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IOT Based Smart Helmet for Construction Workers

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Abstract: *Industrial safety is one of the main aspects of industry. Working environment hazards include suffocation, gas poisoning and gas explosion. Hence air quality and hazardous event detection is very important factor in industry. In order to achieve those safety measures, the proposed system provides a wireless sensor network for monitoring real time situation of working environment from monitoring station. It provides real time monitoring of harmful gases like CO, CH4 and LPG and also temperature and humidity. To overcome those hazardous situation, this system provides emergency alert to the monitoring station. Some workers are not aware of safety and they did not wear helmet properly. For this purpose, a limit switch was used to successfully determine whether the workers had worn their helmet properly or not. The system uses Wi-Fi technology for transmission of data from working environment to the monitoring station. There is an alert switch at working environment for emergency purpose.*

Keywords: Safety, NodeMCU, Sensors, IoT, Cloud Computing.

I. INTRODUCTION

1.1 Overview

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifier and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. IoT has evolved from the convergence of wireless technologies, microelectro mechanical systems (MEMS), microservices and the internet. The convergence has helped tear down the silo walls between operational technology and information technology, allowing unstructured machine-generated data to be analyzed for insights that will drive improvements. In earlier days, LED helmets were deployed in Industries to inform the workers about the hazardous events. Later sensors were deployed to detect the events and the alert can be sent to the remote monitoring unit to avoid losses. several wireless sensor network has been used to detect and transfer datas. The most commonly used technology for wireless transfer is zigbee. One of the main disadvantage in using zigbee as a medium of transfer is the coverage area. The coverage area of zigbee is usually 10– 100 meters line-of-sight, depending on power output and environmental characteristics. Zigbee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. The proposed system uses Wi-Fi technology to transfer data from the working environment to the remote monitoring unit. The merit in using Wi-Fi as a medium of transfer is that it covers wider area and it is the latest modern technology that has been emerging worldwide for transferring data. In this system the transferred data is collected, stored and analyzed using Thingspeak application. Thingspeak is one of the recently developed application in the field of IoT for analysing data transferred by wireless sensor networks. Mining is indispensable to the creation of goods, infrastructure and services which enhance the quality of their lives. As a society we're blessed to enjoy the many advantages that industry manufactured products provide us by processing these raw materials. Working in the earth presents many different security and health dangers. Frequently the underground environment is shaky or unpleasant. The mines that are deeper, the more dangerous it could be to be running jobs. There's oxygen leak that is restricted, and there are challenges related to leaving a mine if a crisis happen. So here we propose a mining tracking as well as safety system for the mining industry using microcontroller based circuit on the worker helmet.

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We use rf based circuitry to detect workers moving through the entire mining site. The helmet is integrated with an rf based tracking system which in coordination with the tracker rf systems help provide data over IOT. The system makes use of atmega microcontroller based rf tracker circuitry to receive the data transmitted by worker helmet nodes. This helps map the current location of workers through the entire mining site. Moreover each worker helmet circuit is integrated with a panic/emergency button. This button when pressed shows an emergency sign over the IOT web interface about the worker emergency. This can be used for any emergencies like – toxic gas inhalation, cave ins, physical injury etc. Thus the system ensures mining worker safety using IOT.

1.2 Motivation

The motivation of this project comes from the real-world challenges that construction workers face daily on the sites. Accidents are on the rise day by day and in countries like India where more prevalent many people die to carelessness carried in wearing helmets. In present day scenario we encounter numerous cases of death due to not using helmet at construction sites. Despite of the fact that helmets are available everywhere, people are not wearing them. In the event of accidents, the message is sent to the emergency contact through nodeMCU.

1.3 Problem Definition and Objectives

To design and implement the system using Internet of Things to provide the safety is a major problem in construction works. This project aims to develop smart wearable devices such as helmet using various sensors that will help in monitoring the health and safety of workers. Hybrid approach to integrate fixed and mobile IoT sensors to measure and monitoring the environment in which the workers are working. Collect the air quality around people, by combining fixed and mobile sensors and alert the managers if any crisis occurred.

1.4. Project Scope and Limitations

1. Person rides the bike even in the areas where mobile network lacks, so GSM network is required for sending SMS. It is expensive.
2. When the helmet is dropped down accidentally, the system treats it as an accident.
3. This makes system a very complex system. Due to this fact, failure in the stock prediction may lead to more time for restoration of the service to consumers. This may require skilled workers requiring knowledge of multiple technologies.
4. There is a chance that the software can be hacked and your personal information misused. The possibilities are endless. Your prescription being changed or your account details being hacked could put you at risk. Hence, all the safety risks become the consumers responsibility.

II. LITERATURE REVIEW

The purpose of this literature review is to investigate the topic of “IoT Based Bike Analyzer: Delivery Boys Safety Mechanism”. Following section explores different references that discuss about various topic related to our project.

“Implementation Of Smart Helmet” Deekshitha K J and Pushpalatha S, 2017

In this paper an IoT product called “Smart Helmet” is proposed, which comprises of two units, motor unit and helmet unit. It consists of different sensors and a transmitter circuitry. The transmitter side microcontroller contains three sensors which are alcohol sensor, vibrate sensor and IR sensor. The receiver side microcontroller comprises of a LCD, GSM module, RF recipient, Receive antenna, DC motor, drive L293D and GPS module [1].

“Accidental Identification and Navigation System In Helmet” A. Ajay, G. Vishnu, V.Kishoreswaminathan, V.Vishwanth, K.Srinivasan and S. Jeevanantham, 2017

A system for intelligent helmet has been proposed. This system detects the occurrence of an accident and makes provisions to sound an alert through the use of a GPS and GSM system. This system aims in providing a low cost intelligent system mainly focusing on the importance of human life[2].

“An IoT based Smart Helmet for Accident Detection and Notification” Prem Kumar M, Rajesh Bagrecha , 2017

The objective of this project is to develop a smart helmet is to provide a means and apparatus for detecting and reporting accidents. Sensors, Wi-Fi enabled processor, and cloud computing infrastructures are utilised for building the system.

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The accident detection system communicates the accelerometer values to the processor which continuously monitors for erratic variations. When an accident occurs, the related details are sent to the emergency contacts by utilizing a cloud based service. The vehicle location is obtained by making use of the global positioning system[3].

"IoT BASED SMART HELMET SYSTEM USING RASP-BERRY Pi-3" Vinith.G and Dr. K.thangarajan, 2017 Shrewd System for Helmet Detection utilizing Raspberry Pi guarantees cap ownership by a motorcyclist consistently by catching a depiction of the rider's head protector utilizing Pi Camera and affirming object location by cascading technique. The primary thought behind the venture is to diminish street fatalities among motorcyclists. An intelligent LED will caution the rider if the protective cap is not recognized after which the rider needs to guarantee the ownership of a cap or else the System will show a notice message which will win the rider a strike in the event that it is overlooked. An automated e-mail alert generation system is also developed in a reporting module of proposed system[4].

"Faaz Smart Helmet" Faizan Manzoor, Shah Asif Bashir, Aaqib Manzoor, Zain Ashraf Wani, Shahid Mohi Ud Din, 2017 The smart helmet includes the integrated electronic system which uses some of the basic components in the world of electronics. The microcontroller coordinates with the GPS, GSM, WIFI and the sensors. The vibration sensor, pressure sensor and the accelerometer sensor triggers after a certain value which can cause damage to the motorcycle rider. Once the sensors are triggered above the certain value, the GPS coordinates along with time will send a message to the family members and the server via WIFI component and GSM[5]. "IMPLEMENTATION AND ANALYSIS OF SMART HEL-MET" Rashmi Vashisth, Sanchit Gupta, Aditya Jain, Sarthak Gupta, Sahil, Prashant Rana, 2017
In this project radio frequency module is responsible for the wireless communication between the helmet and the bike circuit. The Piezo electric buzzer is used to detect speeding and this feature is extended by limiting the speed of the user. The ALCHO-LOCK function is used to prevent drink and drive scenarios Accelerometer detects accidents, and a fog sensor for increasing visibility in case of fog or smog are also used. Another feature known as E-HELMET allows for automatic deduction of the required amount from the users virtual wallet wirelessly preventing the rider to stop and pay for it[6]. "Intelligent Transportation System For Accident Prevention And Detection" Dr.D.Selvathi, P.Pavithra, T.Preethi, 2017
This paper provides an intelligent system for two wheelers accident prevention and detection for human life safety. The prevention part involves, "Smart Helmet", which automatically checks whether the person is wearing the helmet and has nonalcoholic breath while driving. The relay does not ON the engine if these two conditions are not satisfied. The microcontroller controls the function of relay and thus the ignition. The system also enables detection of an accident at any place and reports about the accident to predefined numbers with GSM module. The Microcontroller continuously records all the parameters of automobile for prevention and detection of accident[7]. "Mission On! Innovations in Bike Systems to Provide a Safe Ride Based on IOT" Archana.D, Boomija.G, Manisha.J, Kalaiselvi.V.K.G, 2017 Our system aims in providing a safe bike ride by the use of the sensor that helps the rider know the approaching vehicles and generate vibrations in the bike's handlebar. When a person starts to ride the bike , the person has to plug in the bike key and the bike's coordinate system starts. It is operated through a wireless control system. Most of the time people never mind to wear helmet. Therefore the helmet is fixed with sensors to detect if the person is wearing the helmet or not. After the person has worn it , the helmet will automatically lock and the bike's engine starts[8]. "Smart Helmet & Intelligent Bike System" Prof. Chitte P.P, Mr. Salunke Akshay S, Mr. Thorat Aniruddha N and Mr. Bhosale Nilesh T, 2016
The "Smart Helmet" is a type of protective headgear used by the rider which makes bike driving safer than before. The distinctive utility of project is fall detection, if the bike rider fall from bike it will send message automatically. Here each unit has used a separate microcontroller, for bike unit we use Arduino Lilypad and for helmet unit we use ARM7 lpc2148. Signal transmission between the helmet unit and bike unit is using a RF concept. The advantage of using this project is the detection of accident in remote area can be easily detected and medical services provided in short time[9]. "Intelligent Helmet" Jennifer William, Kaustubh Padwal, Nexon Samuel, Akshay Bawkar, SmitaRukhande, 2016
The proposed system is to develop an intelligent helmet. A module affixed in the helmet will sync with the module affixed on bike. The microcontroller is the actual decision making unit of the entire circuit and the programs will be fed into it. According to the data it will receive from the module on bike it will control the output of remaining components. Based on the output of both the accelerometers on bike and helmet, it will send message to nearest police station in case

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of an accident using GSM module and based on the outputs of alcohol sensor and IR sensor, it will send a relay output to the engine[10].

III. REQUIREMENT AND ANALYSIS

3.1 Introduction

3.1.1 Project Scope

1. We can use this system for smart city development projects
2. We use the system for measuring the air pollution in city
3. We use this system for air quality checks
4. We use it in companies in midc areas to measure the pollution level

3.1.2 User Classes and Characteristics

All users are not aware about Internet of Things or importance of security on the Internet Of Things. User can view the real time status of the field and Internet of Things manage these data. The application shall be developed in such a way that it helps the user to secure its own data. The proposed system will be responsible to display the actual status of the crop. Only authorized person can use this data.

1. User: The user is the authority will monitor the system by using the website. The system will notify the user using text and mails.
2. NodeMCU:NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects.
3. Cloud System: The Cloud system is storage where we can store our data coming from sensors like ultrasonic sensor and MQ-7 sensor. The cloud system will display the readings using the website.
4. Sensors: The sensors will play the main role in this system. The sensors include the temperature, humidity, light and soil moisture sensor which will read the input coming from the drainage system and send this readings to nodeMCU.

3.1.3 Assumptions and Dependencies

- The User is able to handle the sensors and computer system.
- Proposed System requires internet connectivity.
- Physical safety of the system should be maintain.

3.2 Functional Requirements

1. Administrative functions

This system should provide the administrative functions like registration and login for normal users.

2. Authentication

The proposed system authenticate user by their username and password for security reasons.

3. External Interfaces

The system should provide the interface to other systems for external system for better performance.

4. Historical Data

For performance improvement we have to store the historical data of the system so that we can compare the performance of system.

3.3 Non Functional Requirements

1. Performance

The system should provide the high performance for result generation so that system can work properly.

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2. Reliability
The system should be reliable so that user can use the system properly.
3. Maintainability
The system should easy to maintain if any changes or failure is occured.
4. Interoperability
The system is depends on the other systems so that the system should be provide interoprability.

3.4 External Interface Requirement

3.4.1 User Interfaces

The system can be monitored by using web browser.

3.4.2 Hardware Interfaces

Only the extra hardware interface required in our proposed system is the battery back up to power up the system.

3.4.3 Communication Interfaces

The communication between the different parts of the system is important since they depend on each other. The communication interface for the system and user is the wifi connection and the alert notifications which is in the form of text and mails. This will be useful for the user to get information about the patients.

3.5 System Requirements

3.5.1 Software Requirement:

- Arduino IDE
- Text Local API
- 000webhost for webhosting
- Languages for implementation : C, PHP, CSS, HTML
- Gmail
- Geolocation API

3.5.2 Hardware Requirements

- Breadboard
- Jumper wires
- Node MCU / ESP826612E
- MQ-7 sensor
- MQ-35 sensor
- MQ-2 sensor

3.5.3 Database Requirements

The application required Cloud Storage to store all the data come from sensors.

3.6 Analysis Models

Analysis model operate as a link between the system description and the design model. In the analysis model information function and the behavior of the system is define and these are translated into the architecture interface and component level design in the design modeling.

3.7 System Implementation Plan

Task No	Task Name	Start Date	End Date
1	Preliminary Survey	02-08-2021	03-08-2021
2	Introduction and Problem Statement	06-08-2021	10-08-2021
3	Literature Survey	16-08-2021	25-08-2021

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4	Project Statement	28-08-2021	30-08-2021
5	Software Requirement and Specification	31-08-2021	02-09-2021
6	System Design	04-09-2021	07-09-2021
7	Partial Report Submission	30-09-2021	10-12-2021
8	Architectural Design	20-12-2021	27-12-2021
9	Implementation	20-12-2021	28-02-2022
10	System Development	03-03-2022	09-03-2022
11	System Testing	10-03-2022	15-03-2022
12	Paper Publish	25-03-2022	12-04-2022
13	Report Submission	25-04-2022	-

IV. SYSTEM DESIGN

4.1 System Architecture

The below figure specified the system architecture of our project.

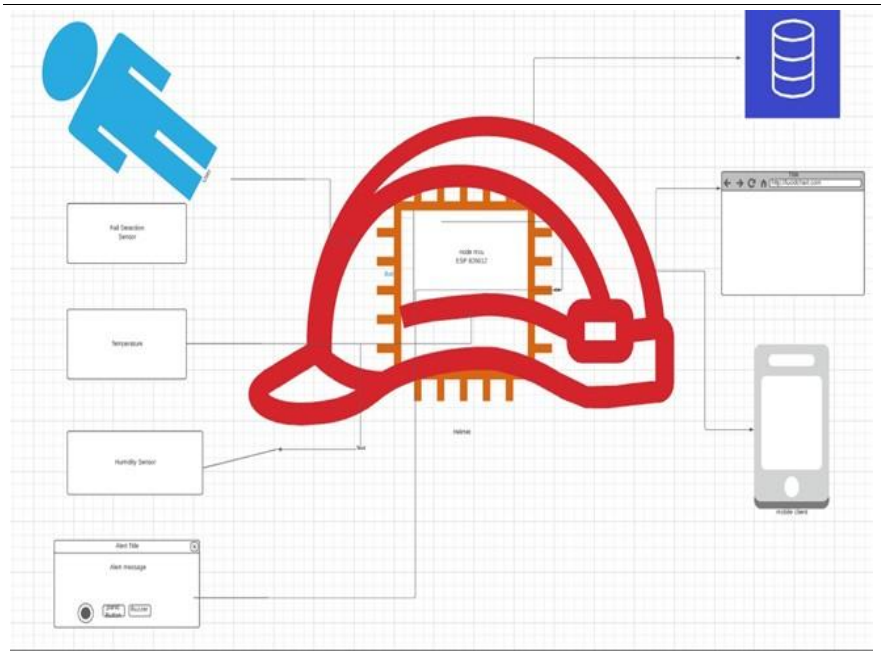

Figure 4.1: System Architecture Diagram

4.2 Working of the Proposed System

The main target of the project is designing a smart helmet for accident avoidance and alcohol detection. The sensors checks if the person is wearing the helmet or not and recognizes the alcoholic substance in the rider's breath. If the person is not wearing the helmet and if he consumes alcohol, the bike will not start. If there is no sign of alcoholic substance present and helmet is used, then only the bike will start. At the point when the rider met with an accident, the sensor recognizes the condition of the motorbike and reports the accident. Then the GPS in the bike will send the location of the accident place to main server of the nearby hospitals.

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4.3 Implementation Details (Modules)

1. Status Of Worker Wearing Helmet : Pressure Sensor(BMP180)
2. Air Quality Content Test :MQ3 Alcohol Sensor
3. Temperature and Humidity : DHT11 Sensor
4. Accident Location: If accident occurred or worker is fallen. It used to Google API sends the SMS to register no. with their current geographical location.

4.3.1 Hardware Modules:

1. IR Sensor

This IR reflective sensor Module used TCRT5000 IR Sensor to detect colour and distance. This sensor module consists on an IR transmitter an IR receiver. IR Transmitter continuously emits IR signal which is then reflected by an obstacle and is then detected by the IR receiver. TCRT5000 Infrared Reflective Sensor Module is often used in line following robots, object sorting Robot because this module can sense if a surface is white or black. The measuring distance range from 1mm to 8mm, and the central point is about 2.5mm. There is also an on-board potentiometer to adjust the sensitivity. The infrared diode will emitting the infrared continually when the module is powered ON, when the emitted infrared light has not been reflected or the strength is not big enough, the receiver diode will in the off state and output pin i.e. DO will be LOW.

2. NodeMCU

NodeMCU is an IoT Module based on ESP8266 Wi-Fi Module. NodeMCU uses Lua Scripting language and is an open source Internet of Things (IoT) platform. This modules has CH340g USB to TTL IC.
Features of Node-MCU IoT Module
1. Open source IoT Platform
2. Easily Programmable
3. Low cost & Simple to Implement 4.WI-FI enabled

3. Pressure Sensor

The BMP180 is the new digital barometric pressure sensor of Bosch Sensor Tec, with a very high performance, which enables applications in advanced mobile devices, such as smart phones, tablet PCs and sports devices. It follows the BMP085 and brings many improvements, like the smaller size and the expansion of digital interfaces. The ultra-low power consumption down to 3 A makes the BMP180 the leader in power saving for your mobile devices. BMP180 is also distinguished by its very stable behavior (performance) with regard to the independency of the supply voltage. BMP180 is the best lowcost sensing solution for measuring barometric pressure and temperature. Because pressure changes with altitude you can also use it as an altimeter! The sensor is soldered onto a PCB with a 3.3V regulator, I2C level shifter and pull-up resistors on the I2C pins. The BMP180 is the next-generation of sensors from Bosch, and replaces the BMP085. The good news is that it is completely identical to the BMP085 in terms of firmware/software/interfacing.

4. DHT11 sensor

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old.

5. Push button

It is going to use as a panic button at that movement when the rider faces the accident condition. If the rider is that much okay to push the button by himself or someone nearby to him can press that button to help the rider.

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6. Graphical User Interface

For GUI we are developing website and android application using PHP, CSS, HTML. All the data collected by the sensor are going to be stored on a cloud and will be shown on website and android application. The message will be sent in form of email as well as text message on the patients parents and friends.

4.4 Algorithm Used

4.4.1 KNN Algorithm

K-Nearest Neighbour is one of the simplest Machine Learning algorithms based on Supervised Learning technique. K-NN algorithm assumes the similarity between the new case/data and available cases and put the new case into the category that is most similar to the available categories. K-NN algorithm stores all the available data and classifies a new data point based on the similarity. This means when new data appears then it can be easily classified into a well suite category by using KNN algorithm. K-NN algorithm can be used for Regression as well as for Classification but mostly it is used for the Classification problems. K-NN is a non-parametric algorithm, which means it does not make any assumption on underlying data. It is also called a lazy learner algorithm because it does not learn from the training set immediately instead it stores the dataset and at the time of classification, it performs an action on the dataset. KNN algorithm at the training phase just stores the dataset and when it gets new data, then it classifies that data into a category that is much similar to the new data. Example: Suppose, we have an image of a creature that looks similar to cat and dog, but we want to know either it is a cat or dog. So for this identification, we can use the KNN algorithm, as it works on a similarity measure. Our KNN model will find the similar features of the new data set to the cats and dogs images and based on the most similar features it will put it in either cat or dog category.

The K-NN working can be explained on the basis of the below algorithm:

- Step-1: Select the number K of the neighbors
- Step-2: Calculate the Euclidean distance of K number of neighbors
- Step-3: Take the K nearest neighbors as per the calculated Euclidean distance.
- Step-4: Among these k neighbors, count the number of the data points in each category.
- Step-5: Assign the new data points to that category for which the number of the neighbor is maximum.
- Step-6: Our model is ready.

4.5 UML Diagrams

The Unified Modeling Language (UML) is a general purpose, developmental, modeling language in the field of software engineering that is intended to provide a standard way to visualize the design of a system. UML was originally motivated by the desire to standardize the disparate notational systems and approaches to software design developed by Grady Booch, Ivar Jacobson and James Rumbaing at Rational Software in 19941995, with further development led by them through 1996. In 1997 UML was adopted as a standard by the Object Management Group (OMG), and has been managed by this organization ever since. In 2005 UML was also published by the International Organization for Standardization (ISO) as an approved ISO standard. Since then it has been periodically revised to cover the latest revision of UML. UML is a standard language for specifying, visualizing, constructing, and documenting the artifacts of software systems. UML was created by Object Management Group (OMG) and UML 1.0 specification draft was proposed to the OMG in January 1997. OMG is continuously putting effort to make a truly industry standard. UML stands for Unified Modeling Language. UML is different from the other common programming languages like C++, Java, COBOL etc. UML is a pictorial language used to make software blue prints. So, UML can be described as a general-purpose visual modeling language to visualize, specify, construct and document software system. Although UML is generally used to model software systems but it is not limited within this boundary. It is also used to model non software systems as well like process flow in a manufacturing unit etc. UML is not a programming language but tools can be used to generate code in various languages using UML diagrams. UML has a direct relation with object-oriented analysis and design. After some standardization UML is become an OMG (Object Management Group) standard.

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4.5.1 Use Case Diagram

Use case diagrams are usually referred to as behavior diagrams used to describe a set of actions (use cases) that some system or systems (subject) should or can perform in collaboration with one or more external users of the system (actors). Each use case should provide some observable and valuable result to the actors or other stakeholders of the system. Note, that UML 2.0 to 2.4 specifications also described use case diagram as a specialization of a class diagram, and class diagram is a structure diagram.

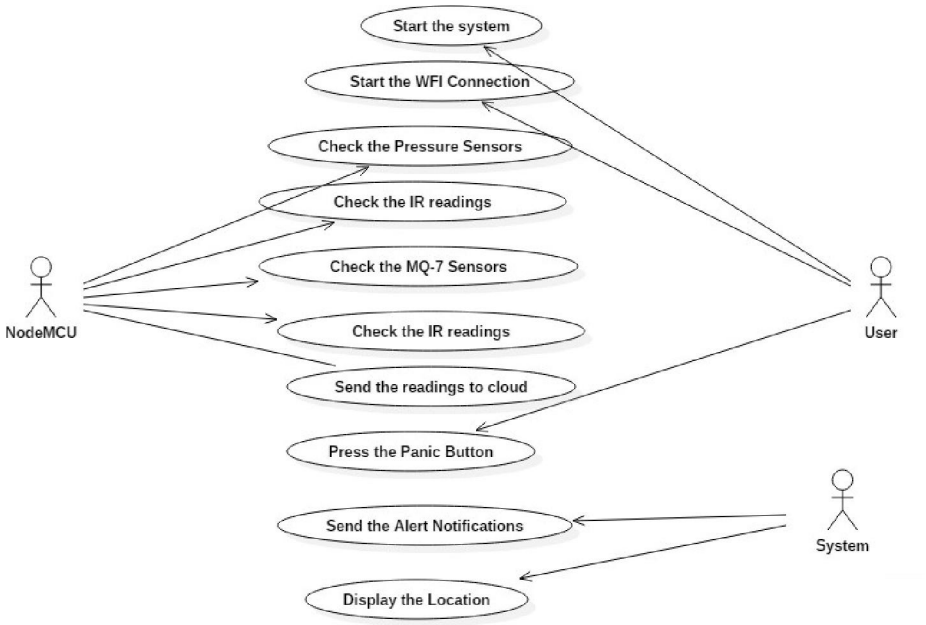

Figure 4.2: Use Case Diagram

4.5.2 Sequence Diagram

A sequence diagram shows object interactions arranged in time sequence. Its depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the Logical View of the system under development. Sequence diagrams are sometimes called event diagrams or event scenarios.

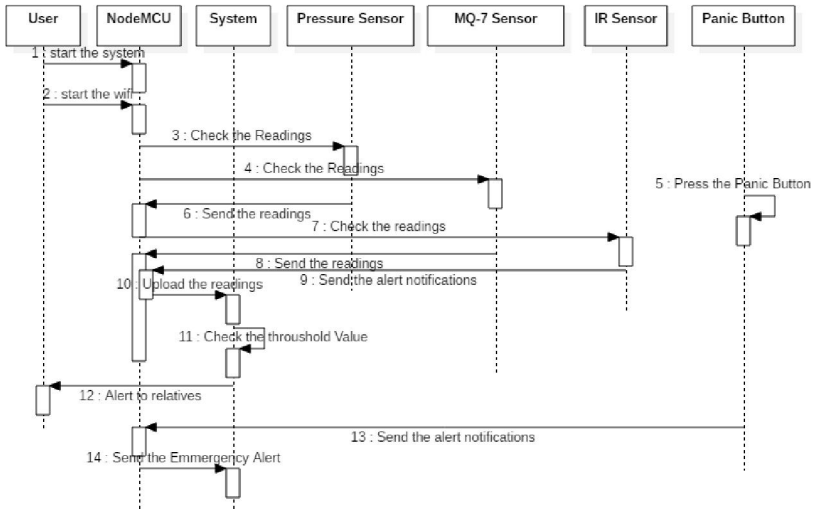

Figure 4.3: Sequence Diagram

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4.5.3 Activity Diagram

It captures the dynamic behavior of the system. Other four diagrams are used to show the message ow from one object to another but activity diagram is used to show message flow from one activity to another. Activity is a particular operation of the system. Activity diagrams are not only used for visualizing the dynamic nature of a system, but they are also used to construct the executable system by using forward and reverse engineering techniques. The only missing thing in the activity diagram is the message part.

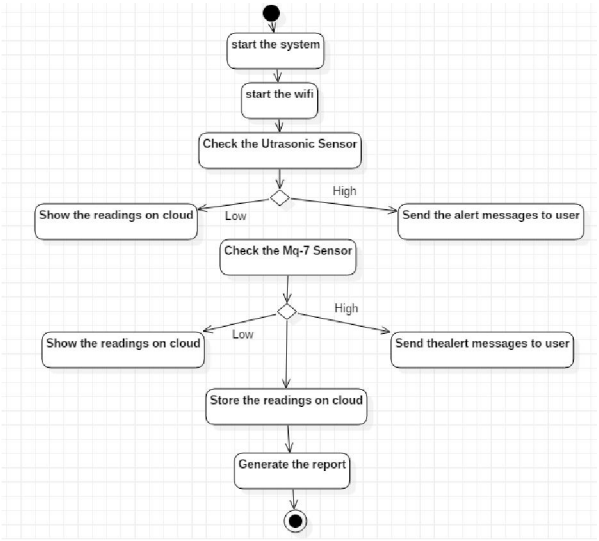

Figure 4.4: Activity Diagram

4.5.4 Class Diagram

A class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among objects. In order to further describe the behavior of systems, these class diagrams can be comcomplemented by a state diagram or UML state machine.

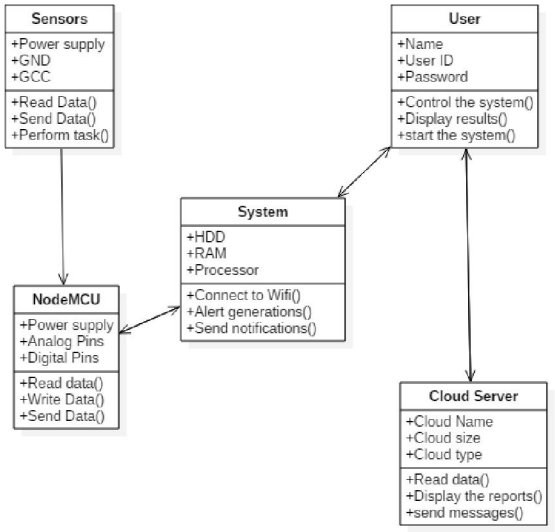

Figure 4.5: Class Diagram

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4.5.5 Package Diagram

Package diagram, a kind of structural diagram, shows the arrangement and organization of model elements in middle to large scale project. Package diagram can show both structure and dependencies between sub-systems or modules, showing different views of a system, for example, as multi-layered (aka multi-tiered) application multilayered application model.

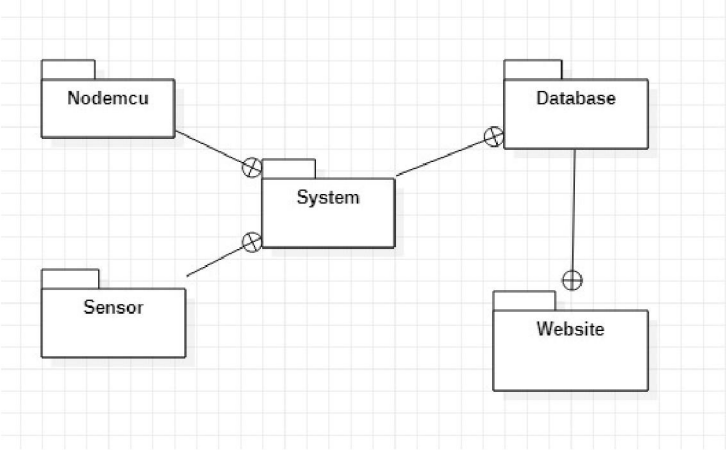

Figure 4.6: Package Diagram

4.5.6 Data Flow Diagram

A data flow diagram (DFD) is a graphical representation of the" flow" of data through an information system, modeling its process aspects. A DFD is often used as a preliminary step to create an overview of the system without going into great detail, which can later be elaborated.[2] DFDs can also be used for the visualization of data processing (structured design). A DFD shows what kind of information will be input to and output from the system, how the data will advance through the system, and where the data will be stored. It does not show information about the timing of process or information about whether processes will operate in sequence or in parallel unlike a flowchart which also shows this information.

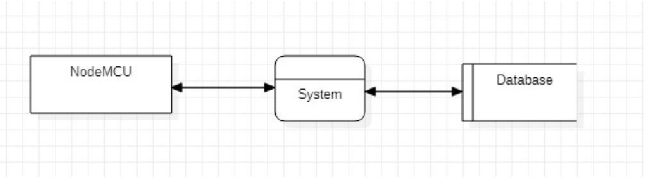

Figure 4.7: DFD Level 0

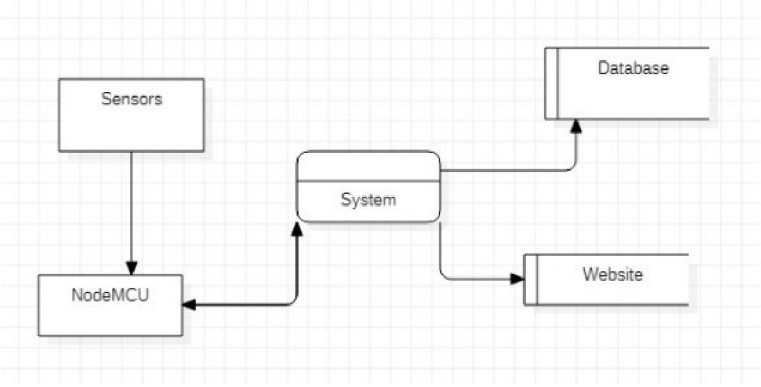

Figure 4.8: DFD Level 1

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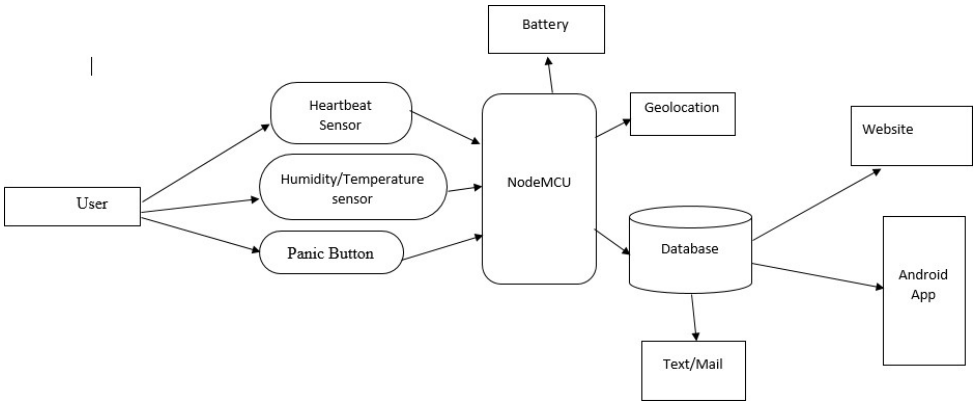

Figure 4.9: DFD Level 2

V. PROJECT PLAN

5.1 Project Estimate

The basis of estimates is an important tool in project management. It involves estimators and project managers to calculate the total cost needed for the entire project. It is used to support proposals, bidding and executing a project.

In a nutshell, the basis of estimates is a method of documenting different important aspects of the project cost estimate to mitigate the cost risk of the project.

It should be a clear document so that those involved in project management will be able to understand as well as assess the estimate. It will make it easier for those in project management to determine the cost, funding options, pricing basics, cost risk, allowances, opportunities and many others using the standard practices.

The basis of estimates requires attachments which include the estimate deliverable checklist, reference documents, benchmarking reports, risk analysis and reconciliation reports among many others. It is important to take note that the basis of estimates is concise, factual and should describe techniques used to create the cost estimate. A well-written basis of the estimate can help determine both the risks and opportunities involved in the project management blueprint.

5.1.1 Reconciled Estimates

The model followed is the Constructive Cost Model (COCOMO) for estimating the effort required in completing the project. Like all the estimation models, the COCOMO model requires sizing information. This information can be specified in the form of:

- Object Point
- Function Point(FP)
- Lines of Source Code(KLOC)

For our project,we use the sizing information in the form of Lines of Source Code.

- Total Lines of Code for our project, KLOC=6k(approx).
- Cost of each person per month, Cp=Rs.200 /(per person-hour)

Equations

The initial effort (Ei) in man months is calculated using the equation:

$E = a * (KLOC)b$

Where,

a = 3.0, b = 1.12, for a semi-detached project E=Efforts in person-hour

$D = a * (E)b$

Where, a = 2.5 ,b = 0.32, for a semi-detached project D=Duration of project in months

Cp = Cost incurred per person-hour Hrs = hours

Efforts

$E = 3.0 * (5.2)1.12$

E = 22.31 person-months

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Total of 22.31 person-months are required to complete the project successfully. Duration of project D = 2.0 ∗ (E)0.32
D = 6.75 months
The approximate duration of project is 7 months. Number of people required for the project
N = 22.31/7 N = 3.83
N = 4 people
Therefore 4 people are required to successfully complete the project on schedule.
Cost of project
C = 4 ∗ 200 ∗ 210 = 168000 Therefore, the cost of project is 168000/(approx.)

5.1.2 Project Resources

A resource is a necessary asset whose main role is to help carry out a certain task or project. A resource can be a person, a team, a tool, finances, and time. Most projects require many different resources in order to be completed.
Resources should be assessed and allocated before a project begins. Poor resource planning can result in running out of resources midway through a project, delaying deadlines, and delivery of the final product or service.
People:
4 Group Members as a developer/Tester.
Hardware Requirements
1. Ultrasonic sensor
2. Node MCU (ESP8266)
3. Power battery.
4. MQ-7 sensor
5. Buzzar
6. MPU6050 Accelerometer Sensor

5.2 Risk Management

5.2.1 Risk Identification

There are multiple sources of risk. For risk identification, the project team should review the program scope, cost estimates, schedule (to include evaluation of the critical path), technical maturity, key performance parameters, performance challenges, stakeholder expectations vs. current plan, external and internal dependencies, implementation challenges, integration, interoperability, supportability, supply-chain vulnerabilities, ability to handle threats, cost deviations, test event expectations, safety, security, and more. In addition, historical data from similar projects, stakeholder interviews, and risk lists provide valuable insight into areas for consideration of risk.
Risk identification is an iterative process. As the program progresses, more information will be gained about the program (e.g., specific design), and the risk statement will be adjusted to reflect the current understanding. New risks will be identified as the project progresses through the life cycle.

5.2.2 Risk Analysis

A risk is a probability that some adverse circumstance will occur. It is potential problemit might happen or it might not. But, regardless of outcome, it is really a good idea to identify it, assess its probability of occurrence, estimate its impact and establish a contingency plan should the problem actually occur. For good software project management, understanding the risks and taking proactive measures to avoid or manage them is a key element. Risk Management is concerned with identifying risks and drawing up plans to minimize their effects on the project.

ID	Risk Description	Probability	Impact		
1	Harware Failure	Low	Low	High	High
2	High Voltage	Low	Low	High	High

Table 5.1: Risk Table

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Probability	Value	Description
High	Probability of occurrence is	> 75%
Medium	Probability of occurrence is	26 − 75%
Low	Probability of occurrence is	< 25%

Table 5.2: Risk Probability definitions

5.2.3 Overview of Risk Mitigation, Monitoring, Management

Risk Mitigation, Monitoring and Management mean risk avoidance. Avoidance is the best strategy by adapting the proactive strategy to risk. The project manager should monitor i.e. keep a check on the project to see whether the risk is becoming more likely or not. Risk management comes into play when the mitigation efforts have failed

Impact	Value	Description
Very High	>10%	Schedule impact or Unacceptable quality
High	5-10%	Schedule impact or Unacceptable quality
Medium	<5%	Schedule impact or Barely noticeable degradation in quality Low Impact on schedule or Quality can be incorporated

Table 5.3: Risk Probabilty Definitions

Risk 1
• Sophistication of the end user's application program
• Mitigation-Develop a front end that is both user friendly and covers all needs.
• Monitor-Test the application with novice, expert and intermediate users.
• Management-Customer should be noticed about the limitations and the scope of the API.

Risk 2
• Delay in completion of modules due to member being sick.
• Mitigation-Keep work of all members documented.
• Monitor-Review is made between members and ideas, thought, plans are discussed in meetings.
• Management-Shift one or more members to sick member's module.

Risk 3
• Schedule might slip due to inexperience
• Mitigation-The planned schedule should be followed strictly.
• Monitor-Check whether work is going according to time.
• Management-Add more members to the project or increase the working hours of already working people.

Risk 4
• Resources might prove insufficient
• Mitigation-Gather all the resources that are required and check whether they are feasible.
• Monitor-Check at any point of time whether the resources allocated are less and whether more resources will be required.
• Management-Increase the fund that is allocated to the resources or try and adjust with the existing resources.

Risk ID	1
Risk Description	Hardware Connectivity
Category	Development Environment
Source	System will require hardware connectivity

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Probability	Low
Impact	High
Response	Mitigate
Risk Status	Occurred

Table 5.4: Risk Impact Definition

5.3 Project Schedule

5.3.1 Project task set

Major Tasks in the Project stages are:

- Task 1: Hardware Setup.
- Task 2: Alert Notification
- Task 3: Fall Detection.
- Task 4: GUI Design.

5.3.2 Task network

Project tasks and their dependencies are noted in this diagrammatic form.

Sr. No.	Temperature Readings	Humidity Readings
1	35	57
2	36	57
3	36	58
4	36	58
5	37	58
6	38	59
7	38	59
8	38	59
9	38	59

Figure 5.1: Project Task Network.

5.3.3 Timeline Chart

A project timeline chart is presented. This include a time line for the entire project. Remaining points should be covered in Project Planner as Annex C %and you can mention here Please refer Annex C for the planner

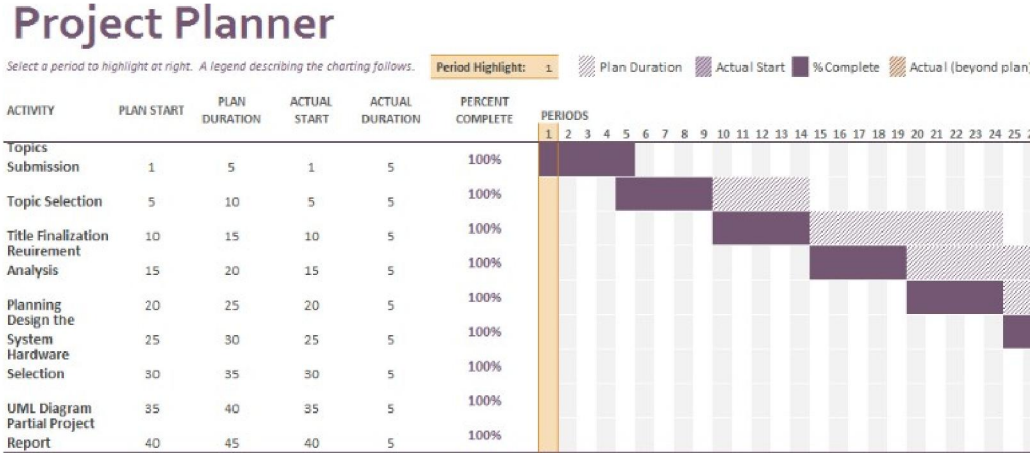

Figure 5.2: Software Project Plan

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5.4 Team Organization

5.4.1 Team Structure

1. Ms. Neha Patil : Project Leader
2. Ms. Akansha Dusane : Software Developer
3. Ms. Bhagyashree Borse : Software Developer and Testing
4. Ms. Shradhha Pawar : Software Tester

VI. SOFTWARE TESTING

Software testing is defined as an activity to check whether the actual results match the expected results and to ensure that the software system is Defect free. It involves execution of a software component or system component to evaluate one or more properties of interest. Software testing also helps to identify errors, gaps or missing requirements in contrary to the actual requirements. It can be either done manually or using automated tools. Some prefer saying Software testing as a White Box and Black Box Testing. In simple terms, Software Testing means Verification of Application Under Test (AUT).

6.1 Types of Testing

Testing for IoT devices broadly revolves around Security, Analytics, Device, Networks, Processors, Operating Systems, Platforms and Standards.

1. Usability Testing:

There are so many devices of different shape and form factors are used by the users. Moreover, the perception also varies from one user to other. That's why checking usability of the system is very important in IoT testing. Usability testing is a way to see how easy to use something is by testing it with real users. Users are asked to complete tasks, typically while they are being observed by a researcher, to see where they encounter problems and experience confusion. If more people encounter similar problems, recommendations will be made to overcome these usability issues. Usability testing is a method used to evaluate how easy a website is to use. The tests take place with real users to measure how 'usable' or 'intuitive' a website is and how easy it is for users to reach their goals.

2. Compatibility Testing:

There are lots of devices which can be connected though IOT system. These devices have varied software and hardware configuration. Therefore, the possible combination are huge. As a result, checking the compatibility in IOT system is important. Compatibility is nothing but the capability of existing or living together. In normal life, Oil is not compatible with water, but milk can be easily combined with water. Compatibility Testing is a type of Software testing to check whether your software is capable of running on different hardware, operating systems, applications, network environments or Mobile devices. Compatibility Testing is a type of Non-functional testing

3. Reliability and Scalability Testing:

Reliability and Scalablity is important for buidling an IOT test enviorment which involves simulation of sensors by utilzing virtualization tools and technolgoies. Reliability testing is defined as a software testing type, that checks whether the software can perform a failure-free operation for a specified period of time in a specified environment. Reliability means "yielding the same," in other terms, the word "reliable" mean something is dependable and that it will give the same outcome every time. The same is true for Reliability testing. Reliability testing in software assures that the product is fault free and is reliable for its intended purpose.

4. Data Integrity Testing:

It's important to check the Data integrity in IOT testing as it involves large amount of data and its applcaiton. Data integrity corresponds to the quality of data in the databases and to the level by which users examine data quality, integrity and reliability. Data integrity testing verifies that the data in the database is accurate and functions as expected within a given application.

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5. Security testing

In the IOT environment, there are many users are accessing a massive amount of data. Thus, it is important to validate user via authentication, have data privacy controls as part of security testing. IoT Security challenges: IoT is data centric where all the devices/system connected operate based on the data that is available. When it comes to the data flow between devices, there is always a chance that the data can be accessed or read when getting transferred. From a testing standpoint, we need to check if the data is protected/encrypted when getting transferred from one device to the other. Wherever, there is an UI, we need to make sure there is a password protection on it.

6. Performance Testing

Performance testing is important to create strategic approach for developing and implementing an IOT testing plan.When we are talking about a system for a healthcare domain, we need to make sure the system is scalable enough for the whole hospital. When the testing is carried out, it is done for 2-10 patients at a time and the data is propagated to 10-20 devices. When the whole hospital is connected and 180-200 patients are connected to the system, the data that is propagated is much bigger than the tested data. As testers, we need to make sure the system performs the same even though the added data is propagated. We should also test the monitoring utility to display the system usage, power usage, temperature etc.

6.2 Test Cases and Test Results

Defining test cases for IoT devices can be considered as a uphill task. Other than testing the real life scenarios there are a few common test scenarios you need to consider while testing IoT devices and the network.

6.2.1 Security

If you don't run adequate security validations, there is no point in testing the functions of the device. Here are a few reasons why:

1. The hub and devices should be properly authenticated (registering to the network) before communication starts. For example, in the case of Bluetooth connection, only paired devices should be able to communicate. Any unauthorized connection should be discarded.
2. Data connection should be easily established after successful registration.
3. The sent data should be in encrypted form.
4. If a maximum number of connections have been attempted, the device should not try to connect again for a pre-defined time period.

6.2.2 Performance

Testing the performance of IoT devices will be another crucial aspect.

1. Every authenticated device in range should be able to connect to hub.
2. The device should be able to send any amount of data to the hub (as per the requirements).
3. If data sent by the device exceeds a predefined amount, transfer of data should be initiated only after a pre-set delay or after confirmation has been received from the hub.
4. The device should be able to send data, even during a low power status. A power status update should be sent to the network if the device goes low in power.

6.2.3 Connectivity

1. The success of an IoT system depends on how well the devices and hub are connected. Even a loss of connection for a fraction of a second can lead to inaccurate data, which will in turn make the system unusable. So testing the connectivity is as important as testing security and performance.
2. The device should be connected to the hub even if the hub is in sleeping/power saving mode.
3. The device should send regular ping messages to make sure the connection is not lost.

6.2.4 Usability

The usability of IoT devices is also an important aspect to consider while testing. For example, if I am using a smartwatch

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to make NFC (near field communication) payments with my bank, usability concerns might arise that need to be tested and verified. As well as being usability concerns, they could also be security concerns for users as the bank transfer deals with their confidential information. Here are a few usability test cases for the above mentioned situation:

1. Verify if payment can be made only on authenticated NFC enabled POS machines.
2. If the wearable is lost, the user should have the provision to block the device (maybe from a mobile device or through an IVR) as soon as possible.
3. There should be a pre-set limit for payment so that the chances of unauthorized payment can be minimized in case of lost/stolen cases.
4. Multiple payments should not happen if the user waves the wearable over the POS machine multiple times.

VII. RESULTS

7.1 Screenshots

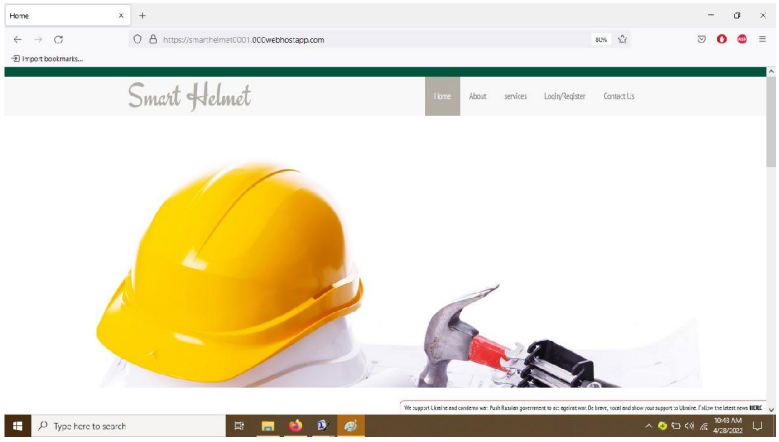

Figure 7.1: Result Outcome

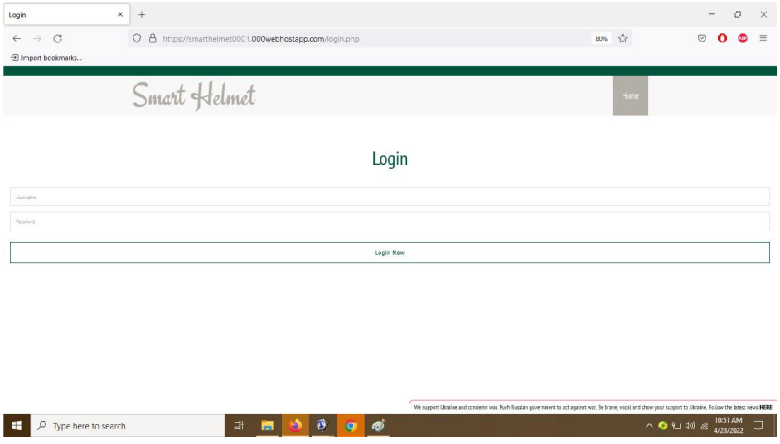

Figure 7.2: Result Outcome

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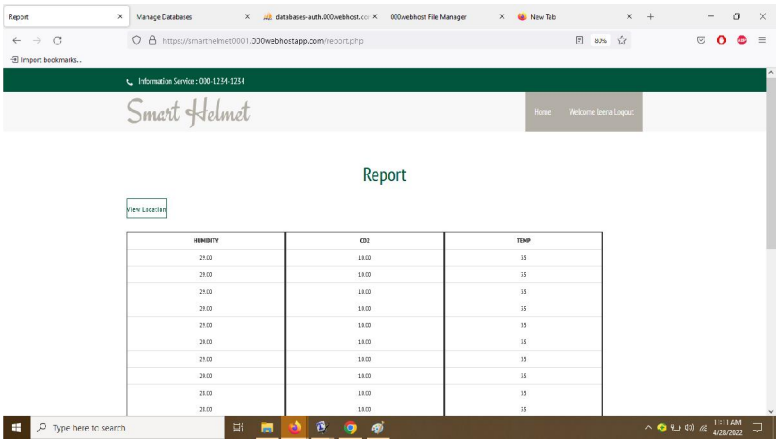

Figure 7.3: Result Outcome

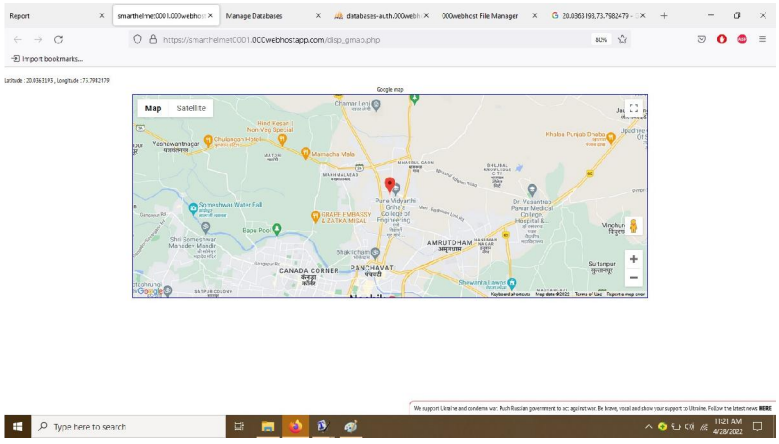

Figure 7.4: Result Outcome

VIII. Conclusion

8.1 Conclusion

We explored a new way to protect the construction workers and other people working in the industries, by combining various sensors and use of Internt of Things. This proposed system is implemented to ensure the complete safety of the workers at the construction site. Through this smart helmet, the contractor can continuously monitor the entire workers involved in construction process and can also get notification about the workers' physical condition and can immediately save the workers from any serious issues in case of emergency. Hence we can reduce the death rate of the construction workers and provides increased security to them.

8.2 Future Work

In future we want implement the system for driving helmet because drunk driving is also an important issue to consider nowadays. Because drunk driving can cause more accidents in the case of bikes than cars. So, the alcohol sensor will check if the driver is drunk or not. If we can make our design more full-proof and get a sponsorship, then we will be to mass produce it. A smart helmet maybe a little bit more expensive than a regular helmet but its benefits certainly outweigh the costs.

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8.3 Applications

1. Smart City Work
2. Coal Mines
3. Industial Company
4. Hospitals

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