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DECLARATION AND AUTHORITY TO SUBMIT PROJECT

a. Students to submit the project

We Christian IDUFASHE and Honorine IRADUKUNDA hereby declare that we carried out the work reported in this report in the Department of INFORMATION AND COMMUNICATION TECHNOLOGY, under the supervision of Patrick NDIZEYE and Pierre Claver MBONITEGEKA. We seriously declare that to the best of our knowledge; no part of this report has been submitted here or elsewhere. It is our own work. It has not been submitted elsewhere in application for award of an academic qualification. All sources of knowledge used have been duly acknowledged. We also declare that project developed during this project remain as RP – IPRC Huye.

Date and signatures of students

IDUFASHE Christian
Date: ……/…../2022
Signature: …….

IRADUKUNDA Honorine
Date: ……/…../2022
Signature: ……

b. authority to submit the project

Names of the supervisors **NDIZEYE Patrick** and **MBONITEGEKA Pierre Claver**

In our capacity as supervisors, we hereby authorize the students to submit their project to the department ready for presentation.

Supervisor
NDIZEYE Patrick
Date ……/…../2022
Signature……

Co-Supervisor
MBONITEGEKA Pierre Claver
Date ……/…../2022
Signature……

DEDICATION

We dedicate this work to our beloved parents, brothers, sisters, classmates and friends who saw this work as a fruitful result of their support, encouragement and love. They had been to our side in time of need, since we started our academic study till now. Finally, we dedicate it to lectures, supervisor and everyone who has contributed and played an enormous role to the complete of this work during those long and exciting years of studying.

ACKNOWLEDGEMENTS

Firstly, and foremost, we wish to express our sincerely gratitude to the almighty God for his blessing and protection during our whole time of our studies until in this project. Moreover, we thank the RP - IPRC Huye Administration and whole RP - IPRC Huye community for uncountable support during our studies. We cannot forget to offer special thanks to our supervisor Mr. Patrick NDIZEYE and MBONITEGEKA Pierre Claver for his guidance and support during our project analysis and design. In additional friends and classmates who have been with us during our studies and finally we thank our families for their help. This project has been successfully completed due to efforts of different people. In this regard we owe them great thanks.

God bless them too much.

ABSTRACT

Agriculture has been and will always be one of the most important sectors in the world. Though this sector is so important it still faces some challenges, as the world population increases, we must produce as much food as possible, one of the many ways to increase our products is to take good care of the harvest so that we can minimize the products lost during the time of harvest while also making sure that our products meet the standard industrial quality of our area.

That's why we directed our research project into developing an IoT automated system that will help farmers during the harvest time to automate the process of sun drying.

Our system is embedded with Smart electronic devices and sensors or actuators, web part. So those electronic devices it contains with sensors to measure the surrounding atmospheric conditions like the temperature, humidity, sun intensity, and detect rain drops depending on the values read the device will automatically close or open the store for sun drying, this device will also continuously send data to the server for storage and further analysis. The next part is web application that where the farmers will be able to remotely see the atmospheric status of the area in their farm, monitor, provide a visual statistical data and control the open and close of the roof through the web application. This project report illustrates the steps, materials and components needed to design and implement this project.

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SYMBOLS, ACRONYMS AND ABBREVIATION

AC: Alternating current

API: application programming interface

ASCII: American Standard Code for Information Interchange

AVR: Automatic Voltage Regulation

CRT: Cathode Ray Tube

CSS: Cascading style sheet

DC: Direct current

GPRS: General Packet Radio Service

GPS: Global positioning system

GSM: Global System for Mobile Communication

HTML: Hypertext markup language

I2C: inter-integrated circuit

IC: integrated circuit

ICSP: in circuit serial programming

ICT: Information Communication and Technology

IDE: Integrated Development Environment

IoT: Internet of things

IPRC: Integrated Polytechnic Regional College

LCD: Liquid Crystal Display

LPG: liquefied petroleum gas

MHz: Megahertz

MS: Microsoft

NTC: Negative temperature coefficient

PC: Personal Computer

PCB: Printed Circuit Board

Ppm: parts per million

PWM: Pulse Width Modulation

RAM: Random access memory

RAB: Rwanda Agriculture and Animal Resources Development Board

RDMS: Relational Database Management Systems

ROM: Read Only Memory

RP: Rwanda Polytechnic

SCDS: Smart Crop Drying System

SDA: Serial data

SIM: subscriber identity module

SMS: Short Message Service

SQL: Structured Query Language

TTL: transistor Transistor logic

UART: Universal asynchronous receiver transmitter

USA: United States of America

USB: Universal Serial Bus

VCC: Voltage common collector

VDC: Direct Current voltage

XAMPP: Cross-platform, Apache server, Maria DB, PHP and Per\

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LIST OF FIGURE

CHAPTER 1: GENERAL INTRODUCTION

1.1 INTRODUCTION

Nowadays, during the rainy season the cultivated crops get affected due to heavy rainfall. This system involves protection of the crops by auto roof which covers the certain area. The rain sensor is activated when there is rainfall and it will give intimation to the controller to close the roof as soon as the rain is detected and also send notification to the farmer by using Internet Once rain is stopped, controller automatically opens the roof. This model also comes with manual control mode with control.

i.e. owner or farmer can open /close the roof manually by sending notification.

Drying is a process that uses heat to remove water from products. This can be done in a number of ways, including using an oven, a microwave, or a dehydrator. When water is removed from a material, its structure changes. This can make the material harder and less likely to spoil.

1.2 BACKGROUND OF THE STUDY

Research of information was done For ABANJYANA NIGIHE KABERE COOPERATIVE That Located in Northern province, MUSANZE District, MUKO sector, where we found that the information of their crops (Maize and Beans) are Drying manually and sometimes they needs some space for the crops to dry which most of the farmers don't have it and it take loads of time to dry up.. This system is to be used by the farmers of ABANJYANANIGIHE COOPERATIVE as it is our case study in order to solve some problems found there.

1.3 PROBLEM STATEMENTS

- When unseasonal rain falls on the harvested crops, which are kept to dried up, they rot up and get destroyed due to which farmers have to face enigma. Some crops must be dried before it is sold to the agriculture market yard.
- The farmer needs some space for the crops to dry which most of the farmers don't have it and it take loads of time to dry up.
- When the temperature changed down directly, farmers needs to move their products from out, here they can late so the product can meet with the rain drops that can let damaging of their products. That can cause also the loss of many products.

- ❖ This manual system it requires large number of unskilled Labour and it takes the long time.
- ❖ High cost of drying, Requires skilled personnel and regular monitoring, Risk of breakdown or fuel shortage at critical times.

1.4 OBJECTIVES OF STUDY

1.4.1 General objectives:

The main objective is to design and implement a “Smart Crop Drying System " that will detect raindrops depending on the values read the device will automatically close or open the store for sun drying, this device will also continuously send data to the server for storage and further analysis.

1.4.2 Specific objectives:

The specific objectives of this research are as follow:

- ➢ This device is used in agriculture purpose in a way when the rain drops falls on the rain sensor, the roof automatically gets over the crops kept for drying
- ➢ Used for prevent the harvested crops from the heavy rain and save the rain water.
- ➢ Drying is needed for the future storage of crops
- ➢ Drying makes crops favorable for processing.
- ➢ Drying is important to insure market price.
- ➢ Drying saves crops from different types of insects or pests that cause crops damage.
- ➢ Drying is essential to improve seed quality.
- ➢ To improve nutritive value, drying is needed.
- ➢ Small amount of labour is required and It takes very short time.

1.5 HYPOTHESIS OF THE PROJECT

Smart Crop Drying System is system that will help farmers during the harvest time to automate the process of sun drying depending on the values read the device will automatically close or open the store for sun drying and user can open or close the roof So it prevent the harvested crops from the heavy rain and save the rain water, need for the future storage of crops and essential to improve seed quality.

1.6 SCOPE OF STUDY

This project is able for measure the surrounding atmospheric conditions like the temperature, humidity, sun intensity, and detect rain drops depending on the values read the device will automatically close or open the store for sun drying, this device will also continuously send data to the server for storage and further analysis and It have the web application that will be able to remotely see the atmospheric status of the area in their farm, monitor , provide a visual statistical data and control the open and close of the roof through the web application

1.7 METHODOLOGY AND TECHNICS

This research was conducted under the use of different tools of data collection including documentations, observation and interview to gather the necessary data helpful to the realization of our project.

The Internet was used to extend the concepts provided by books and observation to view what done in reality and analyzes it for more information. The software development methodology was used is the Proto typing (incremental proto typing).

1.8 SIGNIFICANCE OF THE STUDY

1.8.1 Personal interest

It will help to increase skills and earn money when the project is sold. We would like to make the use of skills and knowledge we have gathered through three academic years of study and it is the future capital that we are empowering.

1.8.2 Community interest

In nowadays life need of using technology in every sector of life especially in agriculture sector, the farmers need to manage their product, The rain sensor is activated when there is rainfall and it will give intimation to the controller to close the roof as soon as the rain is detected and also send Notification to the farmer, Once rain is stopped, controller automatically opens the roof directly.

1.9 ORGANIZATIONS OF STUDY

Chapter 1: General introduction, it contains introduction, background of the study, problem statement, objectives, interest, and scope, Hypothesis of the study.

Chapter 2: Literature Review, it provides details on introduction, review of researches of the system, review of existing systems, methods, techniques and the summary.

Chapter 3: Methodology, it shows system analysis and design that provides details on introduction, database design, the method we used for collecting the information.

Chapter 4: Presentation And Analysis of Results, It deals with Implementation of new system and how it work.

Chapter 5: Conclusion and Recommendation, It Concludes and recommends the work for further researchers.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Smart Crop Drying System is system that will help farmers during the harvest time to automate the process of sun drying depending on the values read the device will automatically close or open the store for sun drying and user can open or close the roof when their happen something which is emergency, this device will also continuously send data to the server for storage and further analysis.

2.2 DEFINITIONS OF THE TERMS

2.2.1 Drying

Definition: Drying is the phase of the post-harvest system during which the product is rapidly dried until it reaches the "safe-moisture" level. The aim of drying is to lower the moisture content of the grain for safe storage and further processing (Basic Agriculture Study March, 9 2020).

Classification of drying

Natural drying

Natural drying: Natural drying means sun drying when excess water is removed by sunlight, the process is called natural drying. Natural drying is done by three ways-

1. By standing crops
2. By cut stock and
3. In threshed grain

Advantage of natural drying

- Cost is less.
- No need skill Labour.
- No need initial investment.
- It does not need any mechanical power.
- No need of any fuel.

Disadvantages of natural during

- It is an uncontrolled method.
- When sun is not available, it is not possible.
- This method require large number of unskilled Labour.
- The process takes long time.
- This method requires large area.
- There is possibility to loss of crops by birds, hens or other animals.
- Normally grain did not dried uniformly.

Artificial drying

Artificial drying: The method, in which excess water of grain removed artificially, is called artificial drying. Artificial drying is three types-

1. Mechanical drying
2. Infrared or dielectric drying
3. Chemical drying

Advantages of artificial drying

- It is a control method.
- It can be done whenever it needs.
- Small amount of labour is required.
- It takes very short time.
- It needs a small area.
- No risks of loss of grain.

Disadvantages of artificial drying

- The method is costly.
- Needs skill labour.
- Needs a large amount of initial investment.
- Co-operating cost is required.

2.3 INFORMATION SYSTEM AND FUNDAMENTALS

2.3.1 Micro Controller

Microcontrollers are tiny, self-contained computers hosted on a microchip. They enable connectivity and control in all the things which could be connected to the internet. Microcontrollers are designed to perform specific functions, and they can be integrated into almost anything ranging from industrial equipment, warehouse inventory items, wearables devices, to home appliances and much more.

The Internet of things (IoT) is enabling our hyperlinked world to get even more connected.

Microprocessors are different than microcontrollers in their design. Microprocessors have the only CPU inside them and no in-memory support while Microcontrollers, on the other side, has CPU, RAM, ROM and other peripherals which are all embedded on the chip. (Pianalytix, June 2021).

2.3.2 Micro Processor

A microprocessor is A Microprocessor Is Defined As A Multipurpose, Programmable Logic Device That Has The Capability To Read Binary Instructions From Memory, Accepts Binary Data As Input, And Thus Processes That Data According To Instructions To Provide Results As Output.(Pianalytix, june 2021**)**

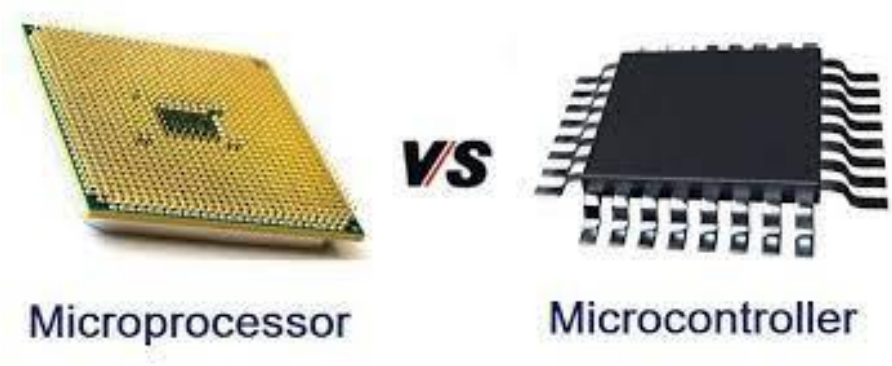


Figure 1 :Micro-processor and Micro-controller

2.3.3 Arduino Uno

Arduino acts as the brain of the system and processes the data from the sensor. Arduino is an open source hardware platform that is readily available for hobbyists & enthusiasts across the globe to build projects. It comes with an ATMEGA microcontroller that processes the data and facilitates the proper working of the IoT system. And the beauty is that the Arduino can be programmed 'n' number of times making it possible for you to build various types of IoT projects just by changing a simple code.(Skyfilabs,2015-2018).

Figure 2: Arduino Uno Arduino Uno

2.3.4 A DC motor

A DC motor (Direct Current motor) is the most common type of motor. DC motors normally have just two leads, one positive and one negative. If you connect these two leads directly to a battery, the motor will rotate. If you switch the leads, the motor will rotate in the opposite direction. (Riasat Ali Khan, January 2022)

Figure 3: DC Motor

2.3.5 ESP32

The ESP32 is a development board that combines Wi-Fi and Bluetooth wireless capabilities, and its dual-core. It supports a wide variety of peripherals such as capacitive touch, ADC, DAC, I2C, SPI, UART, I2S, PWM, and much more. (BehrTech, 1940)

Figure 4: ESP32

2.3.6 DHT11

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc… to measure humidity and temperature instantaneously. DHT11 humidity and temperature sensor is available as a sensor and as a module. (BehrTech, 1940).

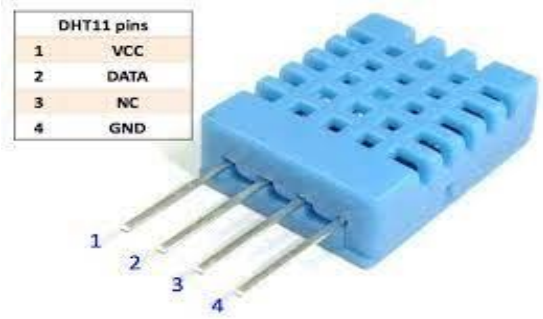


Figure 5: DHT11

2.3.7 A rain sensor

A rain sensor or *rain switch* is a switching device activated by rainfall. There are two main applications for rain sensors. The first is a water conservation device connected to an automatic irrigation system that causes the system to shut down in the event of rainfall. The second is a device used to protect the interior of an automobile from rain and to support the automatic mode of windscreen wipers. (BehrTech, 1940).

Figure 6 : A rain sensor

2.3.8 Temperature

Temperature is the measure of hotness or coldness expressed in terms of any of several scales, including Fahrenheit and Celsius. Temperature indicates the direction in which heat energy will spontaneously flow—i.e., from a hotter body (one at a higher temperature) to a colder body (one at a lower temperature). (BehrTech, 1940)

2.3.9 Humidity

Humidity is the amount of water vapor in the air. If there is a lot of water vapor in the air, the humidity will be high. The higher the humidity, the wetter it feels outside. On the weather reports, humidity is usually explained as relative humidity

Humidity is the concentration of water vapor present in the air. Water vapor, the gaseous state of water, is generally invisible to the human eye. Humidity indicates the likelihood for precipitation, dew, or fog to be present. Humidity depends on the temperature and pressure of the system of interest. (BehrTech, 1940)

2.3.10 Sun intensity

Sun intensity refers to the amount of incoming solar energy, or radiation that reaches the Earth's surface. The angle at which the rays from the sun hit the Earth determines this intensity. The sun's angle -- and hence intensity -- varies significantly depending on a particular spot's geographic location, the time of year, and the time of day. (BehrTech, 1940)

2.3.11 Data Server

Server is a "*Data Integration Controller*" consisting of high reliable industrial computer and non-programming data integration software. It equips standard data management functions developed especially for data collection, process, saving, notice and publishing.(Denso Wave IoT/SmartFactory).

2.3.12 Web Application

A Web application (Web app) is an application program that is stored on a remote server and delivered over the Internet through a browser interface. Web services are Web apps by definition and many, although not all, websites contain Web apps. According to WebAppStorm editor Jarel Remick, any website component that performs some function for the user qualifies as a Web app (TechTarget, Published: 29 Dec 2021)

2.3.13 Smart Roofing

A smart roof is a roof that has independent functions. The operation of a smart roof is controlled and monitored by an algorithm. For example, as it can monitor the humidity of roof structures to adjust their ventilation as required. This means that the building owner does not have to adjust the ventilation, which is automatically controlled by IoT technology.

2.4 DATABASE CONCEPTS

2.4.1 Database

A database is an application that stores the organized collection of records. It can be accessed and manage by the user very easily. It allows us to organize data into tables, rows, columns, and indexes to find the relevant information very quickly (SpringerLink, 2016).

2.4.2 XAMPP

XAMPP is developed by Apache Friends to promote the Apache web server. XAMPP Acronym is X or extended (Apache, MySQL, PHP, PERL); Apache Friends developed this software to help the people to install and configure Apache web server along with MySQL(SpringerLink,2016).

2.4.3 MySQL

MySQL is a relational database management system based on the Structured Query Language, which is the popular language for accessing and managing the records in the database. MySQL is open-source and free software under the GNU license. It is supported by Oracle Company**.** (SpringerLink,2016).

2.4.4 DBMS

Database management system is software that is used to manage the database.(TechTarget, Published: 29 Dec 2021).

2.5 TOOLS, TECHNIQUES, AND LANGUAGES USED IN DEVELOPING THE SOFTWARE

2.5.1 HTML

Hypertext Markup Language (HTML) is the main markup language for creating web pages and other information that can be displayed in a web browser. HTML defines the structure and layout of a Web document by using a variety of tags and attributes. (Javapoint Platform,2011)

2.5.2 PHP

PHP is a recursive acronym that stands for Hypertext Preprocessor. It is a scripting language that's usually embedded in HTML of a web page to make it dynamic. When the page is requested, the web server executes the PHP script and substitutes in the result back into the page. PHP is a server side scripting language and a widely used programming language for web and software product development. This is because it supports different databases like MySQL which is an open source database management system. (Javapoint Platform,2011)

2.5.3 JAVASCRIPT

JavaScript is a programming language that can be included on web pages to make them more interactive. It is used to check or modify the contents of forms, change images, open new windows and write dynamic page content. This allows us to make parts of our web pages appear or disappear or move around on the page. (Haverbek, 2014).

JavaScript is a lightweight, interpreted programming language. It is designed for creating network-centric applications. It is complimentary to and integrated with Java. JavaScript is very easy to implement because it is integrated with HTML. It is open and cross-platform(Javapoint Platform,2011).

2.5.4 CSS

CSS stands for cascading Style Sheet and is a software application used to format layout of web pages. It can be used to define text styles, table sizes and other aspects of web pages that could be defined in the HTML pages. CSS helps the web and application developers create a uniform look across several pages of the website or of applications(Javapoint Platform, 2011)

2.5.5 Notepad++

Notepad++ is a powerful, feature-packed text editor that more or less has everything Notepad needs but lacks (it can replace Notepad in Windows). It supports 27 programming languages, searches regular expressions, and supports syntax highlighting and folding, synchronized edits and views, and much more(Javapoint Platform , 5 Aug 2019)

2.5.6 JAVA

Java is a class-based, object-oriented programming language that is designed to have as few implementation dependencies as possible (Andrew, 2015)

2.5.7 XML

Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable (Berghahn, 2004).

2.5.7 Python

Python is a computer programming language often used to build websites and software, automate tasks, and conduct data analysis. Python is a general-purpose language, meaning it can be used to create a variety of different programs and isn't specialized for any specific problems (Haverbek, 2014).

Python has countless applications in the world of programming and can be of significant value for your business. Python is a language that is widely known for its pragmatic features such as easy readability, database management, security, integration with third-party tools, traffic management, etc.(Javapoint Platform,2011)

2.5.7 C Programming

C language which is known as the mother of every programming language is still the most essential programming language for IoT development. According to the Eclipse Foundation survey, 2018 C is the Developer's language of choice with 56.9 percent overall popularity after Java. Developers who work in the low level means with hardware and constrained RAM loves the C language most. (Dennis Ritchie 1972)

2.6 RELATED STUDIES AND GAPS OF SYSTEM.

Our Related studies is **Food Grain Repository System** that developed by P. Ramchandar Rao and Rajendra Prasad Ch in June 2020, objective of this project was to monitor and control the environmental conditions for proper food grain repository. They have implemented a monitoring and controlling system that monitors and controls the weather parameters like Temperature, Humidity, Gas and Light intensity. The users can control and monitor the above said parameters of the repository using IOT. These sensor values are sent to the cloud. When these values get exceeded by the threshold values then the user can take an action against the conditions. By using of Thingspeak to retrieve the cloud sensor data is monitored and controlled. (Journal mechanics of continua and mathematical sciences, 06 June 2020).

The Gap of **Food Grain Repository System**, it controls and monitors weather parameters like Temperature, Humidity, Gas and Light Intensity but does not help grain in drying time.

While our system called a **Smart Crop Drying System** helps the farmers during the harvest time to automate the process of sun drying depending on the values read the device will automatically close or open the store for sun drying and user can open or close the roof when their happen something which is emergency, this device will also continuously send data to the server for storage and further analysis.

CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

This chapter focuses on how project is developed. It deals with methods and techniques that have been used in this project to collect the data. In any domain on which the research is carried out, some specific methods and other techniques that the research is referring are recommended. It refers to the theoretical analysis of the system development and data collection techniques

3.2 STUDY AREA

ABANJYANA NIGIHE KABERE COOPERATIVE is located in Northern Province, MUSANZE District, MUKO Sector, CYOGO Cell and KABERE Village near KABERE Health Center.

In 2011, twenty eight (28) people joined together as cooperative members with the name of "**ABANJYANA NIGIHE COOPERATIVE KABERE**" in order to support one to each other for improving their standard of living through cultivation of vegetables and fruits where they took their harvest and they sold together to get more profit, After five year in 2016 they changed cultivation into maize and beans and then after they joined by other members that comes from Regional Sector, now the cooperative members are equal to 118 peoples as Their President (WIBABARA Fidel) They Told us .

This cultivation take place on four(4)Hectares, in the harvest time they gain 80 up to 100 Tones and their cultivation moved in the distance from the field to the housekeeping is equal to 2km as maximum distance.

3.3 STUDY DESIGN

ABANJYANA NIGIHE KABERE COOPERATIVE Is cooperative that located in MUSANZE District as we said above, they make cultivation of beans and maize.

They use manual drying on by using Solar to eliminate the moisture content from their crops. The solar dryer consists of cheap material like cement so on the top surface of the dryer is covered by transparent single and double-layered sheets on distance 80m.

When unseasonal rain falls on the harvested crops, the farmer try to pick up quickly their crops to avoid rain drops on their crops, they moved from the sheets on the ground to housekeeping

to keep them. That why we conclude to design this system that called **Smart Crop Drying System** that help them in rain period.

HOUSE KEEPING OF ABANJYANA NIGIHE COOPERATIVE

Figure 7 Housekeeping and Maize

Our system will be small in size according to the field of case study, In order to use this system on the field we will need to extend the components that made our system with large roof 80m, sensors which are strong than current used in our system and Strong Motor of 240V

3.4DATA COLLECTION TECHNIQUES

3.4.1 Documentation

Documentation is one of the method of data collection from written sources internet library, journals and different kind of publications among these sources, we used IPRC Huye Library and internet to find out the information in our research and to have necessary understanding about the project.

Also in this section different people have been consulted for their ideas and we tried to have a discussion looking for how the research for our project could be processed successfully.

3.4.2 Observation

As we've been observing on how the farmers are Drying their products is usually made, we found so many difficulties in that daily work and we came up with the idea of how can we make it easy.

3.4.3 Interviews

After having a trust of making something from carrying out our previous researches if we've been looking for how we can start prototyping some trials, we needed to have the full information of what the examination allowance checking requires, we asked some of the farmers and then we obtained the required info about it.

After these collections of information, we started with making the way it can be made easy to finish all of the described tasks correctly and accurately and as fast as possible and we came up with our project entitled: "Smart Crop Drying System" and we hope it will help more.

3.4.4 Software Development Process Models

Software process models represent a networked sequence of activities, objects, transformations, and events that embody strategies for accomplishing software evolution. Such models can be used to develop more precise and formalized descriptions of software life cycle activities. Their power emerges from their utilization of a sufficiently rich notation, syntax, or semantics, often suitable for computational processing (John w. and Sons, 2001).

What is Prototype Model?

The Prototype model is one of the software development life cycle models in which a prototype is built with minimal requirements. This prototype is then tested and modified based on the feedback received from the client until a final prototype with desired functionalities gets created. This final prototype also acts as a base for the final product.

Prototype model has different types which are: Rapid Throwaway Prototyping, Evolutionary Prototyping, Incremental Prototyping and Extreme Prototyping in our system we are choose incremental prototyping.

This incremental prototype model, final product requirements are break into smaller parts and each part is developed as a separate prototype. In the end, all the parts (prototypes) are merged which becomes a final product.

This incremental prototype model requirement, design, development, implementation, and testing phases. That subsequent release of the module adds a feature to the previous release. The process will continue until the whole software is achieved.(ArtofTesting, April,2021)

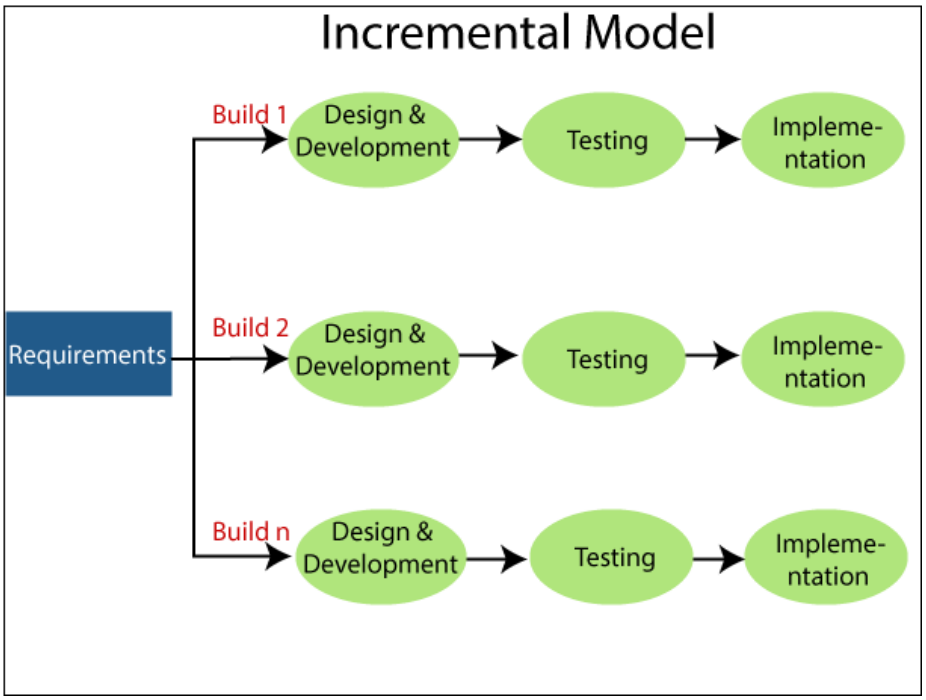


Figure 8: Incremental Model

Phases of incremental Model

Requirement analysis

In the first step of the incremental model, the product analysis expertise identifies the functional requirements and non-functional requirements. This stage plays an important role while developing software under the gradual method.

Design & Development

In this phase of the SDLC's incremental model, the system functionality and design of the development methodology has ended with success. When the software develops new practicality, the incremental model uses the design and development phase.

Testing

In the incremental model, the testing phase examines the performance of each existing function as well as additional functionality. In the testing phase, different methods are used to test the behavior of each task.

Implementation

In the implementation phase, coding is done for developing software. The design of the software, which is made in the designing phase, is now implemented practically, and final

coding is done. Upon completion of this process, the quality of the product working will be enhanced and upgrade to the final system product.

3.5 Problems and Limitations of the project

This project is able for measure the surrounding atmospheric conditions like the temperature, humidity, sun intensity, and detect rain drops depending on the values read the device will automatically close or open the store for sun drying, this device will also continuously send data to the server for storage and further analysis and It have the web application that will be able to remotely see the atmospheric status of the area in their farm, monitor , provide a visual statistical data and control the open and close of the roof through the web application

3.6 Ethical Considerations

This System is implement a “Smart Crop Drying System " that will detect raindrops depending on the values read the device will automatically close or open the store for sun drying, this device will also continuously send data to the server for storage and further analysis.

CHAPTER 4: PRESENTATION AND ANALYSIS OF RESULTS

4.1 INTRODUCTION

This chapter describes in details implementation of "SMART CROP DRYING SYSTEM" That contain with software and Hardware parts and its functionality. It deals with how the System is used by end user after to be implemented.

4.2 SYSTEM DESIGN AND MODELING

4.2.1 System Modeling

UML

UML stands for Unified Modeling Language. It's a rich language to model software solutions, application structures, system behavior and business processes, there are two main categories; structure diagrams and behavioral diagrams (Satish Mishra, 1997).

- ✓ **Structure Diagrams**

- ✦ Class Diagram
- ✦ Component Diagram
- ✦ Deployment Diagram
- ✦ Object Diagram
- ✦ Package Diagram
- ✦ Profile Diagram
- ✦ Composite Structure Diagram

- ✓ **Behavioral Diagrams**

- ✦ Use Case Diagram
- ✦ Activity Diagram
- ✦ State Machine Diagram
- ✦ Sequence Diagram
- ✦ Communication Diagram

Here we use behavior diagram to indicate our system.

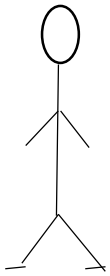
USE CASE DIAGRAM

A use case diagram is a dynamic or behavior diagram in UML. Use Case diagrams model the functionality of a system using actors and use cases. Use cases are set of actions, services and functions that the system needs to perform. In this context a system is operated, such as web site or any application (Bittner, Kurt, 2003).

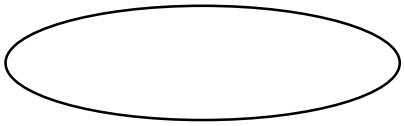
Use Case Diagram Symbols and Notations

- **Boundary of system**: is potentially the entire system as defined in the requirements document

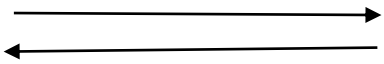
- **Actor**: Someone interacts with use case (system function).



- **Use Case**: is about system function (Process-automated or manual)



- **Communication Link:** (The participation of an actor in a use case is shown by connecting an actor to a use case by a solid link



USE CASE DIAGRAM OF THE SYSTEM

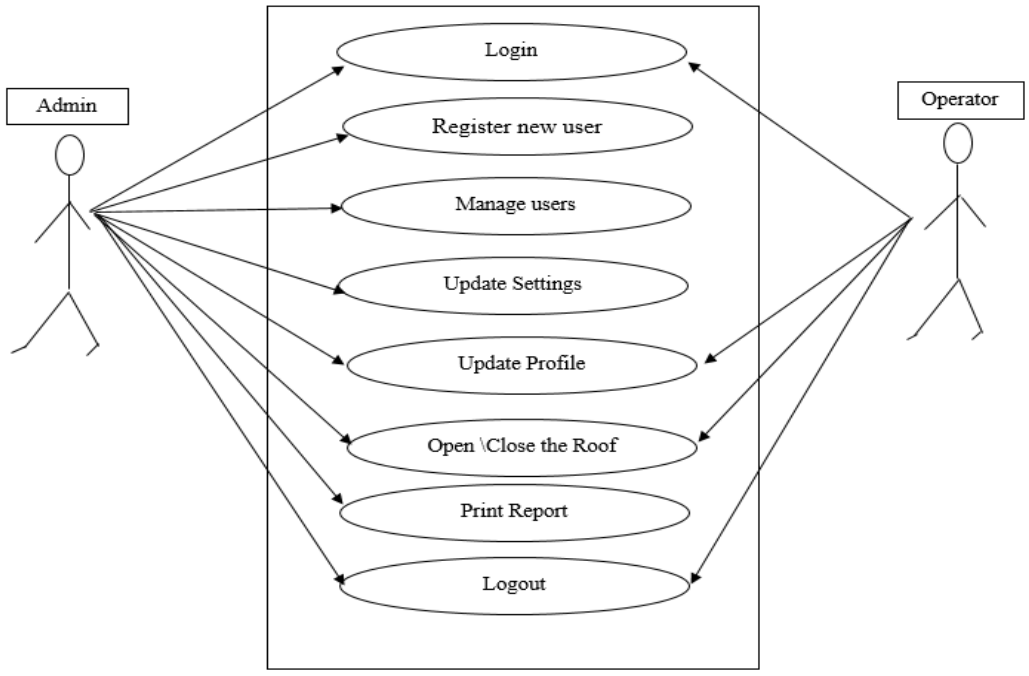


Figure 9 Use Case for Users

ACTIVITY DIAGRAMS

Activity diagram is another important diagram in UML to describe the dynamic aspects of the system. Activity diagram is basically a flowchart to represent the flow from one activity to another activity. (Bittner, Kurt, 2003)

Activity Diagram Symbols and Notations

1.Starting State

The initial state is yet to be used or modified in the activity. Activity Diagrams start from this step. Also known as the entry state. Start Node is the starting point of any activity.

It is depicted as:

2. Action State

A step in which the users or software performs a certain task. It represents an action that is going to take place at this stage of the software system. Generally depicted with the rounded-edged rectangle.

It is depicted as:

3. Control Flow

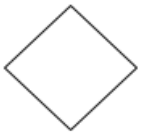
Connectors between two states or two actions to depict the flow. Shows the sequence of execution. Also known as paths. One action state can have multiple control flows input and also output to another action state. A single-headed arrow is used to depict the control flow.

It is depicted as:

4. Decision Node

A conditional node or a decisional node is one where there are multiple options available. Or there are two or more conditions that can be considered at the point of the software system.

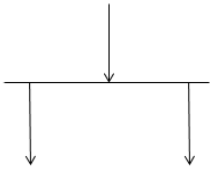
It is depicted as:



5. Fork

A point from where two concurrent or parallel processes are executed or run, or processed. It generally includes a single input but may or may not get one output.

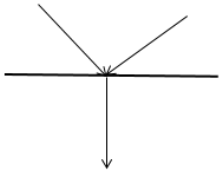
It is depicted as:



6. Join

A join is one where two results of concurrent activities add and form a single result. In joining, there is more than one input, but only one output is obtained. Two results are obtained from two activities, and one result is obtained.

It is depicted as:



7. End State

This is the last stage of the UML activity diagram. This is where the activity ends in a software system ends.

It is depicted as: 

✓ **Activity diagram of Admin**

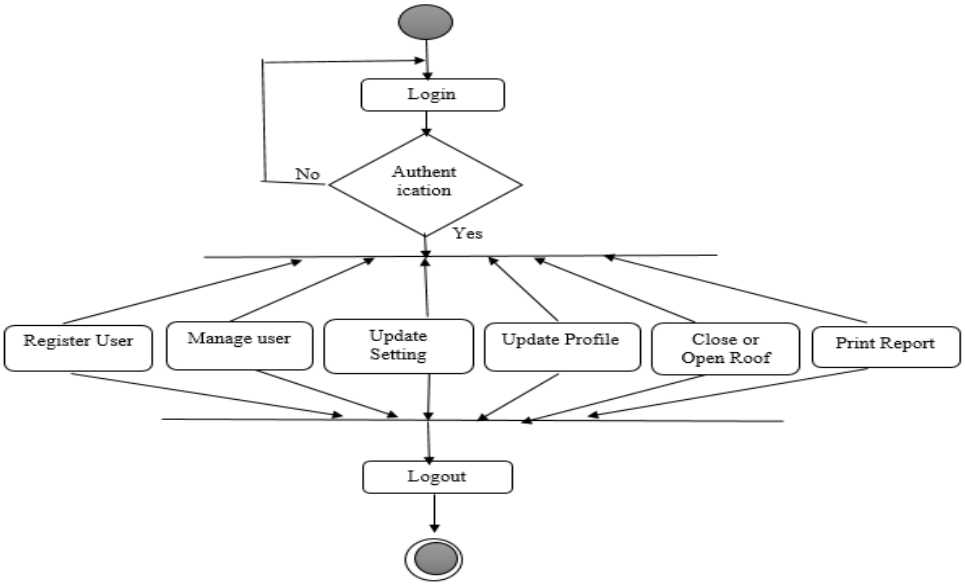


Figure 10 Admin Activity Diagram

✓ **Activity diagram of Operator**

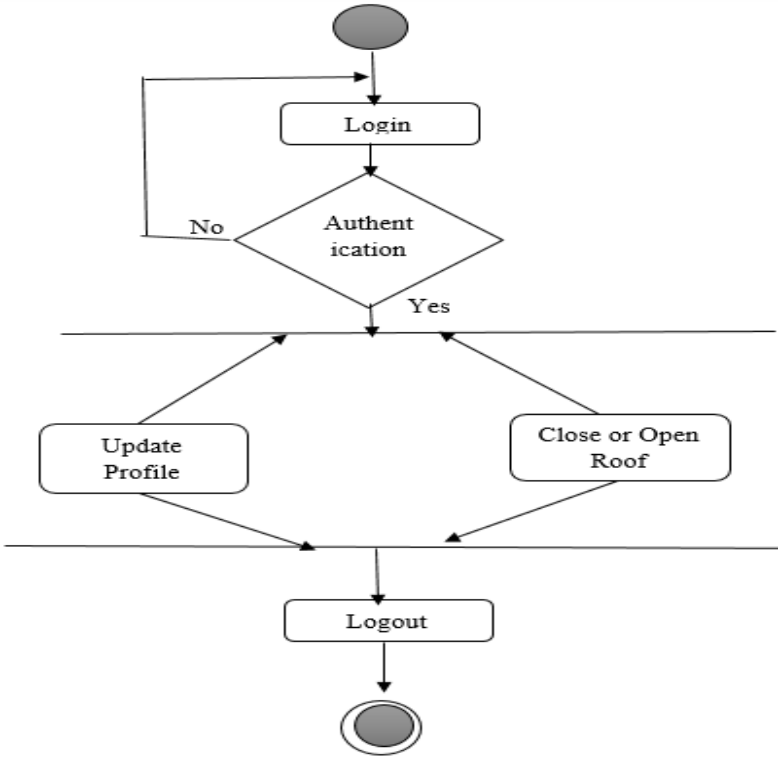


Figure 11 Operator Activity Diagram

4.3 SYSTEM ANALYSIS

The figure shown below makes the flowchart of the system that explains the mechanism of the system step by step from start to the end.

Symbols used in flowchart and Description

Symbol	Name	Function
	Start/end	An oval represents a start or end point
	Arrows	A line is a connector that shows relationships between the representative shapes
	Input/Output	A parallelogram represents input or output
	Process	A rectagle represents a process
	Decision	A diamond indicates a decision

Flowchart that shows how the System Circuit Board it work

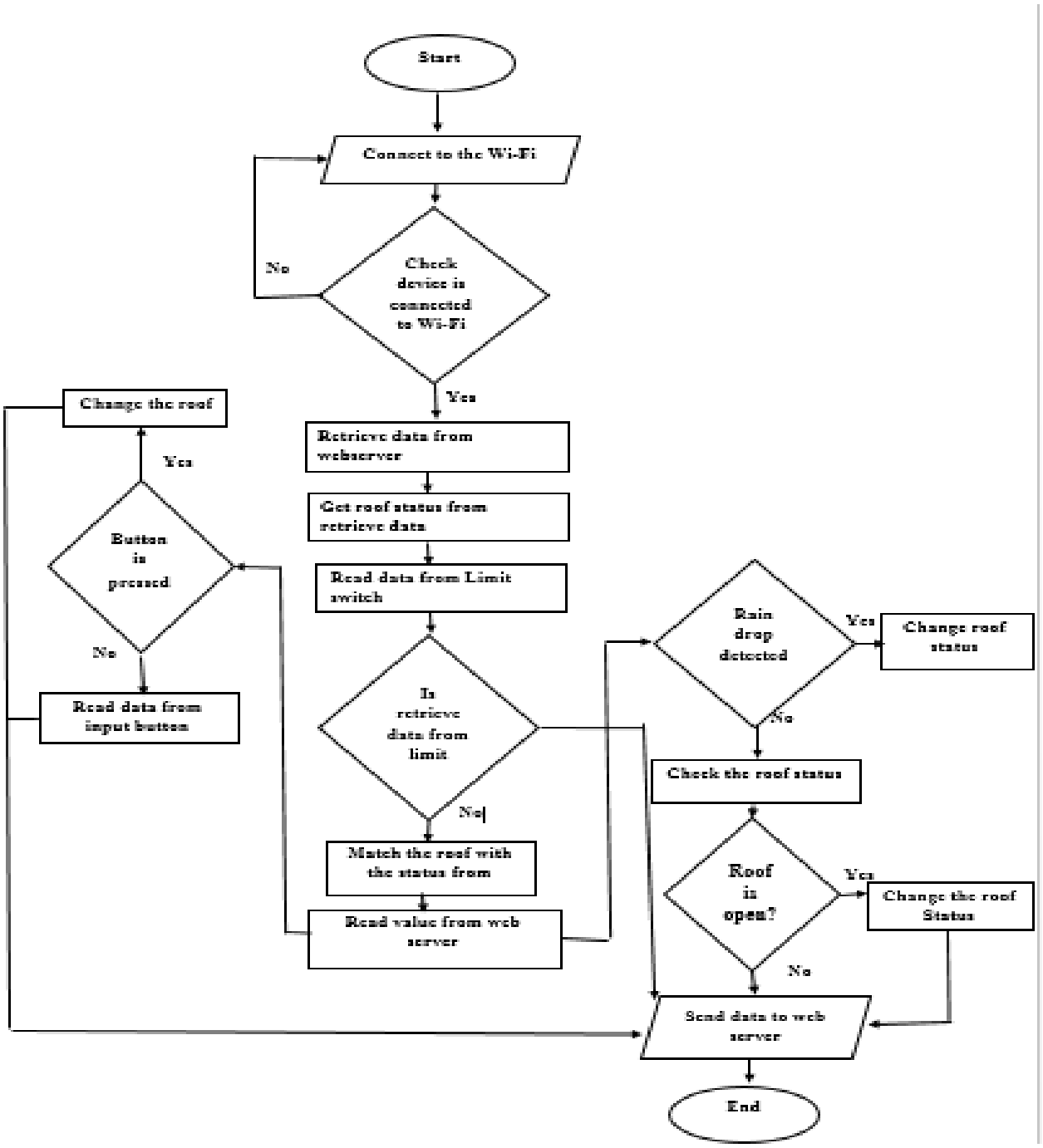


Figure 12: System Circuit board

Flowchart that show how Web application it works

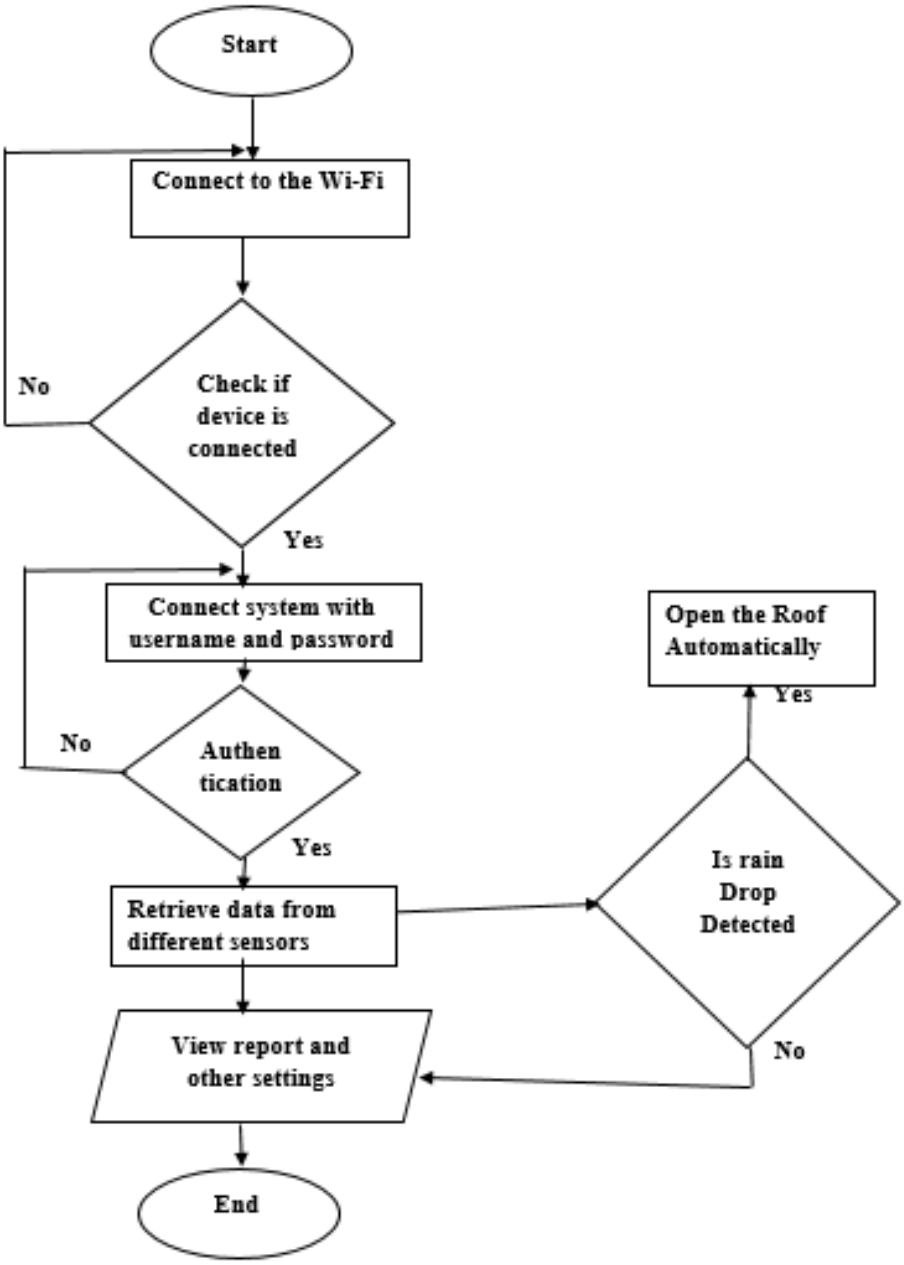
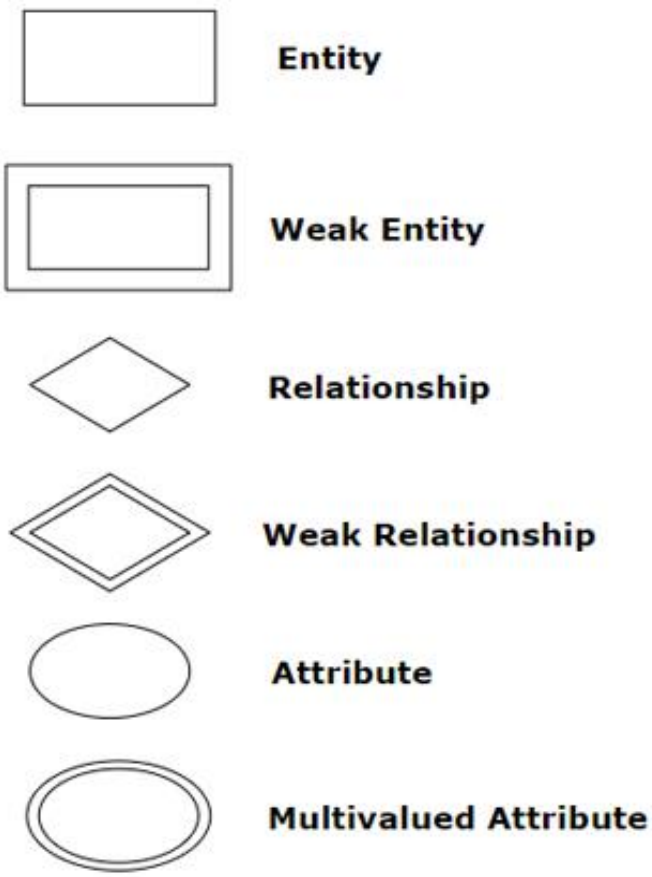


Figure 13: Flowchart of Web application

4.3.1 Entity Relationship Diagram (ERD).

ERD is also known as the Entity-Relationship Model. ERD was originally proposed by Peter Chen. Entity means any object used to store information and are distinguishable, relationship means connection, and diagram/model means a picture uses to represent something. (*Peter Chen*).

The components of ER diagram are as follows



Entity

It may be an object, person, place or event that stores data in a database. In a relationship diagram an entity is represented in rectangle form.

Attributes

It is the name, thing etc. These are the data characteristics of entities or data elements and data fields.

Relationship

It is used to describe the relation between two or more entities. It is represented by a diamond shape.

Cardinality

Cardinality describes the number of entities in one entity set, which can be associated with the number of entities of other sets via relationship set.

It have Four Types which are:

- One to One
- One to Many
- Many to one
- Many to Many

ERD is a diagram which shows entities (tables) and relationships among those entities Smart Crop Dry System

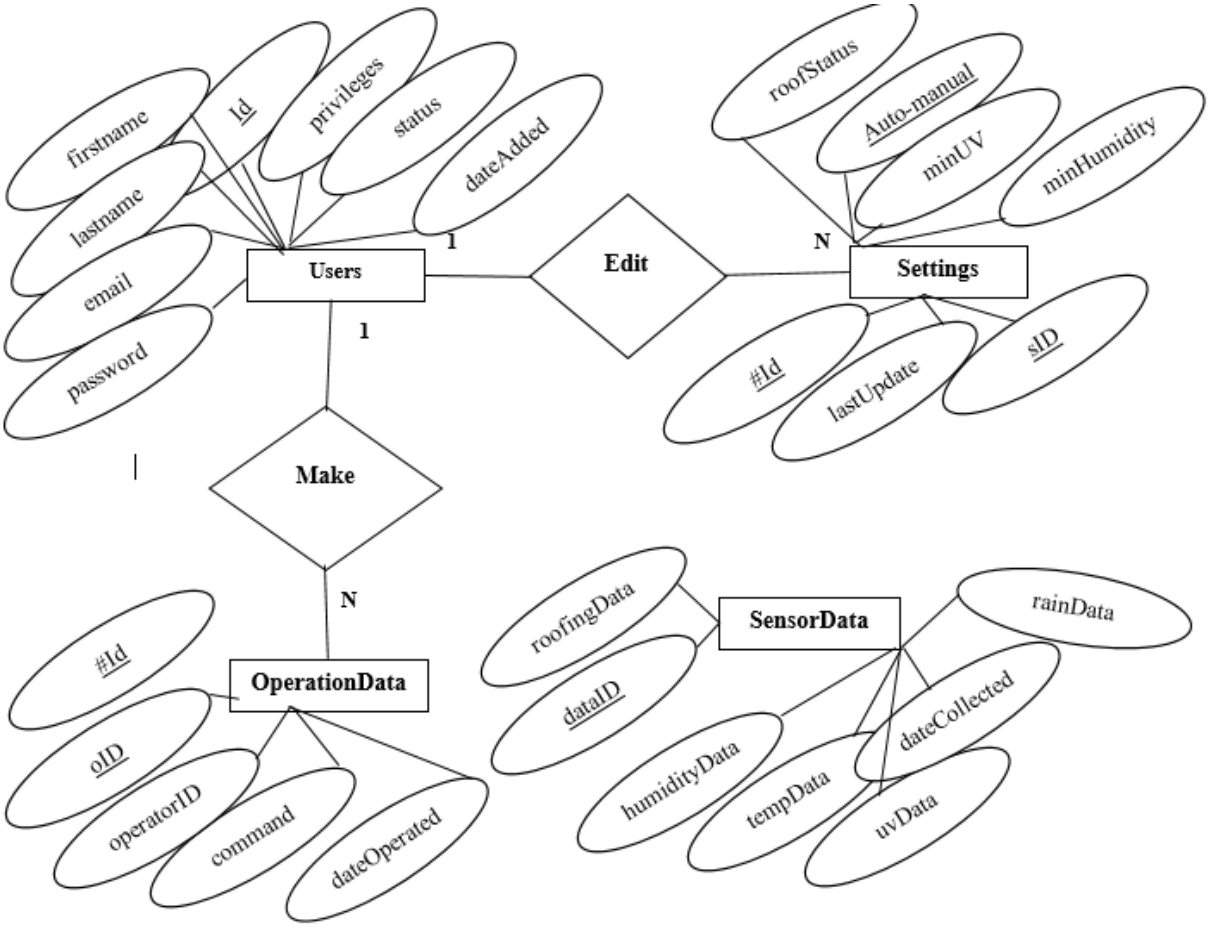


Figure 14 Entity Relation Diagram SCDS

4.3.2 DATA DICTIONARY

A data dictionary is an integral part of a database. It holds information about the database and the data that it stores

Table 1: Table for user.

Users		
Fields	**Data type**	**Constraints**
id	bigint(20) unsigned	Primary key
firstname	Varchar(100)	no
lastname	Varchar(100)	no
Email	Varchar(100)	Unique
password	Varchar(100)	no
privileges	Bigint(11)	no
status	Bigint(11)	no
dateAdded	Date time	no

Table 2 Operation Table

OperationData		
Fields	**Data type**	**Constraints**
oId	bigint(20)	Foreign key
OperatorId	bigint(11)	no
Command	bigint(11)	no
DateAdded	Date time	no

Table 3 Table of Data

Sensordata		
Fields	**Data type**	**Constraints**
DataId	bigint(11)	Primary key
HumidityData	bigint(11)	Foreign Key
tempData	float	Foreign Key
UVData	float	Foreign Key
rainData	bigdata	Foreign Key
roofingData	bigint(11)	Foreign Key
Datecollected	Varchar(12)	no

Table 4 Setting Table

Settings		
Fields	**Data type**	**Constraints**
sID	bigint(11)	Primary key
mainHumidity	bigint(11)	Foreign Key
maintemperature	float	Foreign Key
mainUV	float	Foreign Key
Auto_manual	bigdata	Foreign Key
roofstatus	bigint(11)	Foreign Key
lastupdate	Date Time	no

4.3.4 Interface Design

This is login page that allows the user to access this system.

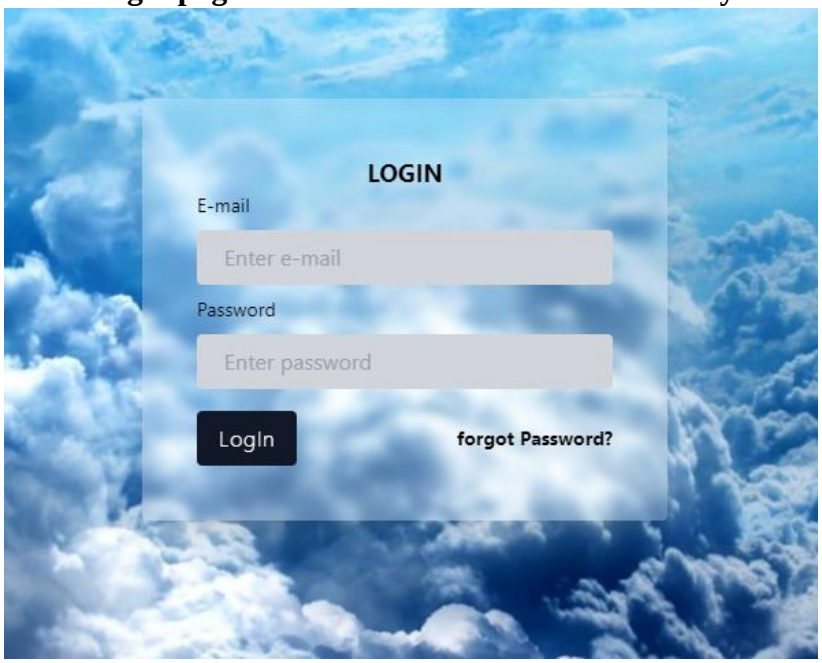


Figure 15: user to Login

This is Dashboard for users, it used for display all data value from sensors and the user can perform other task by using this page.

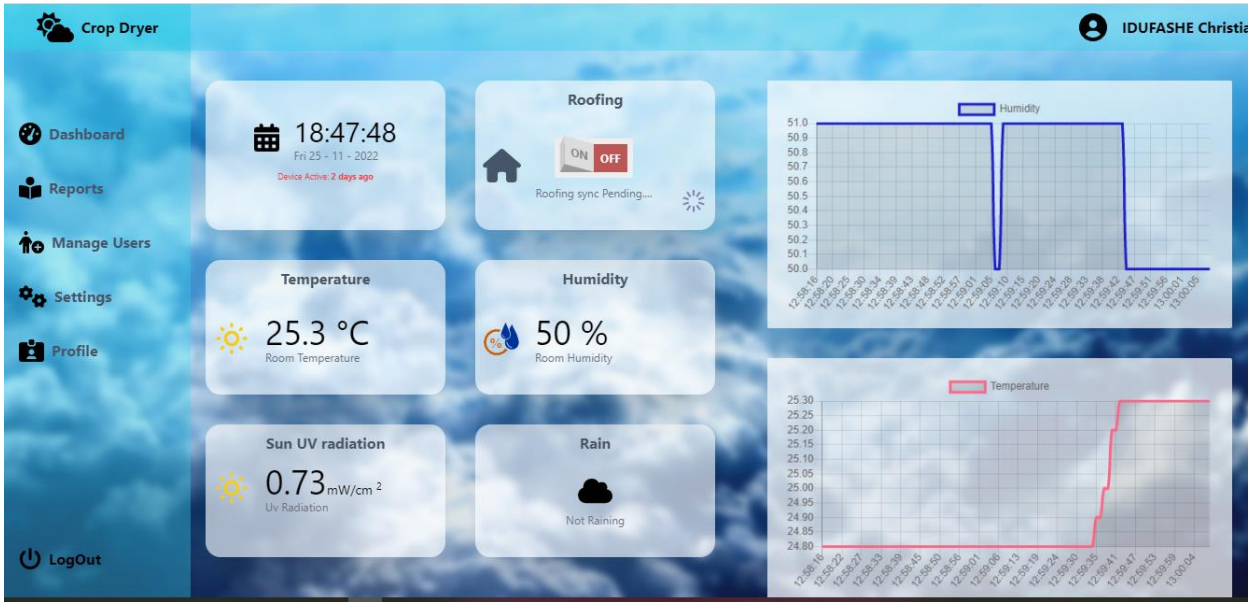


Figure 16: Dashboard of the System

This Page it help the admin to manage users.(Register new user, delete and set privileges for user).

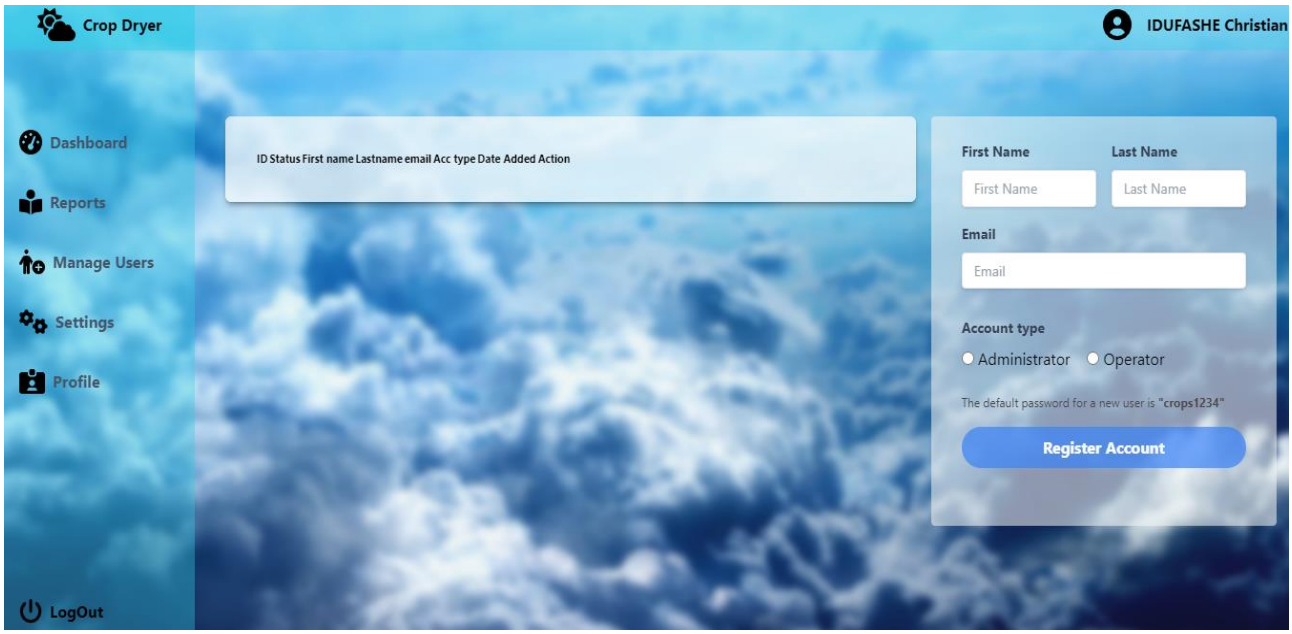


Figure 17: Manage User

This is page of Settings that help the admin to make some changes in the system.

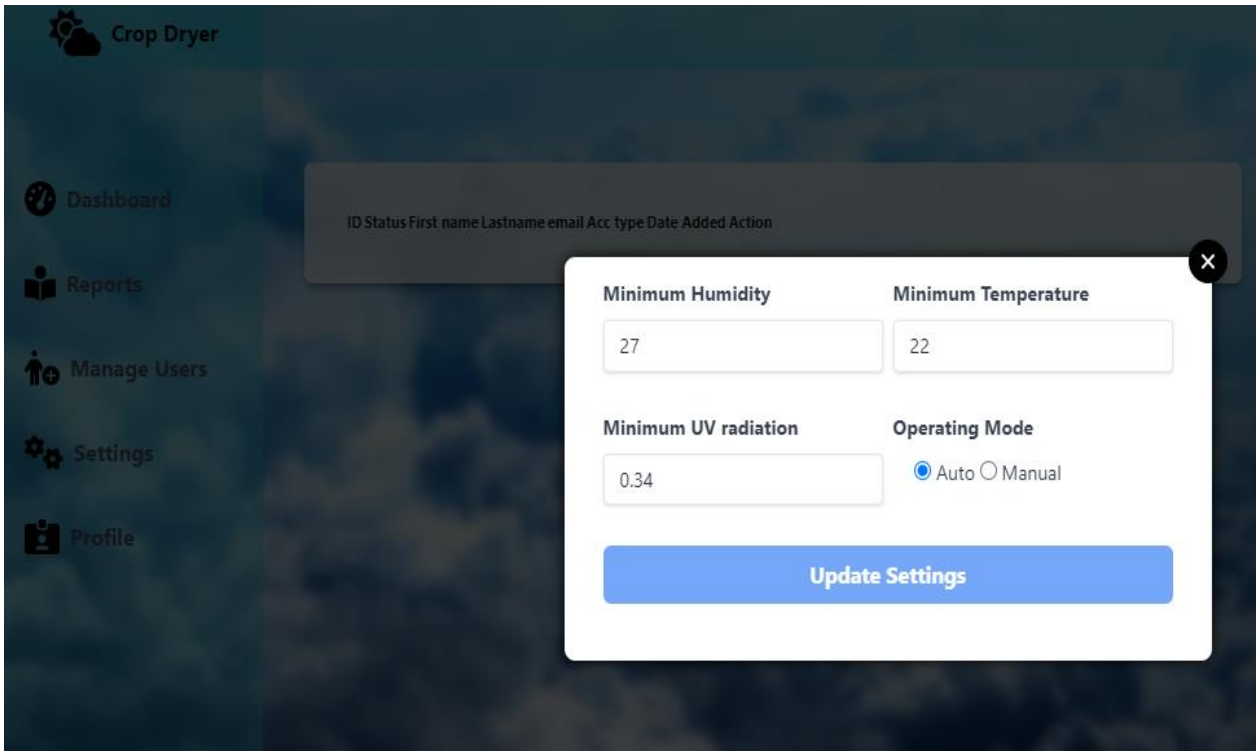


Figure 18: Update System setting

This page it helps the admin to view report of all activities done on the system.

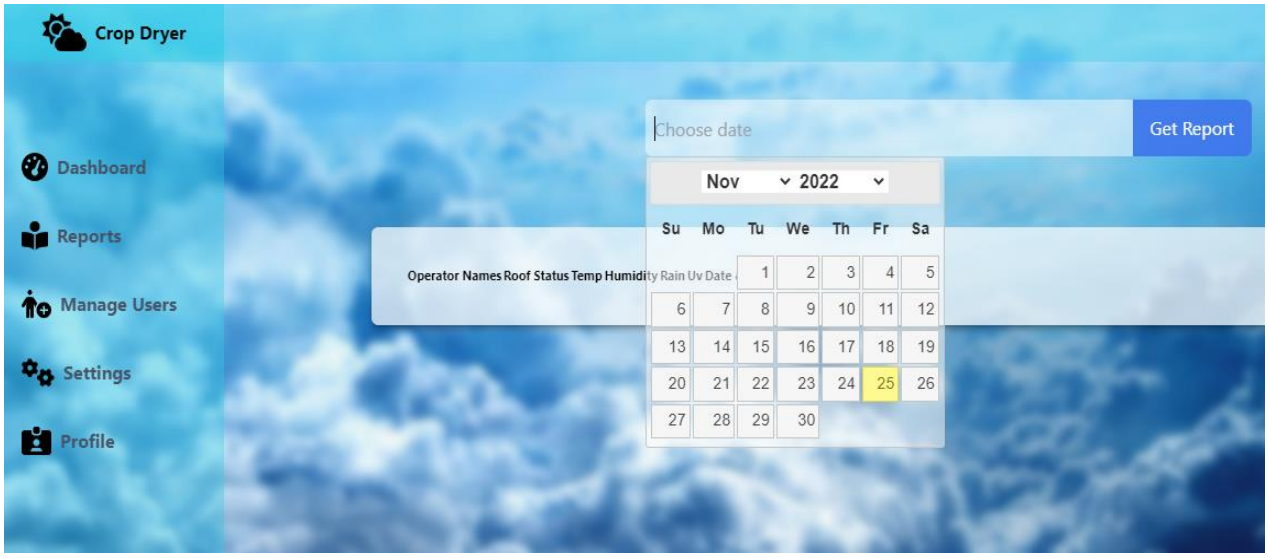


Figure 19: Report

4.5 VERIFICATION OF HYPOTHESIS

The system aimed to achieve the following hypothesis "**Smart Crop Drying System** is helps the farmers during the harvest time to automate the process of sun drying depending on the values read by the devices then automatically close or open the store for sun drying and user can open or close the roof So it prevents the harvested crops from the heavy rain need for essential to improve seed quality".

The system also provides user friendly Interface that monitoring system activities and status of hardware which is easily facilitate user to interact with the system.

The System has been tested and verified.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The Smart Crop Drying System has been achieved successfully using microcontroller unit. The circuit has been tested and verified. We Developed Automatic roof for crop protection shed programmed by using the microcontroller. The program has been successfully tested and verified for several specified conditions. The switching mechanism can be done automatically with the help of microcontroller using DC motor.

By using this project we can protect Our Products in the period of unseasonal rain. We can also increase the rate of production of crops by which we can improve the economical standards of farmers and as production increases the cost of the crop decreases for the users So Using this system eliminates human power and requirement to provide automatic roof mechanism.

5.2 Recommendation

We recommend RAB to enable the best use of the system, we recommend training of the farmers and equipping them with the IoT skills required to run the system.

We recommend government to use this system in Different Cooperatives.

We recommend IPRC HUYE to link us with sector related to the Crop Drying System.

We recommend anyone who can be having any improvement to add to this system in order to achieve goal at higher level that they are allowed to modify it Such as system used for Crop Drying by using Solar energy or electrical energy that help the farmer to Dry up their products in the Rain Season.

REFERENCES

Referencing is a standard way of acknowledging the sources of information (e.g. books, publications from journals, etc.) that have been used in preparing the report.

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APPENDICES

APPENDIX 1: WORK PLAN

No	Task to be performed	Date to be completed	Person assigned to task	Peron required
1.	Project chosen and project proposal	1 week From 5th to 12th July/2022	IDUFASHE Christian IRADUKUNDA Honorine	**2 PERSONS**
2	Project proposal submission and presentation	Week 2-3 25th to 7th July-August 2022	IDUFASHE Christian IRADUKUNDA Honorine	**2 PERSONS**
3	Data collection	Week 4-7 2ndto23th September	IDUFASHE Christian IRADUKUNDA Honorine	**2 PERSONS**
4	Data analysis	Week 8 24th to 30 September/2022	IDUFASHE Christian IRADUKUNDA Honorine	**2 PERSONS**
5	Project design	Week 9 3th to 9th October/2022	IDUFASHE Christian IRADUKUNDA Honorine	**2 PERSONS**
6	Project testing	Week 10-13 10th October to 11th November/2022	IDUFASHE Christian IRADUKUNDA Honorine	**2 PERSONS**
7	Project submission	Week 14 30th November /2022	IDUFASHE Christian IRADUKUNDA Honorine	**2 PERSONS**

Table 5: Work plan

APPENDIX 2: GRANTCHART

Task to be performed	**2022**					
	July	**August**	**September**	**October**	**November**	**December**
Choice of research topic	From 5th to 12th					
Project proposal development	From 25th	To 7th				
Project proposal submission to the department			2nd			
Data collection			From 19th to 23th			
Data analysis			From 24th to 30th			
Project design				From 3th to 9th		
Programming and testing				From 10th	To 11th	
Report writing					14th to 29th	
Submission of the final project document					30th	
Project defence						6th
Submission of final collected document						

Table 6: Grantchart

BUDGET PLAN

- **Preparation for the study**

Nº		**Item**	**No. of Persons**	**No. of Days**	**No. Person-days**	**Cos (RW**
1		Communication	2	28	2	400
2		Restaurant	2	28	2	1000
3		Drink	2	28	2	500
		Sub-total 1				

Table 7: Table of Preparation for the study

- **The survey or experimentation**

Nº	**Item**	**Persons/Materials**	**No. of days**	**Person-Days**	**Unit Cost (RWF)**	**Total (RWF)**
1	Transport	Car, Motor	4	2	3000	24,000
2	Communication	Airtime	4	2	200	1600
Sub-total 2						25,600

Table 8: Table of The survey or experimentation

- **Project supplies**

Nº	**Item**	**Quantity**	**Unit Price RWF**	**Total RWF**
1	Note Books A4	2 Pieces	2000	4000
2	Identification Cards	2 Copies	1000	2000
3	Printing	4 Books	4000	16000
4	Pencil	2 Pieces	300	600
5	Bic	4 Pieces	300	1200
6	Rubber eraser	2 Pieces	500	1000
7	Transport	10 Times	3000	30,000
8	Rent	2 Houses	75000(three months)	150,000(for 2 person)
Sub-Total				**204,800**

Table 9: Table that show Project supplies

- **Production of the report**

Nº	Item	Quantity	No. of days	Pers.-days	Unit Price RWF	Total RWF
1	Crosscheck & Verification of data	Internet(10Gb)	84	2	1000	20,000
2	Entering Data	Computer	84	2	-	-
3	Analysis of Data	Papers and Pens	84	2	10,000	10,000
4	Report (Draft 1-3)	Draft for all	84	2	15,000	15,000
	Sub – total 4					**45,000**

Table 10: Production of Report

- **Workshop for report validation**

Nº	Item	Quantity	NO./Days	Pers-days	Unit Price RWF	Total RWF
1	ESP32	1	84	2	16000	16000
2	ML8511UVBUV Rays	1	84	2	9200	9200
3	DHT11	1	84	2	3500	3500
4	DC Motor 2	2	84	2	8600	17,200
5	Motor Driver	1	84	2	4500	4500
6	Rain fall sensor	1	84	2	2600	2600
7	Power Supply 12v	1	84	2	4500	4500
8	Capacitor	4	84	2	400	1600
9	Resistor 10	10	84	2	100	1000
10	Leds	4	84	2	100	400
11	LCD	1	84	2	9000	9000
12	PCB	1	84	2	1000	1000
14	Jumpers	2	84	2	2000	4000
15	Switch	3	84	2	500	1500
16	Male Header	2	84	2	400	800
17	Breadboard	1	84	2	5000	5000
18	Wires	2m	84	2	1200	1200
	Sub–total					**74,900**

Table 11: Workshop for report validation

APPENDIX 3: BUDGET SUMMARY

Number	**Items**	**Total cost (RWF)**
01	Communication cost	44,400
02	Transport cost	54,000
03	Lodging	15,000
04	Restaurant	84,000
05	Pens	4200
06	Papers	11,000
07	Printing cost	31,000
08	Hardware Devices	74,900
Total Budget		**318,500**

Table 12 : Budget Summary