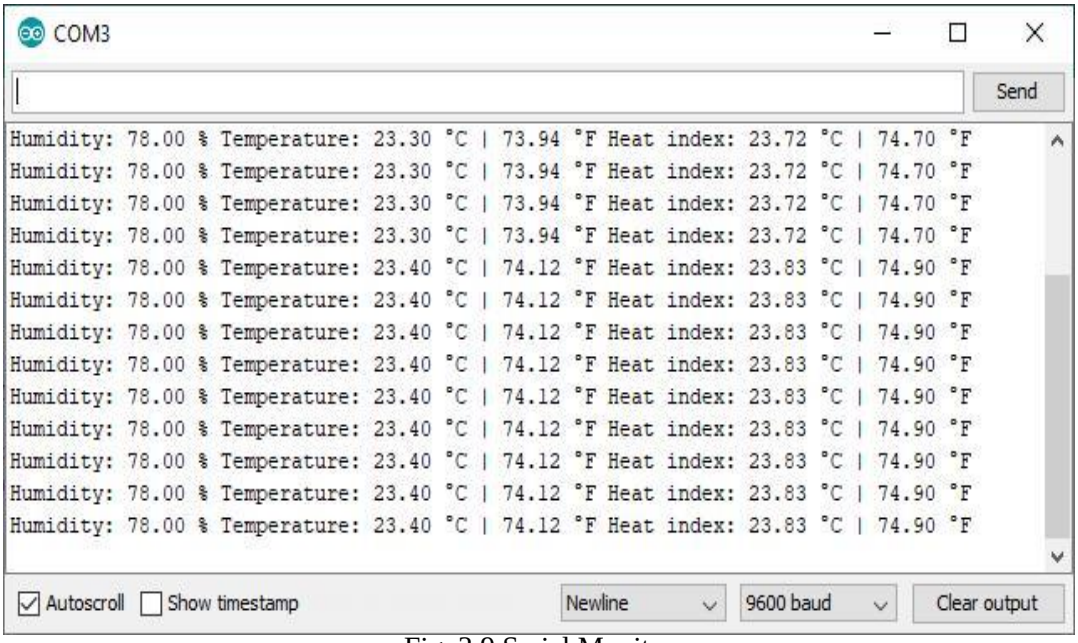


Fig. 3.9 Serial Monitor

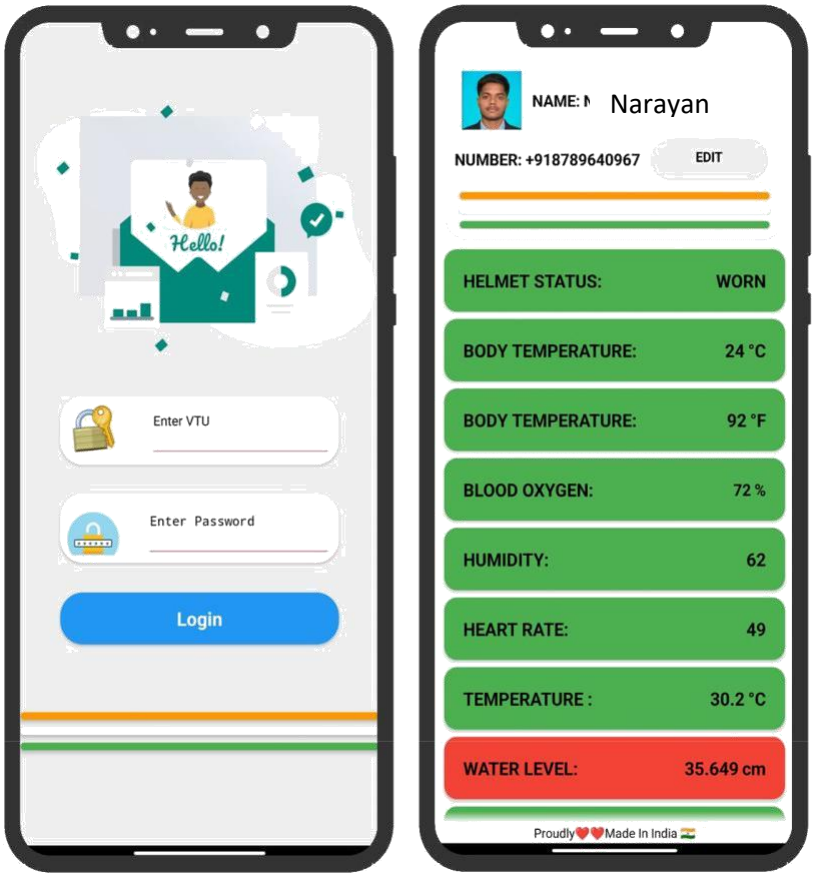
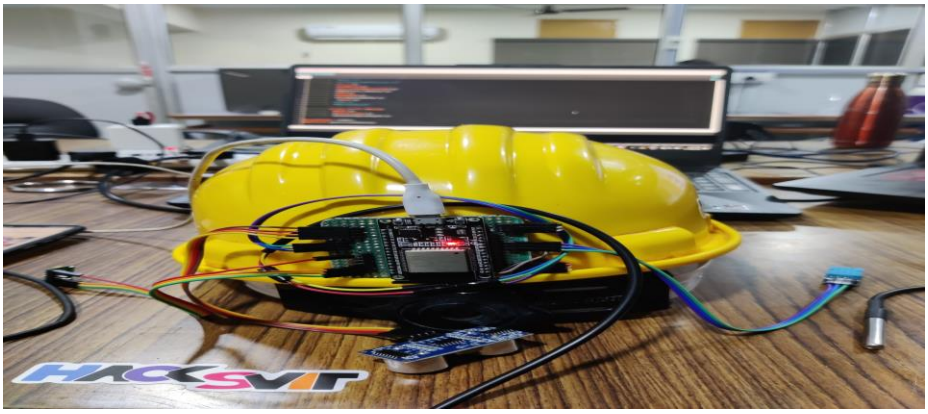


Fig 3.10 Mobile Application

3.8 PHOTOGRAPHS



3.9 APPLICATIONS

1. Mining Industry: The primary application of the smart helmet suit system is in the mining industry itself. It can enhance the safety and health of miners by monitoring hazardous events such as toxic gas presence, helmet removal, and environmental conditions in real-time. The system can provide early warnings and alerts, enabling timely response and preventive measures.

2. Construction Industry: The smart helmet suit system can also be applied in the construction industry, where workers face similar risks and hazards as miners. By monitoring factors like gas leaks, helmet usage, body temperature, and environmental conditions, the system can help prevent accidents and ensure the well-being of workers.

3. Oil and Gas Industry: The oil and gas industry involves working in complex and potentially dangerous environments. The smart helmet suit system can be utilized to monitor gas leaks, heat levels, worker vital signs, and potential equipment damage. This proactive monitoring can significantly enhance safety and reduce the risk of accidents.

4. Manufacturing Industry: Within the manufacturing industry, workers may face various risks, including exposure to harmful substances, heat stress, and potential injuries. The smart helmet suit system can help mitigate these risks by monitoring air quality, temperature, worker vital signs, and other relevant parameters, ensuring a safer work environment.

5. Emergency Response and Disaster Management: During emergency response and disaster management scenarios, the smart helmet suit system can provide vital information about the conditions and well-being of the rescue workers. It can monitor gas levels, body temperature, and heart rate, aiding in assessing the health and safety of the responders in real-time.

3.10 CONCLUSIONS

The implementation of a smart helmet and clothing system for the mining industry represents a ground breaking idea with the potential to dramatically enhance miner safety. This innovative system is designed to monitor hazardous events in real-time, such as rising temperature and humidity levels, the release of dangerous gases like methane and carbon monoxide, and the conscious or unconscious state of the miner. Furthermore, the system will track the removal of a miner's helmet and any ensuing damage that may occur. The proposed system's programming and troubleshooting will be executed in two distinct sections: the helmet section and the control room section. Equipped with a transmitter, the system will relay essential data and alerts to the control room or the nearest manager, while a receiver will allow the control room or manager to access this crucial information. In addition, the system will synchronize the collected data with the Firebase database and disseminate email alerts when necessary. As a whole, this advanced system will significantly improve the safety of miners by facilitating real-time monitoring of their environment, mitigating the risk of accidents, and enabling prompt interventions during emergencies. By employing state-of-the-art sensors and microprocessors, in conjunction with cloud-based technology, the system's efficiency and reliability are markedly increased, making it an exceptionally promising solution for addressing the unique challenges faced by the mining industry. The integration of this cutting-edge technology will revolutionize safety standards in mining and, ultimately, safeguard the lives of those who work in this hazardous field. The adoption of this pioneering smart helmet and clothing system will undoubtedly contribute to a more secure working environment for miners. By providing continuous monitoring and instant alerts, it equips managers and emergency responders with the necessary tools to act swiftly in critical situations.

3.11 FUTURE SCOPE

There are several future enhancements that can be considered for the smart helmet and clothing system for mining industry application : Firstly, the system can be further developed to include more advanced sensors and analytics to provide deeper insights into the working conditions of the miners. For example, the addition of sensors to detect the presence of dust and other particulate matter can help monitor the air quality in the mine and prevent respiratory problems for miners. Secondly, the system can be integrated with machine learning algorithms to provide more ac-curate predictions and preventive measures. By analyzing the data collected by the system, the algorithms can predict potential safety hazards and recommend actions to be taken before they occur. Thirdly, the system can be enhanced with augmented reality (AR) technology to provide miners with a real-time visual display of the environment around them. This can help them navigate through the mine and avoid obstacles or hazardous areas. Lastly, the system can be integrated with communication technology to enable real-time communication between miners and the control room. This can help to improve safety and response times in emergency situations.

3.12 REFERNCES

[1] Abro, Shaikh, Soomro, Abid, Kumar, and Ahmed, 2018, August. Prototyping IOT based smart wearable jacket design for securing the life of coal miners. In 2018 International Conference on Computing, Electronics Communications Engineering (iCCECE) (pp. 134-137). IEEE.

[2] Behr, Kumar, and Hancke, 2016, March. A smart helmet for air quality and haz-ardous event detection for the mining industry. In 2016 IEEE International Con-ference on Industrial Technology (ICIT) (pp. 2026-2031). IEEE.

[3] Eldemerdash, Abdulla, Jayapal, Nataraj, and Abbas, 2020. IoT based smart hel-met for mining industry application. Int. J. Adv. Sci. Technol, 29(1), pp.373-387.

[4] Jagadeesh and Nagaraja, 2017. IoT based Smart Helmet for unsafe event de-tection for mining industry. International Research Journal of Engineering and Technology (IRJET), e-ISSN, pp.2395-0056.

[5] Kartik, 2023. IOT based Smart Helmet for Hazard Detection in mining industry. arXiv preprint arXiv:2304.10156.

[6] Kim, Baek, and Choi, 2021. Smart helmet-based personnel proximity warn-ing system for improving underground mine safety. Applied sciences, 11(10), p.4342.

[7] Mardonova, and Choi, 2018. Review of wearable device technology and its ap-plications to the mining industry. Energies, 11(3), p.547.

[8] Rathod, S., Bagal, P., Gujar, R., Hannure, A. and Waghulde, D., 2021. Smart Helmet for Detection of Unsafe Events in Mining Industy Based on IoT (No. 5799). EasyChair.

[9] Shabina, 2014, March. Smart helmet using RF and WSN technology for under-ground mines safety. In 2014 International Conference on Intelligent Computing Applications (pp. 305-309). IEEE.

[10] Sharma, M. and Maity, T., 2018. Low cost low power smart helmet for real-time remote underground mine environment monitoring. Wireless Personal Communications, 102(1), pp.149-162.