VISVESVARAYA TECHNOLOGICAL UNIVERSITY,
BELAGAVI, KARNATAKA.

BLDEA's V.P. Dr. P.G. HALAKATTI COLLEGE OF ENGINEERING AND TECHNOLOGY, VIJAYAPUR -- 586103

Department of CSE (Artificial Intelligence & Machine Learning)

A PROJECT REPORT ON

"AI BASED SMART FARMING USING IOT"

SUBMITTED BY

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UNDER THE GUIDANCE OF

Prof. Hemavathi b Biradar

Prof. Gurudevi Vanarotti

2023-2024

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BLDEA's V.P. Dr. P.G. HALAKATTI COLLEGE OF ENGINEERING AND TECHNOLOGY, VIJAYAPUR -- 586103

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CERTIFICATE

This is to certify that **Vaishnavi Patil(2BL20CI023), Nidhi Masali(2BL20CI011), Harshita Kulkarni (2BL20CI006), Aishwarya Mukihal(2BL20CI002)** bonafide students of **BLDEA's V. P. Dr. P. G. Halakatti College of Engineering and Technology Vijayapura**, have completed their project entitled as **"AI BASED SMART FARMING USING IOT"** as a partial fulfillment for the award of **Bachelor of Engineering** in **CSE(Artificial Intelligence and Machine Learning)** from **Visvesvaraya Technological University Belagavi,** during the academic year 2023-2024. It is certified that all corrections or suggestions indicated for Internal Assessment have been incorporated in the Report. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering.

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DECLARATION

We, **Nidhi Masali(2BL20CI011) CSE(AI and ML)** VIII semester, **BLDEA's V. P. Dr. P. G. Halakatti College of Engineering and Technology, Vijayapura** are hereby declare that the project titled **"AI BASED SMART FARMING USING IOT"** carried out by us under the supervision of internal guide **Prof. Hemavathi Biradar and prof. Gurudevi Vanarotti** , Department of CSE (Artificial Intelligence & Machine Learning), BLDEA's V. P. Dr. P. G. Halakatti College of Engineering and Technology Vijayapura, submitted in partial fulfillment of the requirement for the award of the degree of **Bachelor of Engineering** in **CSE (Artificial Intelligence & Machine Learning)** from **Visvesvaraya Technological University, Belagavi** during the academic year 2023-2024 for VIII semester curriculum. This report has not been submitted to any other college/university for any award of degree or certificate.

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ABSTRACT

The agricultural sector in India faces significant challenges, including climate variability, water scarcity, and soil degradation. Accurate forecasting of environmental parameters such as temperature, humidity, and soil moisture is crucial for optimizing agricultural practices and enhancing crop yield. However, traditional data collection and analysis methods are often inadequate in terms of scope and efficiency. This paper explores the integration of Artificial Intelligence (AI), Internet of Things (IoT), and big data analytics as a promising solution to address these challenges. By leveraging IoT sensors for real-time environmental monitoring, AI algorithms for data analysis and predictive modelling , and big data analytics for managing large datasets, the proposed system aims to generate accurate forecasts of environmental parameters at various spatial and temporal scales. The system's components include an IoT sensor network for data collection, a central data repository, AI models for precision agriculture, automated monitoring and control mechanisms, a decision support system, and a cloud-based platform for data storage and processing. The objectives of the system encompass precision agriculture, environmental sustainability, predictive maintenance, data-driven decision-making, and increased profitability in agricultural operations. The paper presents the system's architecture, methodologies, and potential applications, highlighting the transformative potential of this integrated approach for revolutionizing agricultural practices in India and enhancing productivity and sustainability.

CONTENTS

Sl. No	Chapters	Page no.
01.	Introduction	01
	1.1 Problem statement	
	1.2 Objectives	
	1.3 Motivation	
02.	Literature survey	05
03.	System analysis	08
	3.1 Existing system	
	3.2 Proposed system	
	3.3 Feasibility study	
04.	Requirement specification	10
	4.1 Functional & Non-functional requirements	
	4.2 System specifications	
05.	Proposed System	23
	5.1 Linear Regression	
	5.2 Mean Squared	
06.	Implementation	26
	6.1 System design	
	6.2 UML diagrams	
	6.3 Software Development Life Cycle	
	6.4 Snapshots	
07.	Applications	41
08.	Conclusion	42
	References	43

LIST OF FIGURES

Figure No.	Figures	Page no
Figure 4.1	Raspbian Operating System	12
Figure 4.2	Raspberry Pi Board	14
Figure 4.3	Ultra Sonic Sensor Device	16
Figure 4.4	PIR Sensor Device	18
Figure 4.5	Humidity and Temperature Device	19
Figure 4.6	Grove Moisture Sensor Device	20
Figure 5.1	Graph of Linear Regression	24
Figure 5.2	Formula for MSE	25
Figure 6.1	Use case diagram	29
Figure 6.2	Class diagram	30
Figure 6.3	Sequence diagram	31
Figure 6.4	Collaboration diagram	31
Figure 6.5	Deployment diagram	32
Figure 6.6	Activity diagram	32
Figure 6.7	Component diagram	33
Figure 6.8	ER diagram	33
Figure 6.9	DFD diagram	34
Figure 6.10	Waterfall Model	36
Figure 6.4.1	Running system results	37
Figure 6.4.2	Stored images	38
Figure 6.4.3	Load Dataset	39
Figure 6.4.4	AI running system results	40

LIST OF ACRONYMS

Acronyms	Definitions
UML	Unified Modeling Language
IR	Infrared
PIR	Passive infrared
IDLE	Integrated Development and Learning Environment
REPL	Read Evaluate Print Loop
DFD	Data Flow Diagram
ER	Entity-Relationship
SDLC	Software Development Life Cycle

CHAPTER 1

INTRODUCTION

Agriculture in India is challenged by huge issues like climate change, water shortage, soil salinity, etc. It is of paramount importance to predict environmental variables like temperature, humidity, soil moisture, etc. accurately to ensure optimal use of resources and better yield. Usually, data collection and prediction tasks are not performed comprehensively and with sufficient frequency. Also, the manual methods of data analysis are not efficient and accurate. The latest trends in AI and IoT domains provide opportunities to collect and analyse data effectively to ensure precise prediction in time.

Being a country with huge agricultural land and varied climate, India is challenged by the problems of accurate prediction of these environmental variables. Accurate prediction of temperature, humidity and soil moisture ensures optimal crop growth, better water management and also helps to combat the negative effects of climate change. Usually, environmental forecasting is carried out based on a few data sources and may not be accurate and scalable.

The trends of AI, IoT and big data analytics can be leveraged to ensure comprehensive and accurate prediction of environmental variables. Data-driven insights can be derived from IoT devices installed with sensors to monitor parameters like temperature, humidity, soil moisture, etc. in real-time. AI algorithms and data analysis techniques help in processing the raw data and environmental prediction model. Thus, accurate environmental predictions can be generated for different spatial and temporal scales which has a huge potential to transform Indian agriculture. Farmers can take better decisions related to choosing the type of crop, scheduling irrigation, pest control, etc. which ultimately leads to better productivity and sustainable agriculture.

Agriculture has come a long way in the last few years. The advent of new generation technologies like Internet of Things (IoT) and Artificial Intelligence (AI) has revolutionized the way farming was done traditionally. The combination of both these technologies has led to the concept of Smart Farming.

Smart Farming involves the usage of IoT devices like sensors, actuators, drones, etc. to collect a huge amount of data related to the farm in real-time. These IoT devices capture data and the AI algorithms help in processing the data to aid farmers in decision-making, optimize resource usage and reduce risks. Whether it is precision farming, livestock management or any other aspect of farming, IoT and AI together have immense potential.

In the era of smart farming, farmers can monitor soil moisture, temperature, humidity, crop health from remote locations and irrigate or apply fertilizers as and when it is needed depending upon the condition of each plant. AI-based predictive analytics help in forecasting crop diseases, pest attacks, unfavourable weather conditions, etc. and help farmers to take necessary steps to ensure optimal productivity.

Also, the IoT devices help in automating farm operations which in turn reduces labour charges and human errors. Autonomous drones with AI-based image recognition technology can cover large areas of farms, detect problematic regions and raise alerts.

Smart Farming will not only change the individual farm but will influence the global food supply, the environment and the economy. By maximizing crop yields while minimizing resource consumption and environmental impact, Smart Farming contributes to the creation of a more resilient and sustainable food system capable of feeding the world's growing population.

As we delve deeper into the realm of Smart Farming, the potential for innovation and advancement is limitless. By embracing IoT and AI technologies, farmers can unlock new frontiers in agricultural efficiency, sustainability, and profitability, shaping a brighter future for agriculture and society as a whole.

1.1 PROBLEM STATEMENT

Smart farming, a combination of IoT and AI, is a revolutionary approach to modernize agricultural practices. It involves deploying an IoT sensor network to collect data on various parameters, such as soil moisture, temperature, humidity, IR sensor, Gas Detector. A central data repository is established to store and integrate this data, with additional data sources like weather forecasts and historical crop yield records. Precision agriculture is achieved by using AI-driven insights to apply water, fertilizers, based on specific crop and soil requirements. Automated monitoring and control are achieved through AI-powered computer vision systems and robotics. A decision support system is developed to provide real-time insights and recommendations. A cloud-based platform is implemented to store and process the data generated by the IoT sensor network and AI models.

1.2 OBJECTIVES

1.2.1 Precision Agriculture:

Implement precision agriculture techniques using IoT-enabled devices and AI algorithms to optimize the application of water, fertilizers, and pesticides based on specific crop and soil requirements in different areas of the farm.

1.2.2 Environmental Sustainability

Promote sustainable farming practices by minimizing the use of water, fertilizers through data-driven decision-making and precise application methods, reducing the environmental impact of agriculture.

1.2.3 Predictive Maintenance

Utilize AI-powered predictive maintenance techniques to monitor and predict equipment failures, enabling proactive maintenance and reducing downtime.

1.2.4 Data-driven Decision Making

Provide farmers with real-time insights, recommendations, and decision support systems powered by AI algorithms and data analytics, enabling informed decision-making and proactive management of farm operations.

1.2.5 Increased Profitability

By optimizing yields, reducing resource waste, and increasing efficiency through IoT and AI technologies, smart farming systems aim to enhance the overall profitability and economic viability of agricultural operations.

1.3 MOTIVATION

The integration of Internet of Things (IoT) and Artificial Intelligence (AI) technologies in smart farming is all about tackling challenges in the agricultural sector and meeting the growing global demand for food in a sustainable way. It's driven by a bunch of reasons like increasing food production, optimizing resources, adapting to climate change, promoting sustainable agriculture, making work more efficient, cutting costs, ensuring food traceability and safety, making data-driven decisions, implementing precision agriculture, and fostering innovation and technological advancement.

Here's why all this matters: By 2050, the world's population is expected to hit a staggering 9.7 billion people. So, it's absolutely crucial that we ramp up agricultural productivity and increase food production. That's where smart farming comes in. With its nifty techniques, we can optimize crop yields, minimize waste, and make the most of our resources. By using IoT sensors and AI-powered analytics, we can closely monitor and control how we apply resources, which leads to big savings and less harm to the environment.

But wait, there's more! Climate change is throwing some serious curveballs at agriculture with its unpredictable weather patterns, droughts, and extreme temperatures. Smart farming can help us adapt by providing real-time data analysis, predictive modeling, and decision support. This helps farmers make smart choices about how to manage their crops, even in the face of a changing climate.

Sustainability is a big deal too. The world is putting a major emphasis on sustainable agriculture, and smart farming is leading the way. By using these cool techniques, we can use less water, fertilizers, and pesticides, which means fewer greenhouse gas emissions and more biodiversity. Plus, smart farming automates tasks like planting, monitoring, and harvesting, which cuts down on manual labor and saves money.

And guess what? Precision agriculture is another perk of smart farming. By applying inputs exactly where and when they're needed, we can optimize yields, reduce waste, and increase efficiency. All of this adds up to better profitability and competitiveness for farmers in the long run. So, smart farming is not just a cool trend—it's an important way to ensure that agriculture can thrive in the future.

CHAPTER 2

LITURATURE SURVEY

[1] Ms. Hemavati Biradar MTech (CSE), (PhD) " Review on IoT Based Multidisciplinary Models for Smart Farming" May 19-20, 2017, India.

The paper reviews multidisciplinary models and methodologies for enabling smart farming and precision agriculture by leveraging emerging technologies. It outlines a comprehensive step-by-step approach for implementing big data analytics projects in agriculture, including data collection from sources like IoT sensors, preprocessing, analysis, and visualization to aid decision making. The accurate estimation of crop water requirements using evapotranspiration modelling and crop coefficients is highlighted. Wireless sensor networks are presented as a cost-effective solution to monitor soil moisture, atmospheric conditions and control irrigation systems. Cyber-physical systems that tightly integrate computational and physical components are proposed to enable real-time monitoring and autonomous management of agricultural operations. The integration of IoT devices with cloud computing is suggested to sense geographical requirements, provide virtual data storage, and reduce costs through pay-per-usage models. Future work involves developing security systems to monitor farm fields and prevent unauthorized access. Overall, the paper advocates adopting a multidisciplinary approach combining IoT, big data, wireless sensing, cyber-physical systems and cloud computing to make farming smarter, more efficient and more productive.

[2] Marco Barenkamp ,A New IoT Gateway for Artificial Intelligence in Agriculture. International Conference on Electrical, Communication and Computer Engineering (ICECCE) 12-13 June 2020, Istanbul, Turkey.

The paper presents a concept for a comprehensive artificial intelligence (AI) system called the "IoT-AI-Platform" that aims to integrate various Internet of Things (IoT) applications and stakeholders across the agricultural value chain. The proposed platform is envisioned as a network connecting commercial system users, agricultural technology providers, and IT experts, enabling them to share data, AI models, and services. The platform would provide a unified infrastructure for developing and deploying AI solutions tailored to different agricultural use cases, such as sensor data interpretation, crop growth prediction, and livestock management. The platform leverages container technology, supports public and private software standards, and aims to establish a de facto industry standard for agricultural AI systems. The paper highlights the potential advantages of the platform, including improved efficiency, sustainability, and the establishment of the origin country as an agricultural technology hub. It also discusses future development requirements, such as legal and organizational structures, marketing strategies, and security considerations.

[3] Kumar Parasuraman, IoT Based Smart Agriculture Automation in Artificial Intelligence

The paper presents an IoT-based smart agriculture automation system leveraging artificial intelligence techniques. It discusses the application of technologies like wireless sensor networks, machine learning, deep learning, and Internet of Things (IoT) to address various challenges in the agriculture sector such as crop disease detection, water management, pest control, and weed monitoring. The proposed system involves collecting data from various sensors monitoring soil parameters, climatic conditions, and crop yields. This data is then fed into machine learning models like Multi-Layer Perceptron (MLP), Recurrent Neural Networks (RNN), and Long Short-Term Memory (LSTM) networks for prediction and decision-making tasks related to crop selection, irrigation scheduling, and yield forecasting. The paper also highlights the potential of integrating IoT devices with cloud computing for virtual data storage and reducing operational costs through pay-per-usage models. The aim is to enable smart farming practices, improve crop productivity, and enhance overall agricultural efficiency through the automation of various agricultural processes using AI and IoT technologies.

[4] AHMAD ALI ALZUBI AND KALDA GALYNA, Artificial Intelligence and Internet of Things for Sustainable Farming and Smart Agriculture, Received 21 June 2023, accepted 12 July 2023, date of publication 24 July 2023, date of current version 2 August 2023.

This paper discusses the role of artificial intelligence (AI) and the Internet of Things (IoT) in enabling sustainable farming and smart agriculture. Technologies like AI and IoT have been employed in farming for some time, and there is a growing interest in leveraging these technologies for sustainable and smart agricultural practices. The paper analyses existing IoT technologies used in smart sustainable agriculture (SSA) to identify architectural components that can facilitate the development of SSA platforms. It examines the current state of research and development in SSA and highlights the challenges faced, such as data sharing, management of IoT and AI devices, interoperability, and handling large amounts of data. The paper proposes an IoT and AI framework as a starting point for SSA, aiming to address the fragmented nature of agricultural processes. It provides an overview of various applications of IoT and AI in agriculture, including smart greenhouses, drones, precision farming, livestock monitoring, crop and soil monitoring, weather monitoring, agricultural robots, and harvest/price estimation. The paper emphasizes the potential of AI and IoT to enhance agricultural productivity, reduce waste, and address sustainability challenges while discussing the current state of adoption and future projections in the field.

[5] Richa Singh, AI and IoT Based Monitoring System for Increasing the Yield in Crop Production. 2020 International Conference on Electrical and Electronics Engineering (ICE3-2020).

This paper presents an AI and IoT based monitoring system to increase crop yield in agriculture. The research focuses on monitoring various physical conditions like humidity, temperature (environment and soil), soil moisture, and light intensity that affect the growth of a marigold plant using an IoT-based system. Different sensors like DHT11, LDR, DS18B20, soil moisture sensors are used to measure these parameters. Data is collected using microcontrollers (Arduino, Node MCU) and stored on the cloud (Thingspeak platform). Plant height and width are captured using a camera and image processing techniques (OpenCV library in Python).A dataset is prepared containing the extracted parameters and the plant growth rate (calculated from height/width changes over time). Various machine learning algorithms like Logistic Regression, Gradient Boosting Classifier, Linear SVC are applied on the dataset to analyse the effect of physical parameters on plant growth. The results identify the most favourable conditions for marigold plant growth, such as light intensity between 1000-1200 lux, humidity 58-78%, soil moisture 45-59%, etc. Logistic Regression, Linear SVC, and Gradient Boosting Classifier gave the highest accuracy of 83.33% in predicting the plant growth rate based on the physical parameters.

CHAPTER 3

SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

The way farming works can vary depending on where you are, the weather, and the resources available. One common method is monoculture farming, where you grow just one crop over a big area. But this approach can cause problems like soil depletion, making plants more vulnerable to pests and diseases, and harming the environment. Using lots of chemical fertilizers can also lead to pollution, health risks, and damage to the soil. Another technique called tillage-based agriculture involves manipulating the soil mechanically, but that can cause issues like erosion, compaction, and loss of carbon. Water-intensive agriculture requires a ton of water, which can deplete resources and make the soil too salty. And when farmers focus on big-scale industrial farming to maximize efficiency and save money, it often leads to less biodiversity, people leaving rural areas, and food insecurity.

But there's hope! By switching to sustainable farming practices like agroecology, organic farming, agroforestry, and conservation agriculture, we can tackle these downsides while also minimizing harm to the environment.

3.1.1 Disadvantages of Existing System

- Soil depletion
- Environmental impact
- Depletion of water resources

3.2 PROPOSED SYSTEM

Sensor integration on farms involves deploying sensors to monitor environmental factors like temperature, humidity, soil moisture, pH levels, and sunlight exposure. Real-time data is collected and transmitted using IoT protocols. AI algorithms analyze the collected data, predicting optimizing irrigation schedules, and forecasting yields. IoT-enabled irrigation systems adjust water supply based on soil moisture levels and weather forecasts. AI algorithms predict maintenance needs for farm equipment, reducing downtime. A decision support system provides farmers with actionable insights and recommendations based on real-time data analysis.

3.2.1 Advantages of Proposed System

- Increased Efficiency
- Improved Yield and Quality
- Cost Reduction
- Scalability and Adaptability

3.3 FEASIBILITY STUDY

3.3.1 Technical Feasibility

The study evaluates the existing infrastructure for IoT sensor networks, data connectivity, and AI models, assessing the compatibility of devices with farm management systems, the availability of high-speed internet connectivity, and the proposed system's scalability and flexibility for future expansions or modifications as technology evolves.

3.3.2 Operational Feasibility

The study evaluates the farm's operational processes and potential integration of IoT and AI technologies to enhance efficiency and productivity. It assesses the impact on workflows, staffing, and personnel training. The system's compatibility with existing equipment and infrastructure is also evaluated. Technical support and software updates are also considered.

3.3.3 Economic Feasibility

The cost-benefit analysis involves estimating the initial investment for hardware, software, infrastructure upgrades, and implementation services, evaluating the potential ROI, assessing long-term operational costs, and exploring government incentives or grants to support the adoption of smart farming technologies. This helps in determining the most suitable approach for the system.

3.3.4 Environmental Feasibility

The proposed system's environmental impact, including energy consumption, waste management, and carbon footprint, is evaluated. It's also assessed for its potential to promote sustainable farming, reduce water usage, minimize fertilizer and pesticide use, and preserve biodiversity.

CHAPTER 4

REQUIREMENT SPECIFICATIONS

4.1 FUNCTIONAL AND NON-FUNCTIONAL REQUIREMENTS

Requirement's analysis is very critical process that enables the success of a system or software project to be assessed. Requirements are generally split into two types: Functional and non-functional requirements.

4.1.1 Functional requirements

The system aims to monitor environmental factors like temperature, humidity, soil moisture, and light levels in real-time using IoT sensors. It collects and analyzes data using AI algorithms to provide insights into crop health and potential issues. The system automatically controls irrigation systems based on real-time data analysis, monitors crop health using image recognition and AI, and implements predictive maintenance algorithms to monitor equipment and machinery condition. AI models predict crop yields based on historical data, weather forecasts, and environmental conditions, aiding in decision-making. Remote control and management are also enabled through web or mobile applications.

4.1.2 Non-Functional requirements

The system should be scalable, reliable, secure, and compatible with various IoT devices, sensors, and equipment from different manufacturers. It should be able to accommodate new sensors and functionalities as the farm expands or requirements change. Robust security measures should be implemented to protect sensitive data. The system should also minimize latency, optimize energy usage, and provide adequate user experience. This is especially important for remote or off-grid farming locations. Overall, the system should be user-friendly and easy to use.

4.2 SYSTEM SPECIFICATIONS

4.2.1 Software requirements

For almost projects we need some software to run programs. Now will see what software we require and what all are the features of the software.

Python: Python is a popular, dynamic, and highly versatile programming language. It's great for developing fast applications, especially for designing and implementing IoT-based smart security and monitoring systems for connected smart farming.

One of Python's standout features is its sophisticated built-in data structures, combined with dynamic typing and dynamic binding. This makes it really useful for connecting existing components using its scripting language capabilities. Python is an amazing and powerful programming language that is easy to use, read, and write. It allows us to connect our projects to the real world.

One of the best things about Python is its clean syntax, which emphasizes readability. It's easy to learn and its simple syntax not only makes code more readable, but also helps reduce the cost of program maintenance. Python also encourages program modularity and code reuse through support for modules and packages. Additionally, Python libraries are freely available for major platforms.

Developers love working with Python because it boosts productivity. Unlike languages that require compilation, Python's editing, testing, and debugging processes are lightning fast. Debugging Python programs is also a breeze as it doesn't cause segmentation errors. When an error is detected, an exception is raised, and the interpreter provides a stack trace to help identify the issue.

Python IDLE: The easiest way to get started with Python is through IDLE, which stands for Integrated Development and Learning Environment. IDLE provides a handy prompt called Read Evaluate Print Loop (REPL) where you can enter Python commands and see the output right on your screen, without needing to use the print function. It's a user-friendly environment designed to make Python development a breeze.

Features of IDLE are as follows:

• The whole program coding can be done using Graphical User Interface toolkit called tkinter and pure python.
• Mostly it works almost same on Mac OS X, Windows, UNIX.
• It gives interactive interpreter in which python shell window afford the coloring of code input, output, error messages.
• Multiple of undo is provided in editing of text in multi window, colorizing, elegant indent and automatic completion and many others.
• Searching provision is extensive; we can search in any window; within any editor windows we can replace; and in many files we can search.

The Shell window and the Editor window are two types of windows in IDLE. We can concurrently work on multiple editor windows. Which window is currently chosen based on that IDLE's menus will get change dynamically.

Linux based Raspbian OS: Raspberry Pi has its own Operating system Raspbian and because of that most of the people want to start with it.

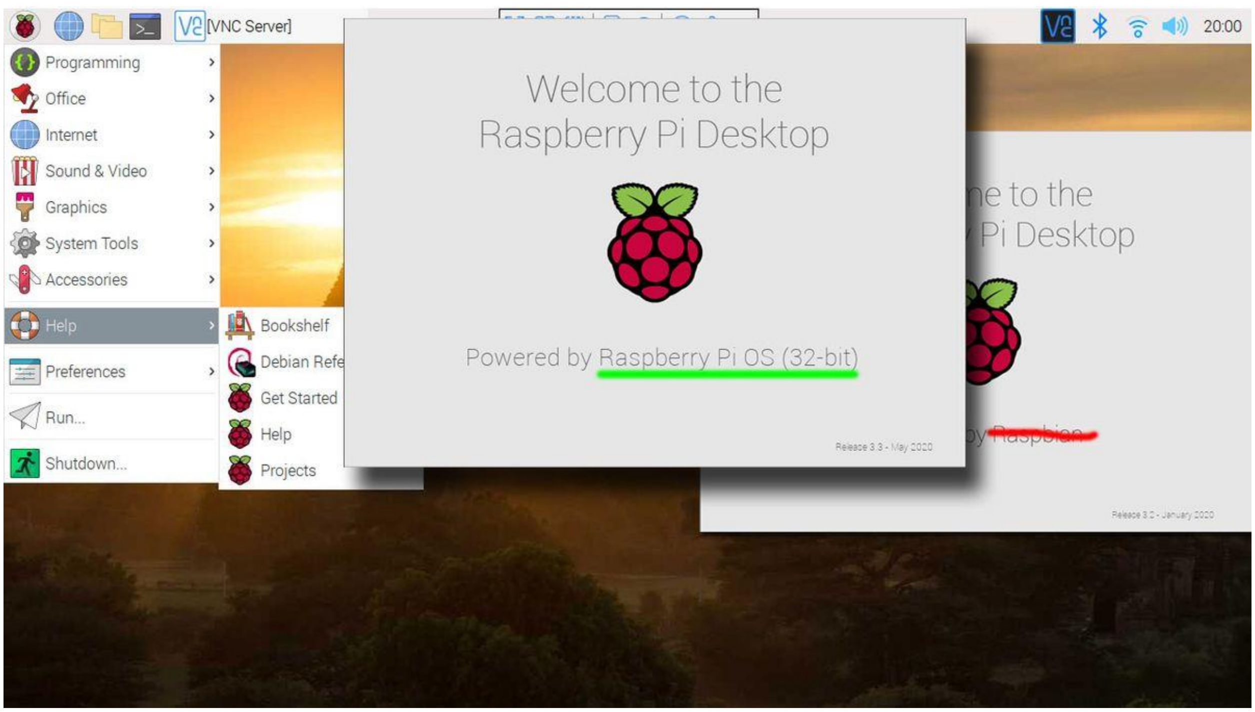


Figure 4.1: Raspbian Operating System

Raspbian is the perfect operating system for Raspberry Pi. It's specifically designed to work seamlessly with this device and comes preloaded with all the software you need to get started. Think of it as a version of Linux that's tailor-made for the Raspberry Pi.

In the image above, you can see what the Raspbian operating system looks like. That's the window you'll be working with when you use Raspbian.

When you start using Raspbian, you can expect to find all the basic programs and utilities you need. This makes it super convenient for beginners who want to dive into their DIY projects without any hassle. Whether you're a coding novice or a seasoned pro, Raspbian has got you covered.

So go ahead and let your creativity run wild! Raspbian is the perfect platform to turn your ideas into amazing real-time projects. Get ready to see your vision come to life.

NetBeans: NetBeans is a platform for developing java software. It supports the modular development of applications (software components called “modules”). Third party developers can expand on NetBeans platform-based apps that also include NetBeans IDE. Its main use is in java programming but also accommodates languages like C, C++, PHP, and HTML.

This means that NetBeans is cross-platform as it runs on many platforms where JVM is compatible with them such as Microsoft Windows, Mac OS X, Linux, Solaris etc.

as dare not worry about services which are already used just they can focus on the logical part of their application because reusable services are provided by NetBeans.

Some of the features are:

- Management of user interface (menus and toolbars)
- Management of user settings
- Management of storage (saving and loading any kind of data)
- Management of window
- Wizard framework which supports step-by-step dialogs
- Visual Library
- Integrated development tools

4.2.2 Hardware requirements

The hardware devices we used in this work are illustrated below.

Raspberry Pi: Raspberry Pi is a small size board which is a powerful computer. Under the Linux Operating System this computer can run very efficiently. There are two models under the Raspberry Pi: Model A and Model B, both are tremendously reasonably priced, costing $25 and $35 correspondingly.

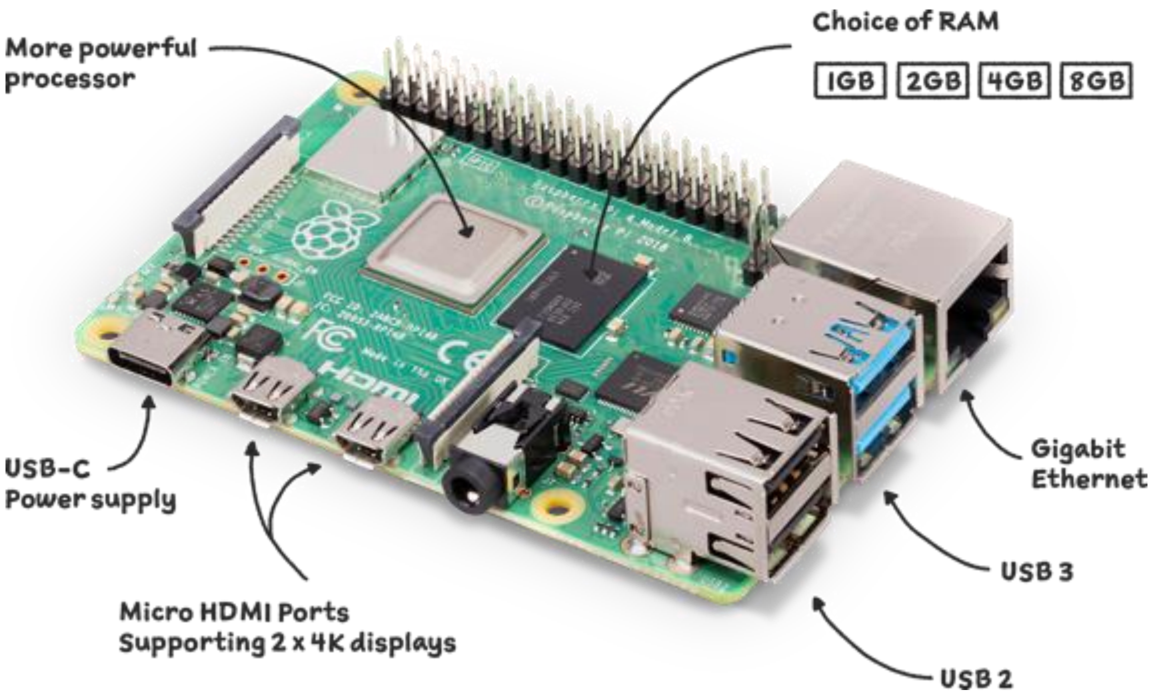


Figure 4.2: Raspberry Pi Board

The Raspberry Pi is a fully attributed computer and we can do most stuff with it that we do with our desktop computer or a laptop. The reason for its low cost is for its operation some of the external parts are needed, like power-supply, keyboard, monitor, a SD card, a box to protect it and so on. Actually, computer boots and runs from an SD card. For storing of data, the SD card is used in this computer and external USB based hard disks and flash memory devices can be connected to this computer to enhance its data capability.

The Raspberry Pi also has ports that we can connect mouse and keyboard, monitor (or TV), hard disk, flash memory device, speaker, Ethernet connector, and SD Card which is shown in figure 2.2.

What all things we can do with a Raspberry Pi? The performance of this Raspbian computer can be comparable with desktop computers when Pentium 2 processor is used and running at 300MHz, commonly we can do nearly everything that we can do on any other Linux desktop computer. Some examples of application areas are here:

• For learning the Linux based operating system general purpose can be used.

• General purpose computer is handy for learning programming languages.

• It is used for learning the working of computer.

• For constructing web site it is helpful.

• Working in word processing and spreadsheets.

• in listening music.

• We can play and watch any video.

• For drawing the pictures and editing of pictures.

• We can play games

• It can be interfaced to external devices to monitor and control.

Technical Specification of Raspberry Pi:

• BCM2837 Broadcom 64bit ARMv7 Quad Core Processor powered Single Board

Computer running at 1.2GHz

• 1GB RAM

• Wi-Fi on board BCM43143

• Bluetooth Low Energy (BLE) on board

• extended GPIO 40pin

• 4 x USB 2 ports

• 4 pole Stereo output and Composite video port

• Full size HDMI

- CSI camera port for connecting the Raspberry Pi camera
- DSI display port for connecting the Raspberry Pi touch screen display
- Micro SD port for loading your operating system and storing data
- Upgraded switched Micro USB power source (now supports up to 2.4 Amps)
- Expected to have the same form factor has the Pi 2 Model B, however the LEDs will change position

Ultrasonic sensor: Now will get to know features of Ultrasonic ranging (UR) module HC-SR04. This UR module HC - SR04 provides 2cm - 400cm non-contact dimension function, the ranging precision can attain to 3mm. The modules comprise of ultrasonic transmitters, receiver and control circuit. The basic principle of work:

• Using Input/output (I/O) trigger for at least 10us high level signal.

• This Module routinely sends eight 40 KHz signal and notice whether there is pulse signals reverse or not.

• Through high level if the signal is back, time of high output IO duration is the time from sending ultrasonic to returning.

Test distance = (high level time × velocity of sound (340M/S)) / 2.

Figure 4.3: Ultra Sonic Sensor Device

Direction for Wire connection: The connection to this ultra sonic device can be done through its four main points which are listed below and shown in above Figure 2.3.

- 5V Supply
- Trigger Pulse Input
- Echo Pulse Output
- 0V Ground

Note:

• It is suggested that the module should not be directly connected to electricity, if connected then the terminal GND should be first connected to module else it will affect to the working of module.

• The range of area should not be less than 0.5 square meters during the testing of objects else it will affect the outcomes of measure.

Parameters: Have a look at the table 2.1 to get the parameters of URD.

Table 2.1: parameters of URD sensor

operational Voltage	DC 5 V
operational Current	15mA
operational Frequency	40Hz
Maximum Range	4m
Minimum Range	2cm
Measuring Angle	15 degree
Trigger Input Signal	100s TTL pulse
Echo Output Signal	Input TTL lever signal and the range in proportion

PIR sensors: PIR sensors are abbreviated as Pyroelectric InfraRed sensors or Passive InfraRed sensors. For sensing the motion PIR sensors are helpful. It will detect motion of an object in or out of the sensors range. These sensors are small in size, low cost and consume less power, somewhat rough, have a wide range of lens and it is easy to interface because of which they used in many applications, in home, in building, in border of our country etc.

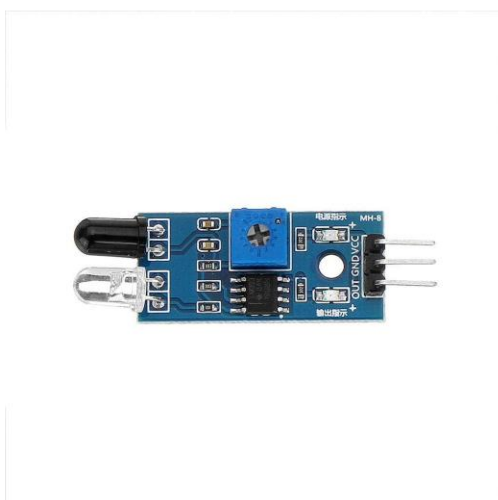


Figure 4.4: PIR Sensor Device

These sensors are made up of pyroelectric sensors along with that it has a bunch of supporting circuits, resistors and capacitors. Commonly all PIR sensors use to include BISS0001 ("Micro

Power PIR Motion Detector IC") chip which is inexpensive chip which is shown as in figure 2.4. From the analog sensor to emit a digital output pulse this chip will do some minor processing on the output of the sensor. But one thing to note that this sensor will only sense and intimate the presence of human not the number of persons and its distance.

Some basic features: Below table 2.2 shows the parameters of PIR sensor.

Table 2.2: features of PIR sensor

Size	Rectangular, 7mm by 5mm detector area.
Price	$2.00 at the Adafruit shop
Output	When motion is detected (triggered) the digital pulse will be high (3V) and when motion is not detected (idle) the digital will be low.
Sensitivity range	800nm to 1100nm with peak response at 940nm. Frequency range is 35KHz to 41KHz with peak detection at 38KHz
Power supply	3-5V DC 3mA

Humidity sensor: The output of this sensor is regulated digital signal. It certifies high consistency and excellent long-term stability, by using the elite digital-signal-acquisition technique and humidity sensing technology. This humidity sensor comprises of resistive type humidity measurement element. It can be connected to 8-bit microcontroller whose performance is high, offering admirable quality, quick response, anti-interference capability and cost-effectiveness.

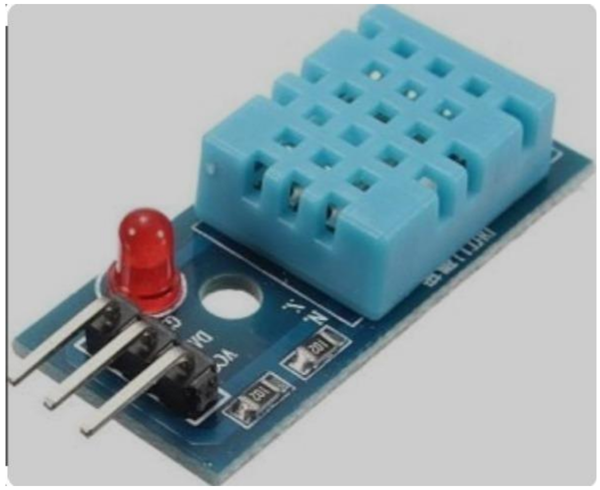


Figure 4.5: Humidity and Temperature Device

Every DHT11 aspect is firmly regulated in the laboratory that is enormously accurate on humidity calibration. The standard coefficients are used by the sensor's internal signal identifying processes which are stored as programs in the OTP memory. The system integration can be made easy and quick by using the single wire serial interface. In became the best selection of most of the applications due to its small size less power utilization and transmission of signal is up to 20 meters. The component is comprised of single row 4-pin package which will be handy for connections and according to the user's request the solutions can be provided. Figure 2.5 shows the device of DHT device.

The power supply to this DHT11 is from 3V to 5.5V. Within one second of supplying the power to the sensor we should not send any instruction to it, in order to pass uneven status. For the sake of power filtering, we need to add one capacitor whose value is 100nF between VDD and GND.

Moisture Sensor: This sensor is called as Grove Moisture Sensor. It is very supportive in detecting of water content from the soil precisely. Its simplified usage helps to the very beginners to use this device, just to insert the device legs into the soil and connect to microcontroller with its cable. It is well suited for 3.3V and 5V input voltage.

One thing to take care about in this is we should not insert whole module into the soil which may direct to damage of the device. The device is shown in figure 2.6. And is not confined from fault or contact of the water circuitry, so this device should not be used in the outdoors.

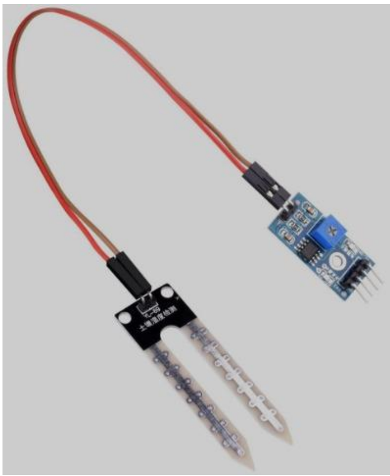


Figure 4.6: Grove Moisture Sensor Device

Specification: In table 2.3 we gave the factors of Moisture Sensor.

Table 2.3: Specification of Moisture Sensor

Item	Minimum	Maximum
Voltage	3.3 V	5 V
Current	0	35
Output Values	0 (in dry soil)	300
	300 (in humid soil)	700
	700 (in water)	950

Platforms which are supported to this device are Arduino, Raspberry Pi and TI Launch Pad. Botanical gardening, Moisture sensing and Consistency Measurement are some of the applications. Some feature of Grove moisture Sensors is:

- It uses measurement of soil resistivity.
- Grove is friendly and easy to use.
- It gives precise data (reading).
- 2 cm X 6 cm in size.

Gas Sensor: This sensor is most wanted device in almost places to prevent occurring of harmful situations hence it plays a vital role. The features of this device are listed below:

- Extensive detecting capacity
- Rapid response time
- Elevated sensitivity
- Drive circuit is simple, firm and long life.

The applications of gas sensor are:

- In home and industries, it is used for detecting the leakage of gas.
- It is more appropriate in detecting LPG, I-butane, propane, methane, alcohol, hydrogen and smoke.

CHAPTER 5

PROPOSED SYSTEM

5.1 LINEAR REGRESSION

Linear regression is also a type of machine-learning algorithm more specifically a supervised machine-learning algorithm that learns from the labelled datasets and maps the data points to the most optimized linear functions. which can be used for prediction on new datasets. This is the simplest form of linear regression, and it involves only one independent variable and one dependent variable. The equation for simple linear regression is:

$y = \beta 0 + \beta 1 X$

where:

Y is the dependent variable

X is the independent variable

β0 is the intercept

β1 is the slope

Classification: It predicts the class of the dataset based on the independent input variable. Class is the categorical or discrete values.

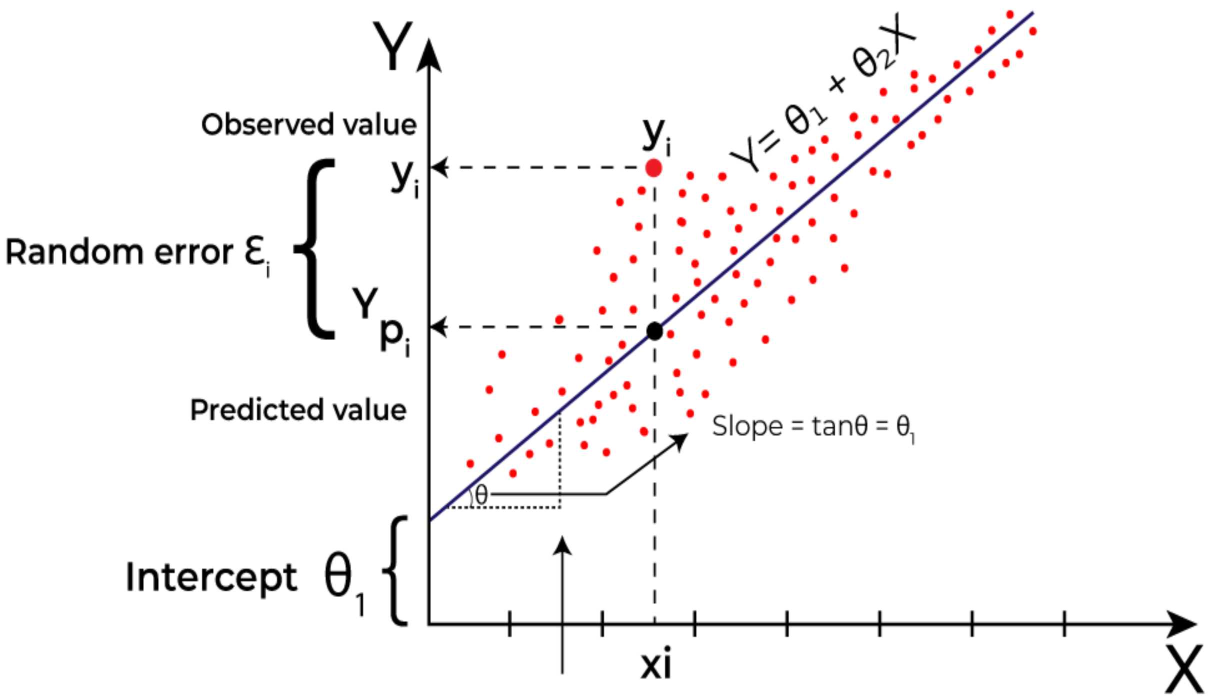
Regression: It predicts the continuous output variables based on the independent input variable. like the prediction of house prices based on different parameters like house age, distance from the main road, location, area, etc.

The interpretability of linear regression is a notable strength. The model's equation provides clear coefficients that elucidate the impact of each independent variable on the dependent variable, facilitating a deeper understanding of the underlying dynamics. Its simplicity is a virtue, as linear regression is transparent, easy to implement, and serves as a foundational concept for more complex algorithms.

Best Fit Line

Our primary objective while using linear regression is to locate the best-fit line, which implies that the error between the predicted and actual values should be kept to a minimum. There will be the least error in the best-fit line.

The best Fit Line equation provides a straight line that represents the relationship between the dependent and independent variables. The slope of the line indicates how much the dependent variable changes for a unit change in the independent variable(s).



Here Y is called a dependent or target variable and X is called an independent variable also known as the predictor of Y. There are many types of functions or modules that can be used for regression. A linear function is the simplest type of function. Here, X may be a single feature or multiple features representing the problem.

The independent feature is the experience i.e, X and Y is the dependent variable. Let's assume there is a linear relationship between X and Y then the salary can be predicted using:

$Y\hat{}=\theta 1+\theta 2X$

OR

$y\hat{}i=\theta 1+\theta 2xi$

5.2 Mean Squared Error

It is simply the average of the square of the difference between the original values and the predicted values.

$$MSE = \frac{1}{N}\sum_{j=1}^{N}(predicted - input)^2$$

Implementation of Mean Squared Error using sklearn:

from sklearn.metrics import mean_squared_error

MSE = mean_squared_error(y_true, y_pred)

CHAPTER 6

IMPLEMENTATION

6.1 SYSTEM DESIGN

6.1.1 Input Design

Input design for a smart farming system using IoT and AI involves determining how data is collected from various sources such as sensors, cameras, drones, and other IoT devices, and how it is processed and utilized for decision-making.

Therefore, the quality of system input determines the quality of system output. Well-designed input forms and screens have following properties –

- It should serve specific purpose effectively such as storing, recording, and retrieving the information.
- It ensures proper completion with accuracy.
- It should be easy to fill and straightforward.
- It should focus on user’s attention, consistency, and simplicity.
- All these objectives are obtained using the knowledge of basic design principles regarding –
    - What are the inputs needed for the system?
    - How end users respond to different elements of forms and screens.

Objectives for Input Design

The objectives of input design are

- Efficient Data Collection
- Comprehensive Data Coverage
- Real-time Data Acquisition
- Data Integration
- Data Quality Assurance

6.1.2 Output Design

Output design for a smart farming system using IoT and AI involves determining how insights, alerts, and recommendations derived from data analysis are presented to farmers and farm managers to facilitate decision-making and improve agricultural operations.

Objectives for Input Design

The objectives of input design are

- Actionable Insights
- Visualization of Data
- Customizable Dashboards
- Real-time Monitoring
- Predictive Analytics

6.1.3 Modules

1. System

1.1 Pre-processing: In this step preprocessing i.e. data cleaning and data filling.

1.2 Training: Use the pre-processed training dataset is used to train our model using our machine learning algorithms.

1.3 Generate accuracy: System generates accuracy for our model and dataset. This tells us how much efficiently model is working.

1.4 Generates results: The results will be displayed.

2. User

2.1 Data collection: The user has to upload data which needs to be classified.

2.2 Model building: User builds the models to fit our data for prediction.

2.3 View Accuracy: Users view the generated accuracy from the system.

2.4 View Results: Users can view the generated classification from the user.

6.2 UML DIAGRAMS

UML stands for Unified Modelling Language. UML is a standardized general-purpose modelling language in the field of object-oriented software engineering. The standard is managed, and was created by, the Object Management Group.

The goal is for UML to become a common language for creating models of object-oriented computer software. In its current form UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with, UML.

The Unified Modelling Language is a standard language for specifying, Visualization, Constructing and documenting the artifacts of software system, as well as for business modelling and other non-software systems.

The UML represents a collection of best engineering practices that have proven successful in the modelling of large and complex systems.

The UML is a very important part of developing objects-oriented software and the software development process. The UML uses mostly graphical notations to express the design of software projects.

6.2.1 GOALS

The Primary goals in the design of the UML are as follows:

1. Provide users a ready-to-use, expressive visual modelling Language so that they can develop and exchange meaningful models.

2. Provide extendibility and specialization mechanisms to extend the core concepts.

3. Be independent of particular programming languages and development process.

4. Provide a formal basis for understanding the modelling language.

5. Encourage the growth of OO tools market.

6. Support higher level development concepts such as collaborations, frameworks, patterns and components.

7. Integrate best practices.

6.2.2 USE CASE DIAGRAM

- A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis.
- Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases.
- The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.

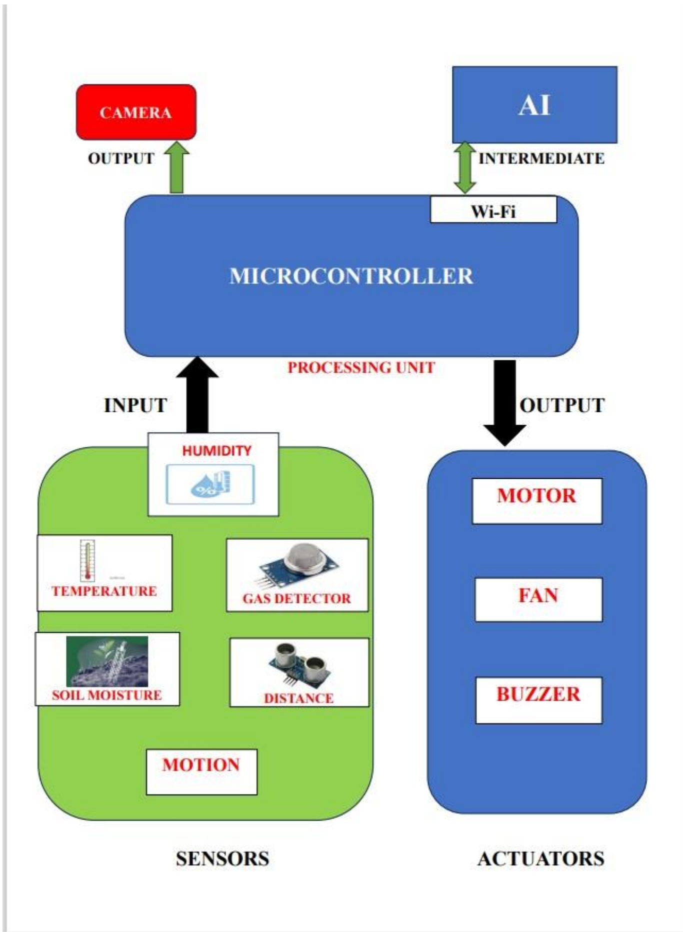


Fig 6.1: Use case diagram

6.2.3 CLASS DIAGRAM

In software engineering, 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 the classes. It explains which class contains information.

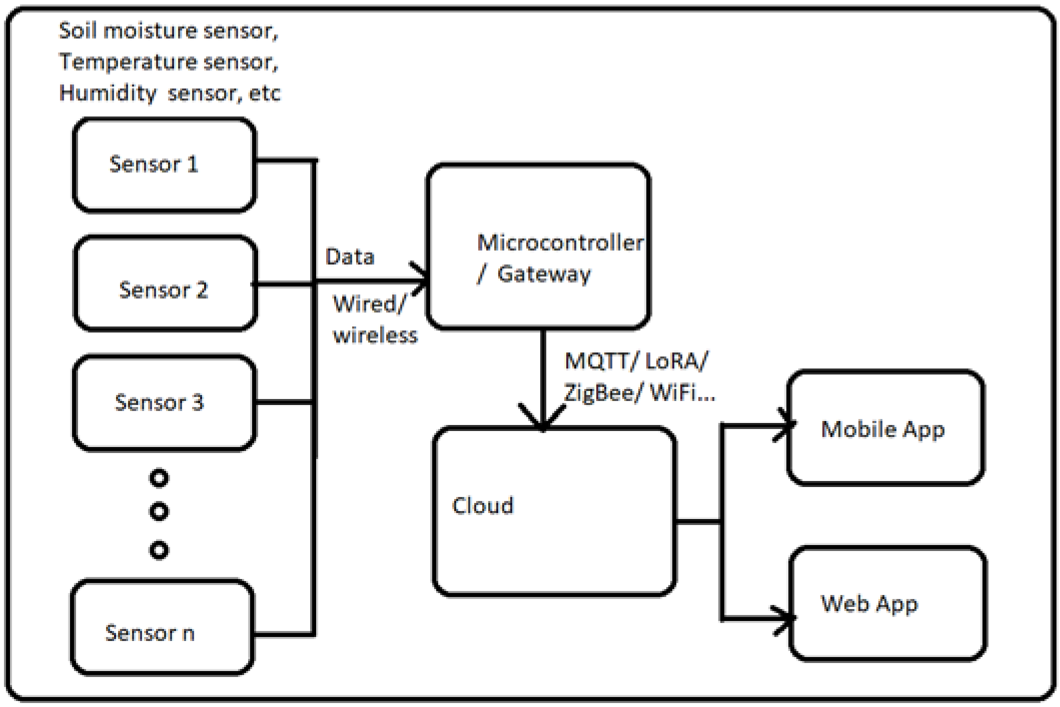


Fig 6.2: Class diagram

6.2.4 SEQUENCE DIAGRAM

- A sequence diagram in Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order.
- It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams

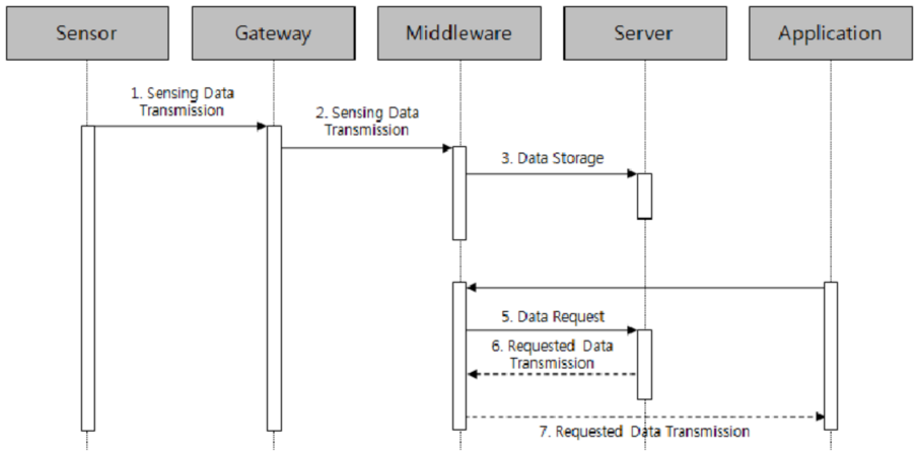


Fig 6.3: Sequence diagram

6.2.5 COLLABORATION DIAGRAM

In collaboration diagram the method call sequence is indicated by some numbering technique as shown below. The number indicates how the methods are called one after another. We have taken the same order management system to describe the collaboration diagram. The method calls are similar to that of a sequence diagram. But the difference is that the sequence diagram does not describe the object organization whereas the collaboration diagram shows the object organization.

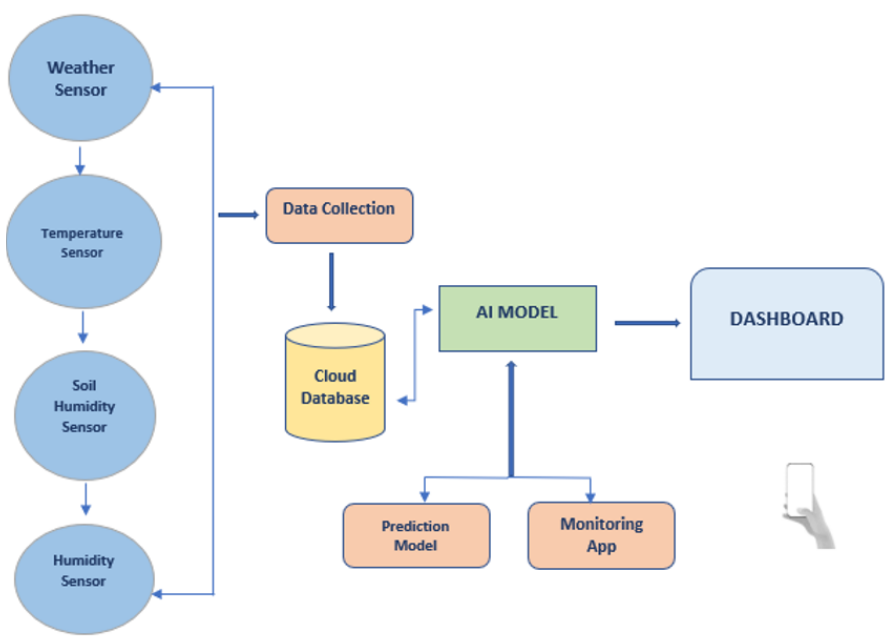


Fig 6.4: Collaboration diagram

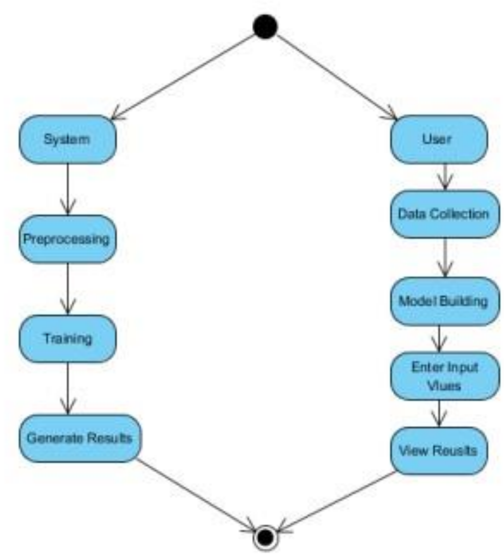
6.2.6 DEPLOYMENT DIAGRAM

Deployment diagram represents the deployment view of a system. It is related to the component diagram. Because the components are deployed using the deployment diagrams. A deployment diagram consists of nodes. Nodes are nothing but physical hardware's used to deploy the application.

Fig 6.5: Deployment diagram

6.2.7 ACTIVITY DIAGRAM

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. In the Unified Modeling Language, activity diagrams can be used to describe the business and operational step-by-step workflows of



components in a system. An activity diagram shows the overall flow of control.

Fig 6.6: Activity diagram

6.2.8 COMPONENT DIAGRAM

A component diagram, also known as a UML component diagram, describes the organization and wiring of the physical components in a system. Component diagrams are often drawn to help model implementation details and double-check that every aspect of the system's required function is covered by planned development.

Fig 6.7: Component diagram

6.2.9 ER DIAGRAM

An Entity–relationship model (ER model) describes the structure of a database with the help of a diagram, which is known as Entity Relationship Diagram (ER Diagram). An ER model is a design or blueprint of a database that can later be implemented as a database. The main components of E-R model are: entity set and relationship set.

An ER diagram shows the relationship among entity sets. An entity set is a group of similar entities and these entities can have attributes. In terms of DBMS, an entity is a table or attribute of a table in database, so by showing relationship among tables and their attributes, ER diagram shows the complete logical structure of a database. Let's have a look at a simple ER diagram to understand this concept.

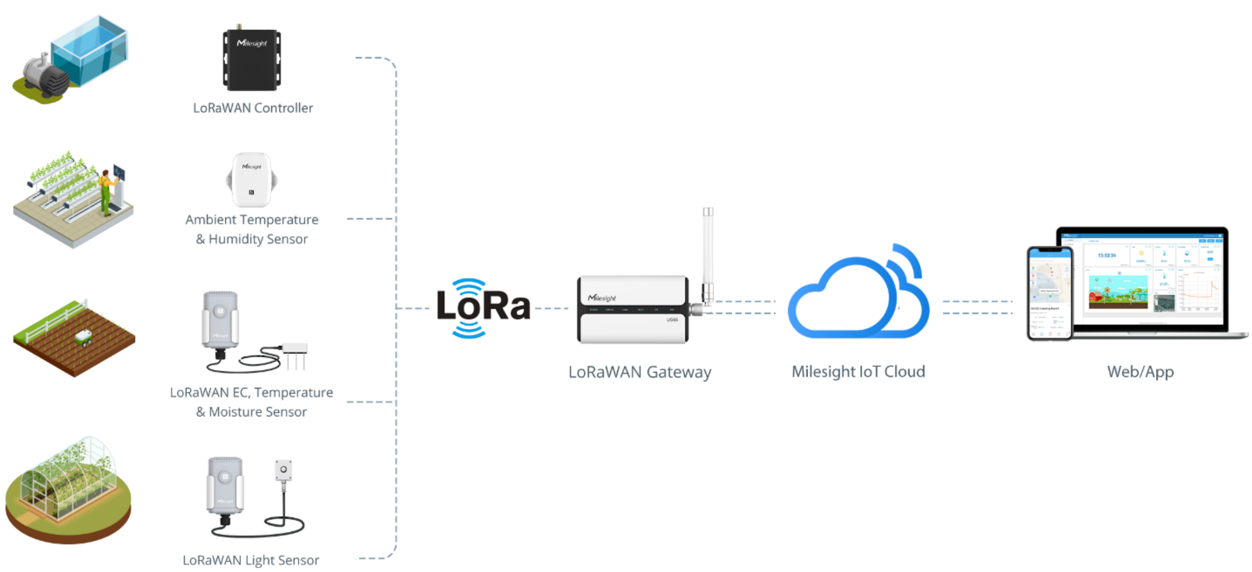


Fig 6.8:ER diagram

6.2.10 DFD DIAGRAM

A Data Flow Diagram (DFD) is a traditional way to visualize the information flows within a system. A neat and clear DFD can depict a good amount of the system requirements graphically. It can be manual, automated, or a combination of both. It shows how information enters and leaves the system, what changes the information and where information is stored. The purpose of a DFD is to show the scope and boundaries of a system as a whole. It may be used as a communications tool between a systems analyst and any person who plays a part in the system that acts as the starting point for redesigning a system.

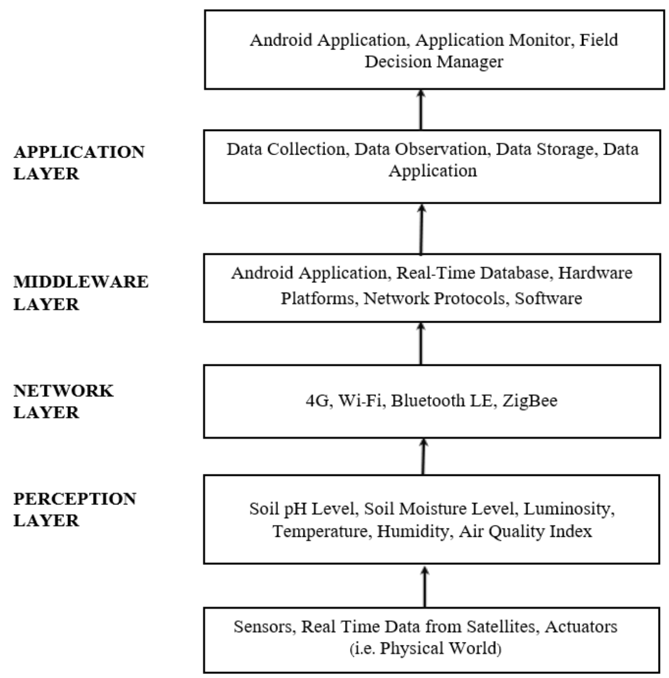


Fig 6.9: DFD diagram

6.3 SOFTWARE DEVELOPMENT LIFE CYCLE – SDLC

- Requirement Gathering and analysis − all possible requirements of the system to be developed are captured in this phase and documented in a requirement specification document.

- System Design − the requirement specifications from first phase are studied in this phase and the system design is prepared. This system design helps in specifying hardware and system requirements and helps in defining the overall system architecture.

- Implementation − with inputs from the system design, the system is first developed in small programs called units, which are integrated in the next phase. Each unit is developed and tested for its functionality, which is referred to as Unit Testing.

- Integration and Testing − All the units developed in the implementation phase are integrated into a system after testing of each unit. Post integration the entire system is tested for any faults and failures.

- Deployment of system − Once the functional and non-functional testing is done; the product is deployed in the customer environment or released into the market.

- Maintenance − There are some issues which come up in the client environment. To fix those issues, patches are released. Also, to enhance the product some better versions are released. Maintenance is done to deliver these changes in the customer environment.

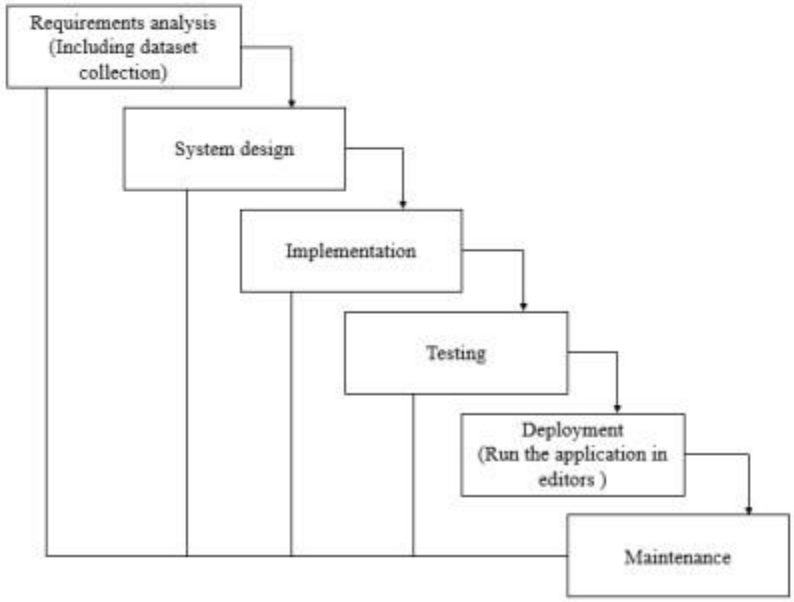
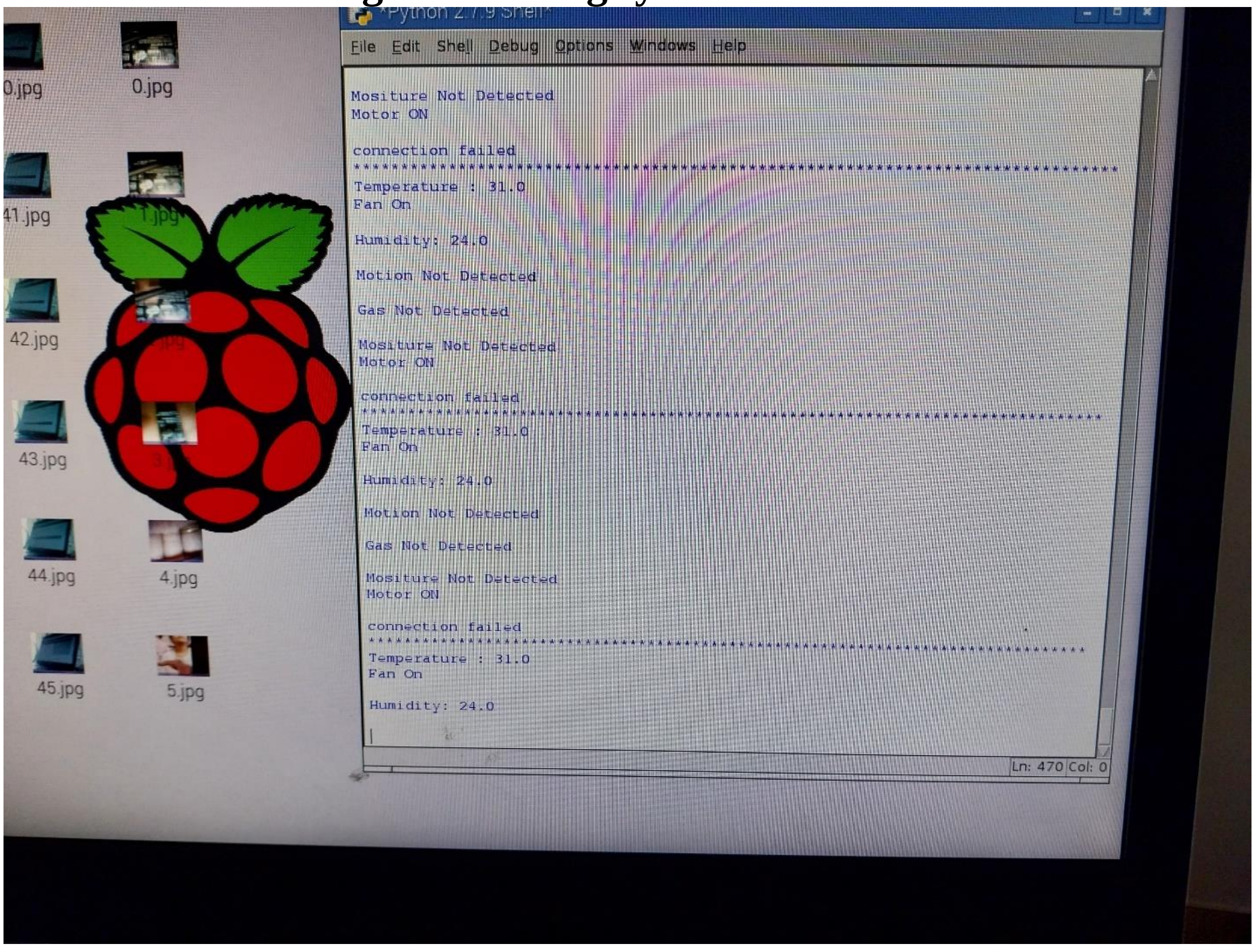


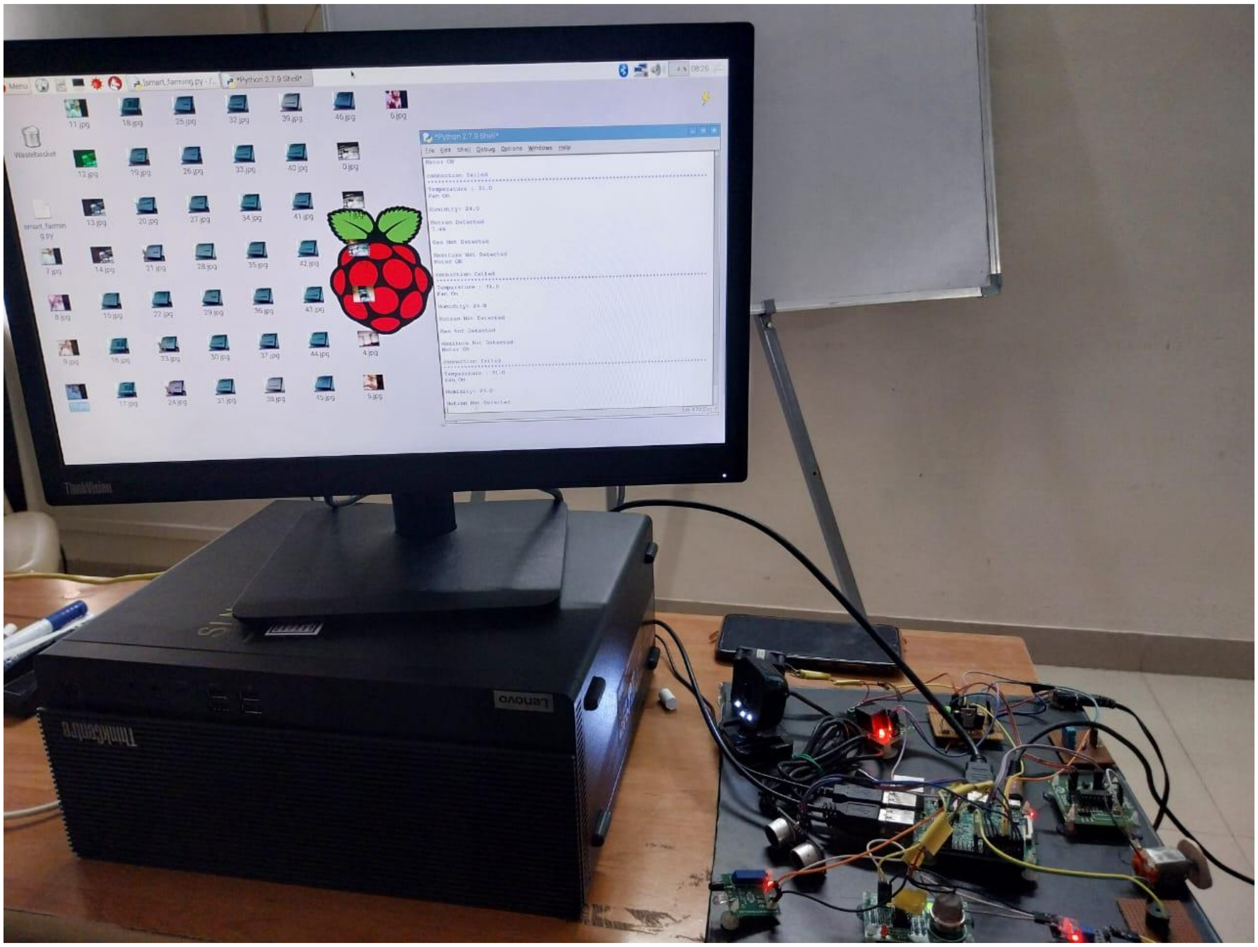
Fig 6.10: Waterfall Model

6.4 SNAP SHOTS

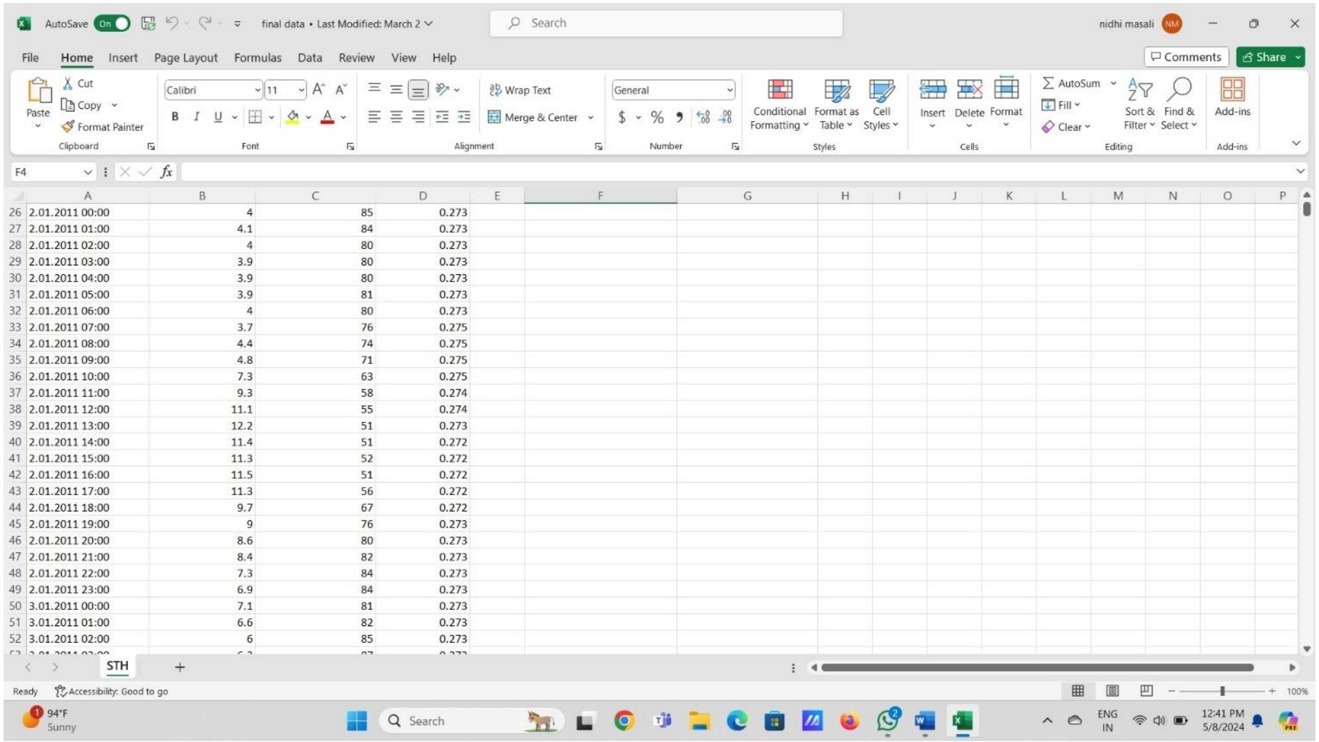
6.4.1 Screen showing the running system results



6.4.2 Screen showing the stored images

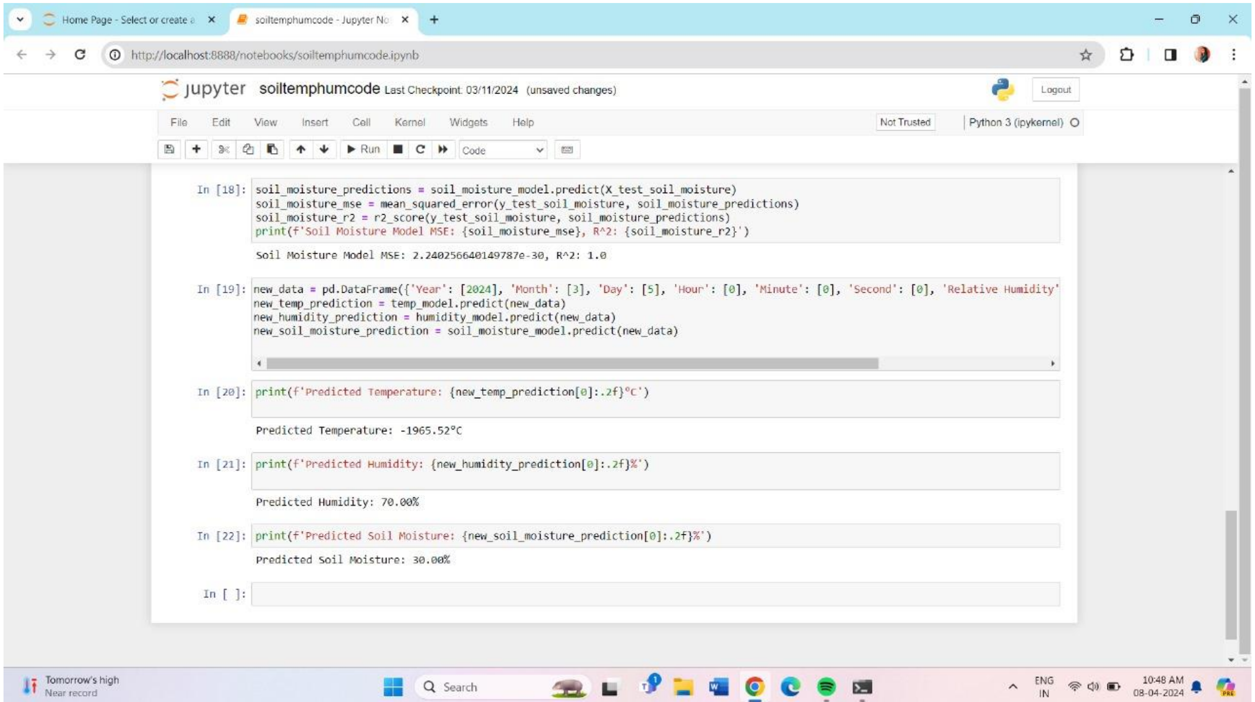


6.4.3 Screen showing the dataset



	A	B	C	D
26	2.01.2011 00:00	4	85	0.273
27	2.01.2011 01:00	4.1	84	0.273
28	2.01.2011 02:00	4	80	0.273
29	2.01.2011 03:00	3.9	80	0.273
30	2.01.2011 04:00	3.9	80	0.273
31	2.01.2011 05:00	3.9	81	0.273
32	2.01.2011 06:00	4	80	0.273
33	2.01.2011 07:00	3.7	76	0.275
34	2.01.2011 08:00	4.4	74	0.275
35	2.01.2011 09:00	4.8	71	0.275
36	2.01.2011 10:00	7.3	63	0.275
37	2.01.2011 11:00	9.3	58	0.274
38	2.01.2011 12:00	11.1	55	0.274
39	2.01.2011 13:00	12.2	51	0.273
40	2.01.2011 14:00	11.4	51	0.272
41	2.01.2011 15:00	11.3	52	0.272
42	2.01.2011 16:00	11.5	51	0.272
43	2.01.2011 17:00	11.3	56	0.272
44	2.01.2011 18:00	9.7	67	0.272
45	2.01.2011 19:00	9	76	0.273
46	2.01.2011 20:00	8.6	80	0.273
47	2.01.2011 21:00	8.4	82	0.273
48	2.01.2011 22:00	7.3	84	0.273
49	2.01.2011 23:00	6.9	84	0.273
50	3.01.2011 00:00	7.1	81	0.273
51	3.01.2011 01:00	6.6	82	0.273
52	3.01.2011 02:00	6	85	0.273

6.4.4 Screen showing the AI running system results



CHAPTER 7

APPLICATIONS

Optimization of Water and Fertilizers:

• **Precision Irrigation:** IoT sensors in the field monitor soil moisture levels and weather conditions, allowing for precise and automated irrigation. This minimizes water wastage and ensures optimal soil moisture for crops.

• **Fertilizer Management:** AI algorithms analyze data from soil sensors and satellite imagery to determine the exact nutrient requirements of crops, leading to efficient and targeted fertilizer application, reducing runoff into waterways.

• **Data-Driven Decision Making:** Crop Selection and Management: AI can analyze local environmental conditions, weather patterns, and market trends to advise farmers on the best crops to plant for maximum yield and profitability.

• **Yield Prediction:** Predictive models can forecast crop yields, helping farmers and stakeholders in planning and resource allocation.

• **Productivity Enhancement Through Automation:** Automated Equipment: Tractors, drones, and robotic systems can perform tasks like planting, weeding, and harvesting, increasing efficiency and reducing the need for manual labor.

• **Crop Monitoring and Management:** Continuous monitoring of crop growth and health using sensors and AI ensures optimal growth conditions and timely interventions.

• **Labor-Intensive Task Automation:** Tasks like weeding, spraying, and picking that traditionally require significant labor can be automated, reducing the labor cost and addressing labor shortages.

• **Remote Farm Management:** Farmers can monitor and manage their farms remotely using smartphones or computers, saving time and effort in field visits.

• **Soil Conservation:** IoT and AI can monitor soil health, suggesting practices to prevent erosion and degradation.

CHAPTER 8

CONCLUSION

In conclusion, leveraging AI, IoT, and big data analytics offers a transformative solution for addressing the challenges faced by the agricultural sector in India. By integrating these technologies into environmental monitoring and forecasting systems, stakeholders can gain valuable insights to optimize resource allocation, mitigate risks, and enhance resilience in the face of changing environmental conditions.

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