A Project Report on

Kisaan Dost:A Comprehensive ML and IoT based Web Framework for Smart Agriculture

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Engineering

in

Information Technology

by

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Academic Year 2023-2024

Approval Sheet

This Project Report entitled ***"Kisaan Dost: A Comprehensive ML and IoT-based Web Framework for Smart Agriculture"*** Submitted by ***"Adarsh Singh" (20104080), "Kanan Sananse"(20104125), "Shruti Pinjarkar"(20104016)***is approved for the partial fulfillment of the requirenment for the award of the degree of ***Bachelor of Engineering*** in ***Information Technology*** from ***University of Mumbai***.

Prof. Sonal Jain
Guide

Dr. Kiran Deshpande
HOD, Information Technology

Place:A.P.Shah Institute of Technology, Thane
Date:

CERTIFICATE

This is to certify that the project entitled ***"Kisaan Dost:A Comprehensive ML and IoT based Web Framework for Smart Agriculture"*** submitted by ***"Adarsh Singh" (20104080),"Kanan Sananse" (20104125),"Shruti Pinjarjar" (20104016)*** for the partial fulfillment of the requirement for award of a degree ***Bachelor of Engineering*** in ***Information Technology***,to the University of Mumbai,is a bonafide work carried out during academic year 2023-2024.

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Date:

Acknowledgement

We have great pleasure in presenting the report on **Kisaan Dost: A Comprehensive ML and IoT-based Web Framework for Smart Agriculture.** We take this opportunity to express our sincere thanks towards our guide **Prof. Sonal Jain** for providing the technical guidelines and suggestions regarding line of work. We would like to express our gratitude towards his constant encouragement, support and guidance through the development of project.

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, We have adequately cited and referenced the original sources. We also declare that We have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Date:

Abstract

More than 70 percent of rural families in India depend on agriculture for their living, highlighting its vital role in the country's economy. The agriculture industry is an important part of India's economy, contributing around 17 percent to GDP. Because farmers don't have up-to-the-minute information about soil acidity, the proportion of different soil contents (such as nitrogen, phosphorus, and potassium), soil moisture, and other environmental factors, inefficient farming practices lead to a decrease in overall crop yield. We will be developing the web-framework "Kisaan Dost" based on Machine Learning (ML), the Internet of Things (IoT), and real-time data analytics to address the issues of underproduction, overfertilization, and soil quality deterioration. Using the hardware module, the proposed system will be able to extract data about soil quality and environmental parameters in real-time from the farm field. This data will then processed and sent to cloud and fog computing servers through wireless communication between the gateway and the servers. Utilizing technologies such as real-time data analytics and machine learning, valuable insights are being derived regarding how much fertilizer to apply to soil in order to maintain its quality and optimize crop growth. These insights can then be used to make informed decisions about farming, such as which crops are best suited to specific climates and soil types, and how to maximize crop yields. In order to support optimal crop yield, the proposed system encourages environmentally friendly approaches to different farming techniques and makes it easy for many stakeholders in the agricultural industry to access the information insights that are created.

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List of Abbreviations

DFD: Data Flow Diagram
IOT: Internet of Things
GDP: Gross Domestic Product
EDA: Exploratory Data Analysis
ML: Machine Learning
AI: Artificial Intelligence
GUI: Graphical User Interface
ANN: Artificial neural networks
DHT11: Digital Temperature And Humidity Sensor
LDR: Light Dependent Resistor

Chapter 1

Introduction

Agriculture is considered to be one of the major sectors in the Indian economy as it contributes 20.19 percent in India's total GDP, and approximately more than 60 percent of the Indian population is engaged in agriculture and other allied activities like animal husbandry for their living. The idea is to develop IOT integrated system (BHU PARIKSHAK) to overcome problem of under productivity, overfertilization and soil quality degradation. BHU PARIKSHAK is enabled with various environmental and soil quality parameter sensing modules which are utilized to sense and extract on-field data instances. System is inter-connected with fog computing server to store and compute data instances.Data instance from server is passed as an Input parameter to ML model being deployed over Flask and BI tool from where Feature evaluation and Data visualization task is undertaken. Server is also integrated with Kisaan Dost web-app to access the visuals of knowledge report insights.

1.1 Motivation

The main motivation behind this project is to empower farmers and users to effectively monitor their crops or cultivation areas, ensuring that plants receive the necessary resources, such as light and water, without the need for constant physical presence. By integrating advanced sensor technology and automation, this system aims to create a self-sustaining environment for plants, making it possible to adjust resource allocation based on real-time data and climatic conditions. This approach offers several key advantages. Firstly, it alleviates the burden of daily, manual resource management for farmers, allowing them to focus on other essential aspects of farming and reducing the risk of human error in resource allocation. Secondly, it ensures that plants receive a consistent and optimal supply of resources, which is crucial for their healthy growth. The incorporation of soil sensors, for instance, enables the system to detect soil moisture levels and respond accordingly. If the sensors indicate sufficient moisture due to natural rainfall, the system can adjust the watering schedule or even skip watering altogether, saving resources and preventing over-watering, which can be detrimental to plant health. On the other hand, if the sensors detect a lack of moisture, the system can initiate watering automatically to maintain the ideal soil conditions. In essence, this project aims to create a smart and self regulating cultivation environment that maximizes resource efficiency, minimizes manual effort, and ultimately leads to consistent and healthy plant growth. It not only benefits individual users and farmers but can also contribute to sustainable and responsible agricultural practices on a larger scale.

1.2 Problem Statement

- Uncontrolled and Large-Scale Manual Interference:
  Unregulated farming practices often include excessive plowing, overuse of pesticides and herbicides, and poor irrigation management. The utilization of these methods may pose risks to natural ecosystems, soil quality, and ultimately impact productivity and agricultural yields. Implementing procedures consistently without considering site-specific factors is a common issue in large-scale manual interference.

- Lack of Real-Time Soil Quality Information:
  A major problem faced is the absence of current data on elements of soil quality, like moisture content, nutrients, pH level and also the parameter like required temperature and humidity. Without a comprehensive understanding of the soil, farmers face challenges in effectively applying fertilizers and other inputs, resulting in resource wastage. This leads to an imbalance in fertilization, resulting in decreased agricultural productivity.

- Under Fertilization:
  Inadequate access to up-to-date information on soil quality often results in insufficient fertilization, causing crops to be deprived of the essential nutrients necessary for their optimal growth. This leads to a decrease in agricultural productivity, which directly affects farmers' income and raises concerns about the safety of food. Inadequate supply of essential nutrients for optimal crop growth and productivity may result in reduced agricultural yields, decreased farmer income, and potential food security issues.

1.3 Objectives

- To enable controlled optimization of crop growth and farm yields, parallelly maintaining Soil quality through generated insights regarding various in-field parameters using Data extraction modules and evaluation model.
- To help farmers to grow plants under controlled climatic conditions for optimum produce using simple reflex based AI model utilized in automated irrigation system.
- To get an insights of knowledge report regarding factors affecting plant growth, thus helping stakeholders take informed decisions of farming practices using Power BI.
- To overcome the problem of over or under fertilization which is major concern for soil quality maintenance using Machine Learning Model.

1.4 Scope

- Can be a Farming Companion as real-time data on weather, pests, and crop health, aiding farmers in making informed decisions for better yields.

- Can be used to evaluate EDA analysis to study various constraint dependencies for optimal yield production.

- Can be used for soil health insights as by providing recommendations to maintain or enhance soil quality for sustainable farming.

- Can be used for visualizing crop parameters as user-friendly visuals will illustrate how factors like temperature, humidity, light intensity and soil moisture impact crop growth, facilitating data-driven decisions.

- Can be used for Automated Irrigation with Simple-Reflex AI by Deploying sensors, AI automates irrigation by triggering it based on real-time conditions, conserving water and ensuring crops receive optimal moisture.

Chapter 2

Literature Review

Review Paper 1[1]: Agro Farming using Machine Learning

In the agriculture sector, the farmers and Agro-businesses make many decisions which include factors influencing them. The main intention for agricultural planning is the accurate yield estimation for various crops. Data mining techniques implemented in Machine learning using Python are the approach for accomplishing practical and effective solutions for this problem. Environmental conditions, variability in soil, input levels, combinations, and commodity prices have made it all the more relevant for farmers to use the data and acquire help to create critical farming decisions. This paper focuses on the analysis of the agriculture data and finding optimal parameters to maximize crop production using Machine Learning. Issues like scarcity of water, natural calamities, usage of poisonous chemicals like pesticides and fertilizers for safeguarding crops are taken care of while developing this project. This paper also focuses on getting the correct fertilizers and pesticides to fight back attackers.

Review Paper 2[2]: IOT Based Smart Agriculture Monitoring System

The agriculture sector is facing numerous challenges such as water scarcity, climate change, and low productivity due to outdated farming practices.This paper proposes an IOT Based Smart Agriculture Monitoring System aimed at increasing agricultural productivity by automating and optimizing crop management. The system uses various sensors to monitor environmental conditions in real-time. The data collected is processed by a microcontroller and transmitted wirelessly to a web application that provides farmers with visualized information about their crops. The system is designed to be affordable and easy to use, allowing farmers to monitor their crops remotely and take necessary actions to optimize their growth. By providing farmers with real-time data on their crops, the system can help them make informed decisions regarding water and fertilizer usage, pest control, and harvesting times. This, in turn, can lead to increased crop yields, reduced costs, and improved profitability.

Review Paper 3[3]: Smart Agriculture Monitoring and Control System Using IOT

Agriculture provides a wealth of data analysis parameters, resulting in increased crop yields. The use of IoT devices in smart farming aids in the modernization of information and communication. For better crop growth moisture, mineral, light and other factors can be assumed. This research looks into a few of these characteristics for data analysis with the goal of assisting users in making better agricultural decisions using IoT. The technique is intended to help farmers increase their agricultural output.

Review Paper 4[4]: Machine Learning Approaches for Smart Agriculture

India's agricultural sector is an essential component of the country's economy. More over half of the population in India relies on agriculture. This is high time that the Country needs to focus on improvisation in the smart agriculture. Machine learning is the wide perspective technique which is massively occupying its role in many of the worldwide areas.The system in this paper proposes learning of the agricultural field includes plant management, crop and yield management, soil management, disease management, weed management, water management, animal tracking etc., Full Farm management can be improved further by using Machine Learning to sensor data Artificial Intelligence system Application which provides more suggestions in decision making. Plant management system can be improved by adopting ANN based Machine learning Algorithm. For crop, soil and weed management, ML open ups many opportunities by improving the data collection. A defined data collection of the agro-farm is flexible enough to work efficiently in ML platform.

Review Paper 5 [5]: Farming Guru: - Machine Learning Based Innovation for Smart Farming

According to Census of India, the Indian population would grow in leaps and bound in near future i.e. by 2025, whereas agricultural lands will record up to 4 percent only. Thus, this paper describes an app "Farming guru" " which will help farmers in effective farming, by making them smarter. Diverse seasons, market and atmosphere influence the production of crop, but changes in these factors account in major loss to a farmer. These factors can be reduced by using this app which comprises of five major sectors namely, Crop analysis, accurate weather forecast, learning (ML) based approach related to the knowledge of humidity, zones of cultivation, atmospheric conditions along with pressure and suitable market for crops beforehand. Knowing weather before cultivation can protect farms as well as farmers from huge losses. The current paper anticipates a model and system design to not only analyze crops and weather but also help the farmers in managing finances by providing an opportunity to trade their tools for extra income as well as mange their income by providing a budget calculator.

Chapter 3

Project Design

3.1 Existing System

In today's world, the majority of agricultural businesses continue to use antiquated methods, which often lead to poor yields and significant waste of resources. Despite the fact that certain Internet of Things-based agricultural systems have been established, these systems often focus on particular activities such as crop management or soil monitoring. The limited integration of these technologies across a variety of agricultural operations is the cause of the incomplete information that these technologies may provide. In addition, the conventional agricultural data analytics and visualization technologies typically lack the capability to operate in real time and are not well-suited to deal with the complicated problems that farmers encounter. It is necessary to have a cutting-edge system that makes use of the Internet of Things in order to link environmental and soil quality monitoring modules in a smooth manner in order to give an integrated response to the different challenges that are now being faced by agriculture.

3.2 Proposed System

Integrated sensor nodes are used to extract a variety of in-field data and soil quality information. These modules gather important data in real-time from the agricultural environment. the collected data is then transmitted to Gateway using wired communication.

The data is then transferred to data preprocessor for converting the data in required format and structure. The data then is transmitted to deployed fog computing server, from there the data instances is passed as an input feature to deployed ML model is cloud which is utilized for generating output insights which is presented in web application (Kisaan Dost) dashboard for ease to access of information to various farming stakeholders for supporting informed decision making approach in various farming practices.

The cloud Server is used to visualize data instances, giving a graphical representation of the in-field and soil quality characteristics. The data variances are thoroughly examined, which are displayed in a variety of field charts. For effective organization and future use, the retrieved data is kept on a database server. The saved data is an input feature for the machine learning (ML) model. The machine learning model generates output characteristics that provide insight's analysis after processing the input. The online Kisaan Dost application incorporates the ML model's output features.

Farmers and other stakeholders get real-time insights and predictions produced from processed data through the online application. The ML Algorithm used in this system is Random Forest which uses random subsets of training data and characteristics to create several decision trees. Real-time data from IoT devices gathers details about a range of agriculturally important parameters, including temperature, humidity, light intensity, and soil pH, soil nutrients and moisture. This data is used as the system's testing dataset. From the IoT data, few features are then chosen. These could include temperature, quality of the soil, and other elements of the environment that affect crop growth..
The random forest is trained using historical data from multiple sources. A distinct subset of this historical data is used to train each decision tree in the forest, taking into account various feature combinations. Through this approach, the random forest is able to identify patterns and connections between favourable crop outcomes and environmental conditions.
The trained random forest is then supplied with real-time data from the Internet of Things sensors. A prediction is made by each decision tree in the forest using the input features. In a classification job, the decision tree with the majority vote determines the final forecast. In a regression task, the average of each tree's individual predictions is the final prediction.
Based on the output of the random forest, the best crops suitable for that particular environment are suggested. For example, it will advise planting wheat, for instance, if the majority of the trees indicate that the weather is suitable for growing wheat.
The system adjusts to changed environmental conditions since it makes use of real-time data from IoT devices. Based on the most recent data, the random forest can immediately modify its recommendations in the event of a sudden increase in temperature or decrease in any soil nutrients and pH levels.
The web framework also includes the weather report of the particular location and the assistance (chatbot) medium which will help the farming stakeholders to interact with AI and find answers for their agriculture related queries.
Real-time data analytics is being utilized to empower farmers with the tools and knowledge necessary to enhance crop productivity, optimize resource utilization, food security, and promote sustainable and environment friendly approach in farming practices.
Sensors placed in field monitor the crops for changes in light, humidity, temperature, etc. Any anomaly detected by the sensors is analyzed, and the farmer is notified. Thus, remote sensing and real-time data analytics can help prevent the spread of diseases in crops and keep an eye on the growth of crops.

3.2.1 Critical Components of System Architecture

- Integrated Sensor Nodes: Responsible for collecting real-time in-field data and soil quality information from the agricultural environment and farm field.
- IoT Device: Gather real-time data on agriculturally important parameters such as temperature, humidity, light intensity, soil pH.
- Fog Computing Server: Receives and processes data instances, acting as an intermediary between sensor nodes and the cloud server.
- Cloud Server: Utilized for deploying machine learning models, generating output insights, and visualizing data instances on the Kisaan Dost web application dashboard.

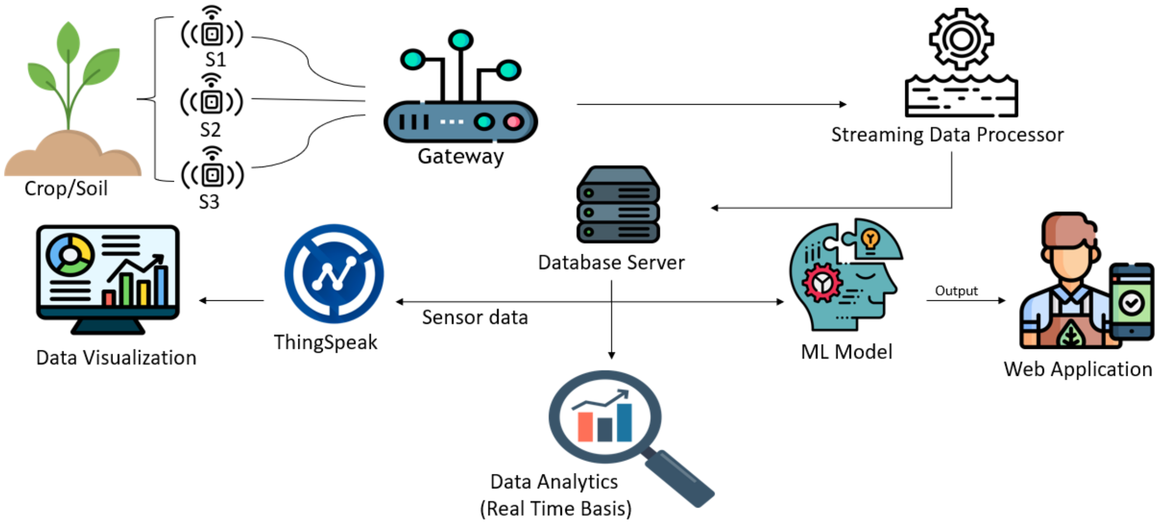


Figure 3.1: System Architecture

- Machine Learning (ML) Model (Random Forest): Used for analyzing data and making predictions based on historical and real-time data from IoT devices.
- Database Server: Stores retrieved data for future use and as input features for the ML model.
- Web Application (Kisaan Dost): Provides a user-friendly interface for farmers and stakeholders to access real-time insights, predictions, and weather reports, as well as interact with AI through a chatbot.
- Real-Time Data Analytics: Empowers farmers with tools and knowledge to enhance crop productivity, optimize resource utilization, ensure food security, and promote sustainable farming practices.

3.3 System Diagrams

3.3.1 Activity Diagram

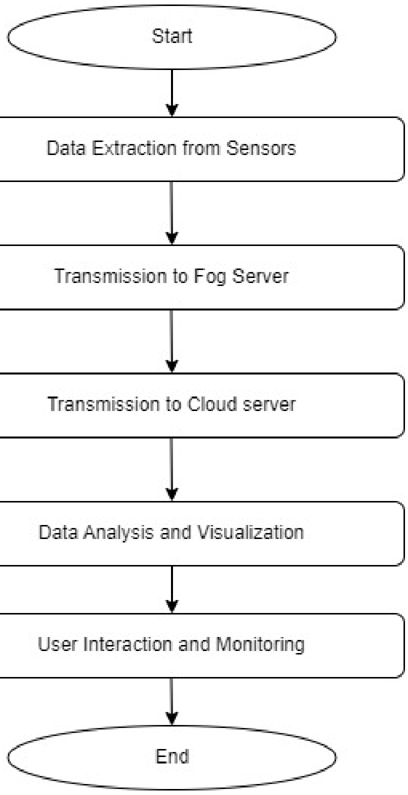


Figure 3.2: Activity Diagram

- The initial step is where the process begins.
- In second step, data is collected from various sensors deployed in the field. They collect real-time data of the factors affecting crop yield.
- Once the data is collected from the sensors, it is transmitted to a fog server. Fog computing involves processing data at the edge of the network, closer to where it is generated, rather than sending it to a centralized cloud server.
- Data from the fog server is sent to the cloud server for deeper analysis and long-term storage, leveraging its enhanced resources and capabilities.
- Next, data at the cloud server is analyzed for patterns, trends, and predictive modeling. Visualization techniques like graphs and dashboards are used for user-friendly data presentation.
- After data analysis and visualization, users interact with the system via dashboards and accessing historical data for informed decision-making based on sensor network data.
- The final step of the process, indicates the completion of the activity diagram.

3.3.2 Use Case Diagram

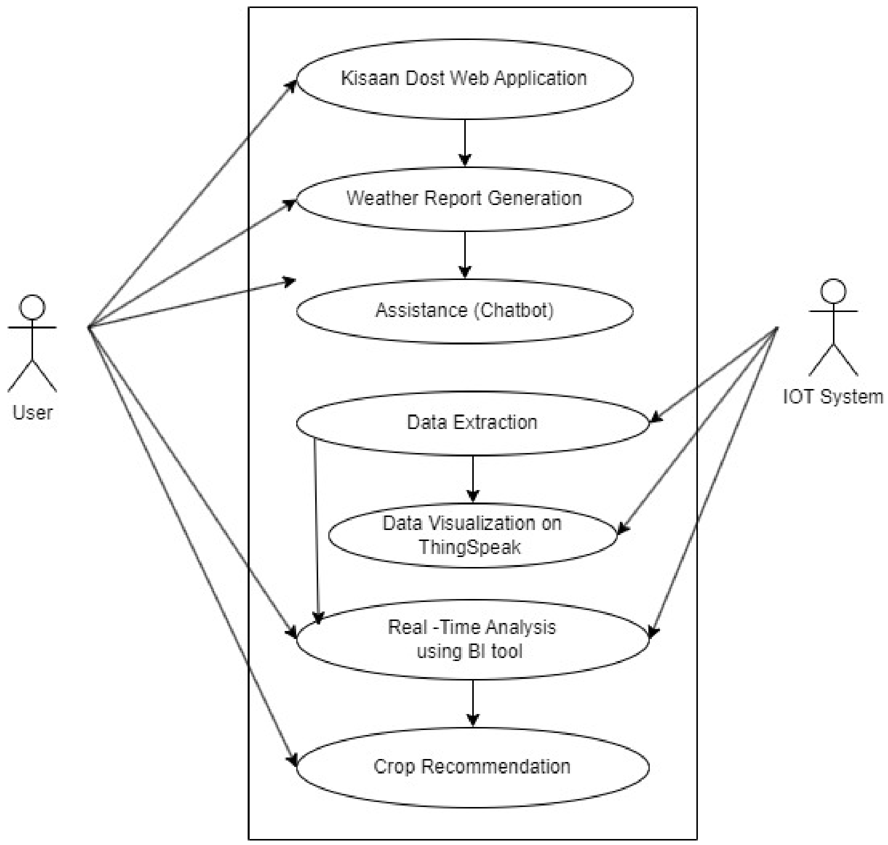


Figure 3.3: Use Case Diagram

- In the use case diagram shown above, there are two actors i.e. User and the IOT system.
- The user farmer is able to access the Kisaan Dost web application (GUI).
- Then the user has the access to the weather report generated which is location specific.
- The user can also get assistance regarding any query on agriculture.
- The IOT System is the other actor which is used for the extraction of data.
- The data that is extracted is then visualized on the ThingSpeak cloud server.
- The data analysis is done using the BI tool to gain knowledge and insights about the crop yield production.
- The crop recommendation system is also included to which provides user with proper crop recommendation.

Chapter 4

Project Implementation

4.1 Code Snippets

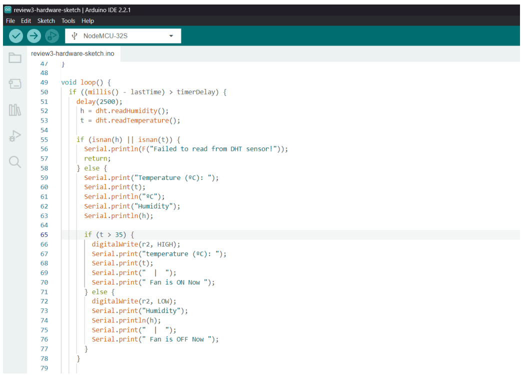


Figure 4.1: Arduino IDE code 1

This code define the logic which controls the functioning of the actuators depending on the sensor values.

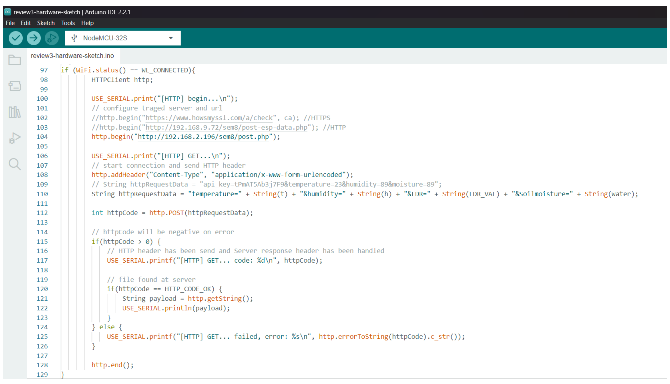


Figure 4.2: Arduino IDE code 2

This figure includes the code through which the data is sent to the database server through http transmission protocol.

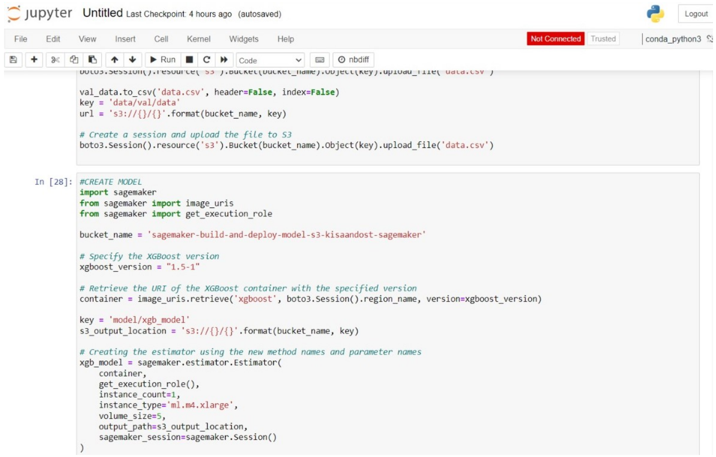


Figure 4.3: ML Model Creation

This includes the code of ML Model creation.

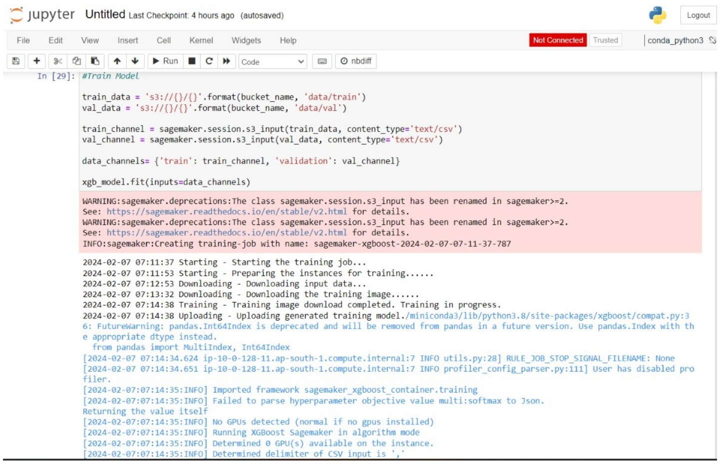


Figure 4.4: Training of ML Model

This includes the code of training ML Model.

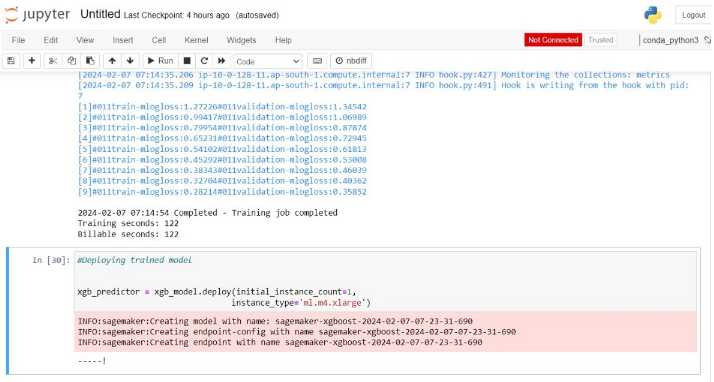


Figure 4.5: Deploy trained ML Model

This includes the deployment of trained ML Model.

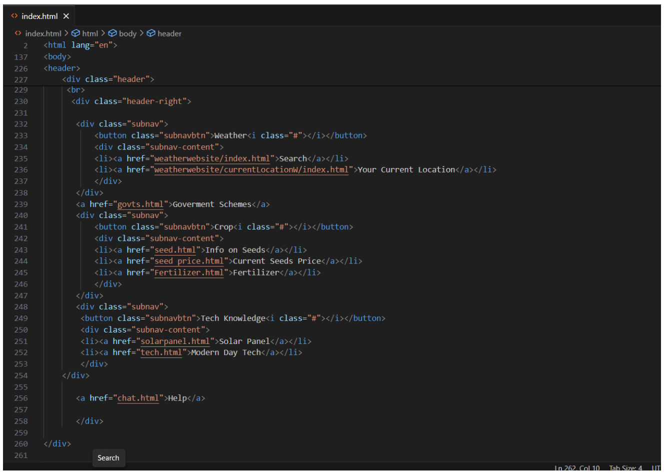


Figure 4.6: Web-Application Home Page

This includes the code of the home page of the Web Framework (Kisaan Dost)

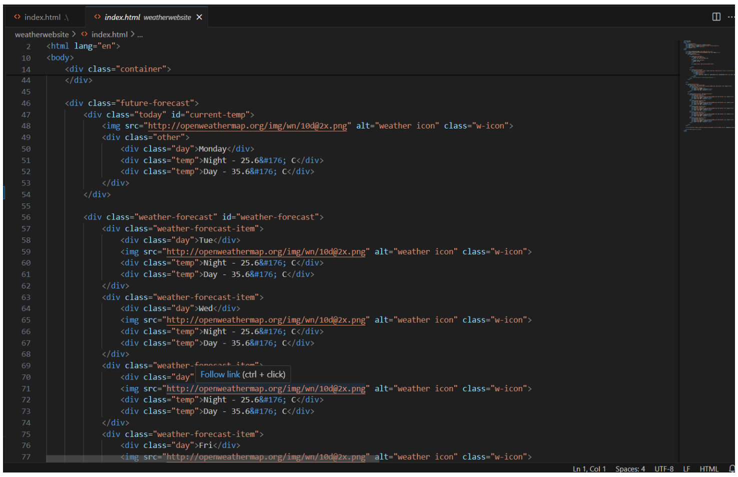


Figure 4.7: Weather report Generation

This includes the code of the weather report generated based on specific Geo-location using API.

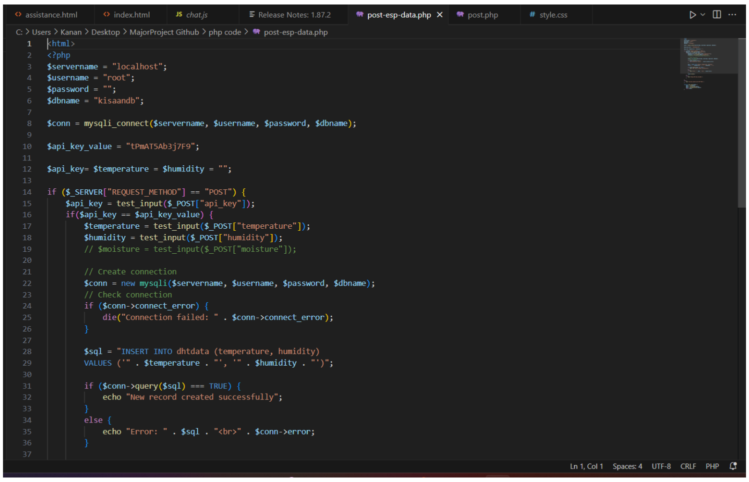
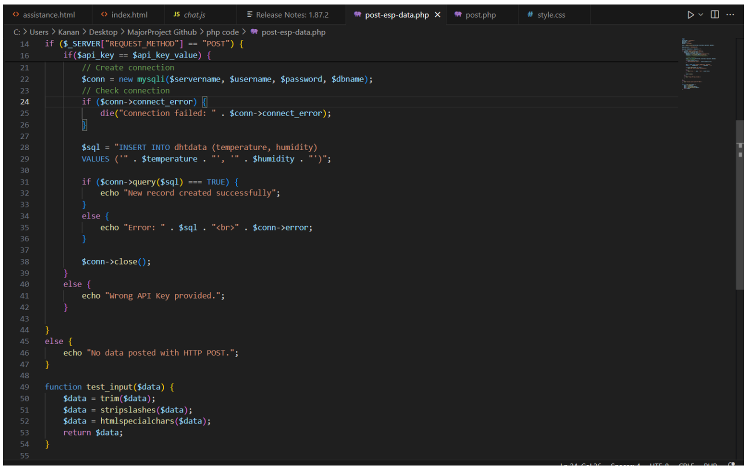


Figure 4.8: Establishing connection

This code includes the connection establishment with the database server.



```php
if ($_SERVER["REQUEST_METHOD"] == "POST") {
    if($api_key == $api_key_value) {
        // Create connection
        $conn = new mysqli($servername, $username, $password, $dbname);
        // Check connection
        if ($conn->connect_error) {
            die("Connection failed: " . $conn->connect_error);
        }

        $sql = "INSERT INTO dhtdata (temperature, humidity)
        VALUES ('" . $temperature . "', '" . $humidity . "')";

        if ($conn->query($sql) === TRUE) {
            echo "New record created successfully";
        }
        else {
            echo "Error: " . $sql . "<br>" . $conn->error;
        }

        $conn->close();
    }
    else {
        echo "Wrong API Key provided.";
    }

}
else {
    echo "No data posted with HTTP POST.";
}

function test_input($data) {
    $data = trim($data);
    $data = stripslashes($data);
    $data = htmlspecialchars($data);
    return $data;
}
```

Figure 4.9: SQL Query for storing data

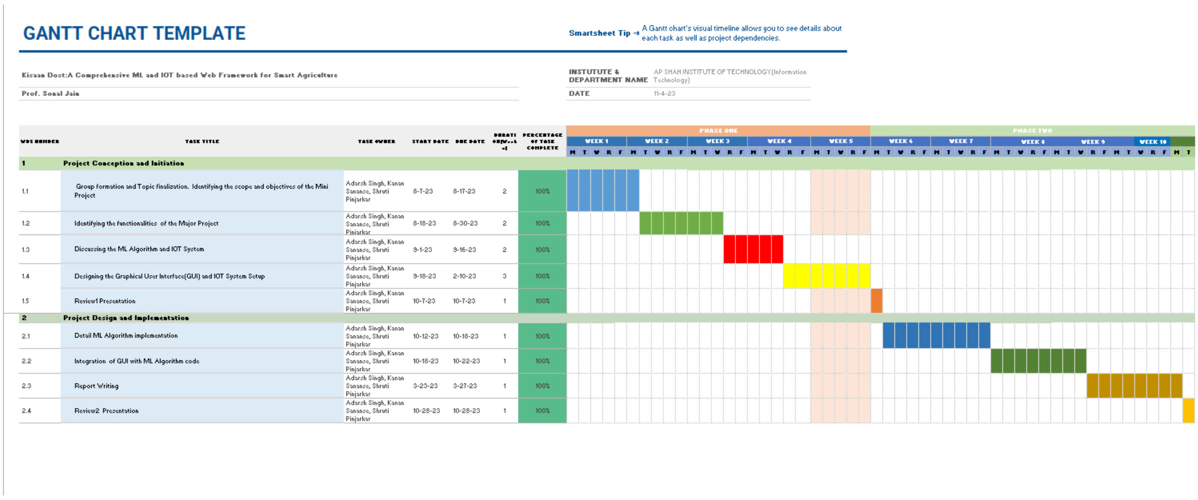
This code includes the queries to store the collected data in database .

4.2 Steps to access the System

Our project, Kisaan Dost , is developed using HTML, CSS, and JavaScript. HTML and CSS contribute to the frontend design, while JavaScript serves to connect the backend components. Visual Studio Code is the chosen development environment, and for sensor programming, C programming within the Arduino IDE is employed. To access our project, follow these steps:

- Step 1 : Open Visual Studio Code.
- Step 2 : Navigate to the KISAANDOST folder.
- Step 3 : Utilize the Go Live feature in VS Code to access the website.
- Step 4 : Access the website for gaining knowledge about agriculture and the weather conditions.
- Step 5 : Explore and utilize the website as needed.
- Step 6 : Open BI dashboard for data analysis for gaining insights.

4.3 Timeline Sem VIII


GANTT CHART TEMPLATE

Smartsheet Tip → A Gantt chart's visual timeline allows you to see details about each task as well as project dependencies.

Kisaan Dost:A Comprehensive ML and IOT based Web Framework for Smart Agriculture

Prof. Sonal Jain

INSTUTUTE & DEPARTMENT NAME: AP SHAH INSTITUTE OF TECHNOLOGY(Information Technology)

DATE: 11-4-23

WBS NUMBER	TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION[Week]	PERCENTAGE OF TASK COMPLETE
1	Project Conception and Initiation					
1.1	Group formation and Topic finalization. Identifying the scope and objectives of the Mini Project	Adarsh Singh, Kanan Sananse, Shruti Pinjarkar	8-7-23	8-17-23	2	100%
1.2	Identifying the functionalities of the Major Project	Adarsh Singh, Kanan Sananse, Shruti Pinjarkar	8-18-23	8-30-23	2	100%
1.3	Discussing the ML Algorithm and IOT System	Adarsh Singh, Kanan Sananse, Shruti Pinjarkar	9-1-23	9-16-23	2	100%
1.4	Designing the Graphical User Interface(GUI) and IOT System Setup	Adarsh Singh, Kanan Sananse, Shruti Pinjarkar	9-18-23	2-10-23	3	100%
1.5	Review1 Presentation	Adarsh Singh, Kanan Sananse, Shruti Pinjarkar	10-7-23	10-7-23	1	100%
2	Project Design and Implementation					
2.1	Detail ML Algorithm implementation	Adarsh Singh, Kanan Sananse, Shruti Pinjarkar	10-12-23	10-18-23	1	100%
2.2	Integration of GUI with ML Algorithm code	Adarsh Singh, Kanan Sananse, Shruti Pinjarkar	10-18-23	10-22-23	1	100%
2.3	Report Writing	Adarsh Singh, Kanan Sananse, Shruti Pinjarkar	3-23-23	3-27-23	1	100%
2.4	Review2 Presentation	Adarsh Singh, Kanan Sananse, Shruti Pinjarkar	10-28-23	10-28-23	1	100%

Figure 4.10: Timeline of the Project

Chapter 5

Testing

5.1 Software Testing

A blend of conventional software testing methodologies and specialist approaches works well for machine learning. To guarantee data quality and model performance, use unit testing and integration testing for individual components. The evaluation of end-to-end functioning through system testing should prioritize security and edge case considerations. To maintain model accuracy and adjust to changing data patterns, it is essential to conduct ongoing testing and monitoring.
In order to test machine learning (ML), data quality validation, model training, model deployment, and security and robustness checks are all necessary. Assure dependable connectivity and precise sensor data for Internet of Things-based smart agriculture. Examine the actuators' power consumption, scalability, and response. Use penetration testing to address privacy issues and security flaws. Test the system's resistance to failures and assess its performance under varied loads. Use automation and thorough testing techniques to ensure effective development and deployment.

5.2 Functional Testing

Functional testing in machine learning (ML) involves validating input data, checking accurate model training and inference, testing data preprocessing, and ensuring seamless integration with other system components. In the context of Internet of Things (IoT), functional testing focuses on verifying device connectivity, testing sensor data accuracy, confirming actuator responsiveness, validating communication protocols, ensuring effective edge computing, and conducting integration tests. Both ML and IoT functional testing aim to guarantee that the systems meet specified requirements and operate reliably in real-world scenarios, with automated testing tools aiding in efficiency throughout the development and deployment processes.
In IoT-based system, a mix of manual and automated testing methods is beneficial. Perform functional testing to validate connectivity, communication protocols, and device behavior. Implement performance testing for scalability and power consumption assessments. Conduct security testing, including penetration testing, to identify and address vulnerabilities. Automation can streamline repetitive tasks, allowing for efficient regression testing and ensuring reliability in the dynamic IoT environment. Integrating testing into the development

lifecycle is key to achieving robustness in ML and IoT-based system.

Chapter 6

Result and Discussions

The web-based platform, "Kisaan Dost," is an innovative solution for farmers that use ML and IoT to transform several parts of farming. Ultimately, it aims to optimize and enhance crop output while maintaining soil quality by generating information and insights about essential soil and agricultural field factors. In order to address the ongoing issues of poor productivity and under-fertilization in agriculture, Kisaan Dost employs a systematic approach. The first step is to use the integrated sensor modules to collect data on several soil quality metrics and in-field variables. A variety of parameters, including soil nutrient levels, moisture, temperature, and more, are monitored in real time by these sensors. Afterwards, the data is sent to a cloud server and a fog computing server using the Wi-Fi module that is included inside the microcontroller. Data may be centralized in this way, making it easier to analyze and make decisions. In order to visualize the data and provide users and farmers an easy-to-navigate interface for tracking and analyzing agricultural metrics, the cloud server is vital. The "Kisaan Dost" system's capacity to display the changes in different data instances of in-field parameters is a strong suit. The data visualization tool makes it easy to analyze and evaluate insights from agricultural operations by presenting the data in the form of user-friendly field charts. Important aspects influencing crop development may be shown graphically, including patterns in soil moisture, nutrient variations, soil pH, temperature changes, and more. The data-driven, all-encompassing method of farming presented in "Kisaan Dost" equips farmers and agricultural professionals to make smart choices. It enables real-time data-driven interventions, optimum fertilization, and accurate resource allocation, all of which contribute to improved crop yields and long-term soil quality management. Addressing important challenges and contributing to more efficient and ecologically responsible agricultural techniques, this comprehensive approach represents a major advancement in contemporary agriculture.

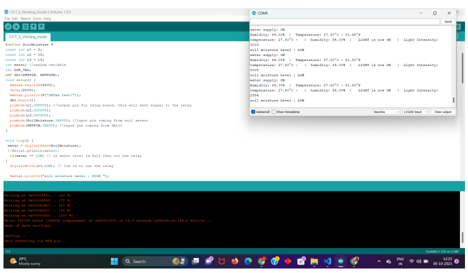


Figure 6.1: Readings from IoT System

The above shows the Working of the code written which displays the extraction of data from IoT System and also proper functioning of logic applied in the code which is further stored in database.

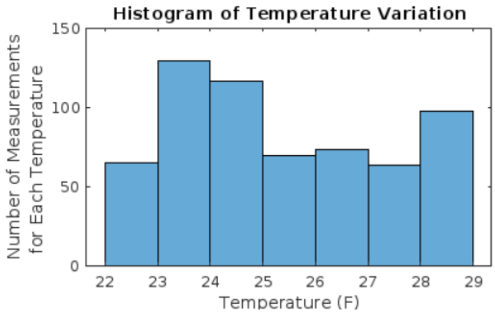


Figure 6.2: Use a histogram to understand variation in data

The above shows the graph of variation in the temperature for the particular time instance with the delay of 10000 Milliseconds

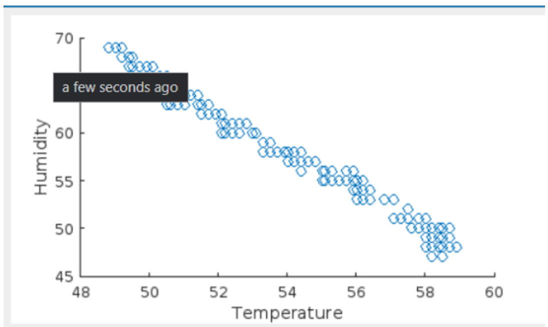


Figure 6.3: Visualize correlation between temperature and humidity

The above shows the graph visualization for the correlation of temperature and humidity for the time instance.

Chapter 7

Conclusion

The proposed web framework, named "Kisaan Dost," is a cutting-edge agricultural solution that leverages Machine Learning (ML), Internet of Things (IoT), and Deep Learning technologies to revolutionize various aspects of farming practices. Its primary goal is to generate knowledge and insights about critical soil and farming field parameters, ultimately leading to the optimization and improvement of crop yield while ensuring the maintenance of soil quality. To tackle the persistent challenges of under productivity and under-fertilization in agriculture, Kisaan Dost follows a well-structured process. It begins with the data extraction of various in-field and soil quality parameters using integrated sensing modules. These sensors collect real-time data on factors such as soil nutrient levels, moisture content, temperature, and more. The collected data is then transmitted to both a fog computing server and the ThingSpeak Cloud server via the Wi-Fi module integrated into a Micro-controller. This enables the centralization of data, making it accessible for analysis and decision-making. The ThingSpeak Cloud server plays a crucial role in visualizing the data, providing farmers and users with a user-friendly interface to monitor and analyze their agricultural parameters. One of the key strengths of the "Kisaan Dost" system is its ability to visualize the variations in various data instances of in-field parameters. The data is presented in the form of intuitive field charts hosted on the ThingSpeak platform, making it easier for users to interpret and understand the dynamics of their agricultural practices. These visualizations can include trends in soil moisture levels, nutrient variations, temperature fluctuations, and other essential factors that impact crop growth. By offering this comprehensive, data-driven approach to farming, "Kisaan Dost" empowers farmers and agricultural practitioners with the knowledge they need to make informed decisions. It allows for precise resource allocation, optimized fertilization, and timely interventions based on real-time data, ultimately leading to enhanced crop yields and the sustainable maintenance of soil quality. This holistic system represents a significant step forward in modern agriculture, addressing critical issues and contributing to more efficient and environmentally responsible farming practices.

Chapter 8

Future Scope

- Expanded Constraint Analysis: Continuously refining the Exploratory Data Analysis (EDA) analysis to study additional constraint dependencies and factors influencing optimal yield production. This could involve integrating more diverse datasets and employing advanced statistical techniques to uncover nuanced patterns.

- Precision Agriculture Techniques: Further developing soil health insights by incorporating advanced sensors and technologies. This may include leveraging IoT devices to collect detailed soil data, enabling precise recommendations for maintaining or enhancing soil quality.

- Enhanced Data Visualization: Evolving the visualizations of crop parameters to include more comprehensive and interactive features. This could involve the integration of 3D modeling or augmented reality to offer a more immersive experience, aiding farmers in better understanding the impact of environmental factors on crop growth.

- Integration with Agricultural Supply Chain: Connecting the Farming Companion to other elements of the agricultural supply chain. This could involve linking with market data, enabling farmers to make informed decisions not only on cultivation but also on selling their produce.

- User Customization: Allowing farmers to customize the system to their specific farming practices and preferences. Providing a user-friendly interface where farmers can set personalized parameters and preferences for their crops.

- Collaboration and Knowledge Sharing: Facilitating collaboration and knowledge sharing among farmers. Implementing features such as a community platform where farmers can share experiences, best practices, and insights, fostering a sense of community and collective learning.

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Appendices

Appendix-A: Visual Studio Code Download and Installation For Software

1. Download the Visual Studio Code installer for Windows.

2. Once it is downloaded, run the installer(VSCodeUserSetup-1.84.0.exe).

3. By default, VS Code is installed under C://Users//Kanan//AppData//Local//Programs //VS Code.

Appendix-B:Installation of Extensions on VS Code

1. Install python:

- Click on the box icon on the activity bar or use a keyboard shortcut: Ctrl + Shift + X to open the extension panel.
- Type python keyword in the search bar.
- The Python extension automatically installs Pylance, Jupyter, and isort extensions. It comes with a complete collection of tools for Data Science, web development, and software engineering.

Appendix-C: Arduino IDE Download and Installation For Hardware connectivity

1. Download Arduino IDE 2.2.1 from https://www.arduino.cc/en/softwarefuture-version-of-the-arduino-ide.

2. Extract the exe file and after extracting complete the installation by agreeing to the terms and conditions.

Publication

Patent has been officially filed for the system proposed titled **"Kisaan Dost: A Comprehensive ML and IOT based Web Framework for Smart Agriculture"**.