"KRUSHI MITRA"

A PROJECT REPORT

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Project Report

titled

KRUSHI MITRA

Submitted

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Declaration

We hereby declare that the work being presented in this Report entitled "Krushi Mitra" by Project Group Id : 5D2, and submitted to the Department of Computer Engineering at Sarvajanik College of Engineering & Technology, Surat; is an authentic record of our own work carried out during the period of ODD semester 2024-2025 under the supervision of Prof. (Dr.) Pariza Kamboj.

Neither the source code there in, nor the content of the report have been copied or downloaded from any other source. We understand that our result grades would be revoked if later it is found to be so.

We also declare that we have read all the instructions given below.

____

(Sign of all members of the group)

Department of Computer Engineering

SARVAJANIK COLLEGE OF ENGINEERING & TECHNOLOGY, SURAT

(2024-25)

CERTIFICATE

This is to certify that the project entitled Krushi Mitra has been carried out by Deep Dhaval Patel (ET21BTCO075), Drashti Dipeshbhai Patel (ET21BTCO080), Jaydeep Patel (ET21BTCO084), Om Patel (ET21BTCO091), and Priya Sisodiya (ET21BTCO120), students of B.Tech. IV (CO), Semester-VII, under my guidance in fulfillment of the degree of Bachelor of Technology in Computer Engineering of Sarvajanik University, Surat for the academic year Nov - Dec, 2024.

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(2024-25)

Approval Sheet

This is to state that the Report "Krushi Mitra" submitted by Project Group Id : 5D2 is approved.

Evaluation Committee

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Date: ________________

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Abstract

*This project proposes a Smart Agricultural Management System, **Krushi Mitra**, which uses IoT, deep learning, data science and web-based technology to improve farm operations. The system is made up of three modules that strive to maximize resource utilization and production.*

The first module is an automated watering system with sensors that measure soil moisture levels. It uses solenoid valves, pipes, sensors and Arduino to manage water flow over a network of pipes, ensuring that crops get the right amount of water while reducing waste.

The second module focuses on animal infiltration prevention. The device uses a USB camera, Arduino, buzzer, and a deep learning algorithm to detect animals in real time, including oxen, cows, and pigs. A buzzer is integrated to produce sounds that dissuade these animals from accessing farmed regions, so protecting crops from damage.

The third module involves soil nutrient detection. This function analyzes real-time data from soil sensors and machine learning algorithms to assess nutrient levels, allowing for more accurate crop predictions and customized fertilizer recommendations based on specific nutrient deficits.

*Overall, this integrated approach seeks to address fundamental issues in modern agriculture, such as effective water management, crop protection, and soil health. By combining these technologies, **Krushi Mitra** aims to increase agricultural productivity while also promoting sustainable farming methods that benefit both farmers and the environment.*

Acknowledgement

*We would like to offer our heartfelt gratitude to everyone who helped us construct our final year project, **Krushi Mitra**.*

First and foremost, we want to express our gratitude to our project supervisor and mentor, Prof. (Dr.) Pariza Kamboj, whose counsel and skills were vital throughout this trip. Their insights shaped our project and enhanced our grasp of the issue.

We are also grateful to our teammates, Deep Patel, Drashti Patel, Jaydeep Patel, Om Patel, and Priya Sisodiya, for their collaborative attitude, encouragement, and support throughout the project. Our talks and shared ideas were crucial in overcoming obstacles and improving the quality of our work.

In addition, we would like to thank our families for their continuous support and encouragement, which allowed us to focus on our job and strive for perfection.

We also want to thank the Department of Computer Engineering for providing the resources and tools that enabled the project's successful completion. Their devotion to agricultural research and innovation is admirable.

Finally, we'd like to honor the larger agricultural community and the farmers that inspire projects like ours. Their commitment to sustainable practices and increased agricultural yields inspires us to develop solutions that can have a significant impact.

Thank you all for your invaluable contributions and support, which have made this project possible.

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1. Introduction

Agriculture is the foundation of many economies and is vital to guaranteeing food security and long-term prosperity [1]. However, modern farming has considerable obstacles, such as inefficient water management, crop damage caused by animal encroachment, and decreased soil fertility [2]. These concerns necessitate novel solutions that incorporate technology into traditional farming processes to increase efficiency and sustainability [3].

In response to these issues, this project focuses on creating **Krushi Mitra**, a system that employs cutting-edge technology such as IoT, deep learning, and real-time sensor data collection [4]. The system is intended to handle three critical areas of farming: effective water management, crop protection from animal intrusion, and nutrient analysis to improve crop planning and fertilizer recommendations incorporated through 3 different modules respectively.

The first **Krushi Mitra** module automates irrigation by monitoring rainwater levels and regulating water flow, ensuring that crops receive the right quantity of water while reducing waste [5]. The second module detects animals such as oxen, cows, and pigs using a USB camera connected to a laptop, which captures live photos from the farm. A deep learning model, MobileNetV2, pre-trained to detect these animals, processes the captured images and the performance of the model is assessed using accuracy. If an animal is detected, a request is sent to the Raspberry Pi, which activates a buzzer using Flask to deter the animals and protect the crops [6]. The final module monitors soil nutrient concentration using an NPK sensor and makes real-time suggestions on crops and fertilizers [7].

This study describes the conception, development, and implementation of **Krushi Mitra,** including the technology employed, the obstacles encountered, and the project's potential impact on modern agricultural techniques. The purpose of this system is to provide a holistic solution for increasing productivity and boosting agricultural sustainability.

The integration of technology in agriculture has immense potential to transform traditional farming methods into more efficient and data-driven processes. **Krushi Mitra** is designed to assist farmers in making informed decisions by utilizing real-time data, automation, and intelligent systems. By addressing critical issues like water conservation, crop protection, and soil health management, **Krushi Mitra** aims to reduce manual labour, minimize resource wastage, and ultimately improve crop yield [8].

This project not only demonstrates the power of integrating IoT and deep learning in agriculture but also lays the groundwork for future advancements in smart farming technologies. **Krushi Mitra** serves as a model for how technology can be harnessed to promote more sustainable and efficient farming practices, ensuring that agriculture continues to meet the growing demands of the global population.

2. Aims and Objectives of the work

2.1 Aim

Krushi Mitra aims to create a smart, integrated agriculture management system that uses IoT, deep learning, and sensors to optimize farming processes. This project aims to:

1. Improve Water Management: Automate irrigation with real-time rainwater level sensors, and solenoid valve control to ensure optimal water use and promote sustainable irrigation practices.

2. Protect Crops from Animal Intrusion: Use a USB camera, deep learning algorithms and a Raspberry Pi-based buzzer system to blow after identifying animals like oxen, cows, and pigs, to avoid crop damage.

3. Improve agricultural and Soil Health: Analyze soil nutrient levels using an NPK sensor to anticipate suitable crops and propose fertilizers, thereby increasing agricultural production, optimizing resource use, and sustaining soil health.

2.2 Objectives

The primary objectives of **Krushi Mitra** are to develop an intelligent, technology-driven agricultural management system that addresses critical challenges in modern farming. By integrating IoT, deep learning, and sensor-based solutions, the project aims to optimize resource utilization, enhance crop productivity, and promote sustainable farming practices. The specific objectives are as follows:

1. Automate Irrigation: Create an IoT-based system that detects rainwater level in real-time, and operates solenoid valves to ensure efficient and precise water distribution across farmlands.

2. Animal Intrusion Detection: Using a USB camera, a Raspberry Pi buzzer system, and a deep learning-powered system, the module will recognize animals such as oxen, cows, and pigs and block their entry into farm fields using a non-invasive frequency generator. A USB camera, Raspberry Pi, and a deep learning technique detect and deter animals, protecting crops humanely without physical barriers.

3. Soil Nutrient Analysis: Create a system that evaluates soil nutrient levels in real-time and makes suggestions for appropriate crops and fertilizers, thereby increasing yield and encouraging sustainable farming.

4. Resource optimisation: Reduce water waste, prevent crop damage, and improve soil health by incorporating intelligent solutions that limit the need for manual intervention while maximising efficiency.

5. Promote Sustainability: Develop a scalable and flexible solution that assists farmers in adopting sustainable practices, hence increasing productivity while minimizing environmental impacts.

3. Project Description

Krushi Mitra is an innovative agricultural management system designed to address key challenges in farming by integrating IoT, deep learning, and sensor technologies. The project is divided into three main modules, each targeting a critical aspect of modern agriculture: water management, animal intrusion prevention, and soil nutrient analysis.

3.1 Water Irrigation System

Krushi Mitra's automated irrigation system uses IoT and sensor technology to optimize water utilization [12]. Soil moisture sensors are distributed across the field to continuously monitor moisture levels at various depths. These sensors interact with a central controller, which handles the data in real-time [13]. Based on the moisture readings, the controller activates or deactivates solenoid valves, which regulate the flow of water through a network of pipes. This guarantees that each region of the field receives an appropriate amount of water, eliminating both overwatering and underwatering.

The system is programmed to work autonomously, altering watering schedules based on soil characteristics and weather patterns, which can be incorporated using other data sources. This saves water waste, manual effort, and provides the best growing conditions for crops. The automation can also be overridden manually using a mobile or web-based interface, giving the farmer more control. The ultimate goal is to conserve water, a valuable resource, while also improving crop health and output.

As seen in Fig. 3.1.1, we can understand the overall workflow of the system. Initially, the water will flow from the source to the main pipe. Smaller pipes are fitted perpendicularly on the main pipe. At first, the first 3 smaller pipes will be opened for the water to flow through the fields using solenoid valves. At the end of the field, there are water level sensors that will detect the water and the ESP8266 is used to close the solenoid valve to restrict the water from overflowing. Next, after these 3 pipes have been shut, the next 3 pipes will be opened and the same procedure will occur until all the fields have received optimal water.

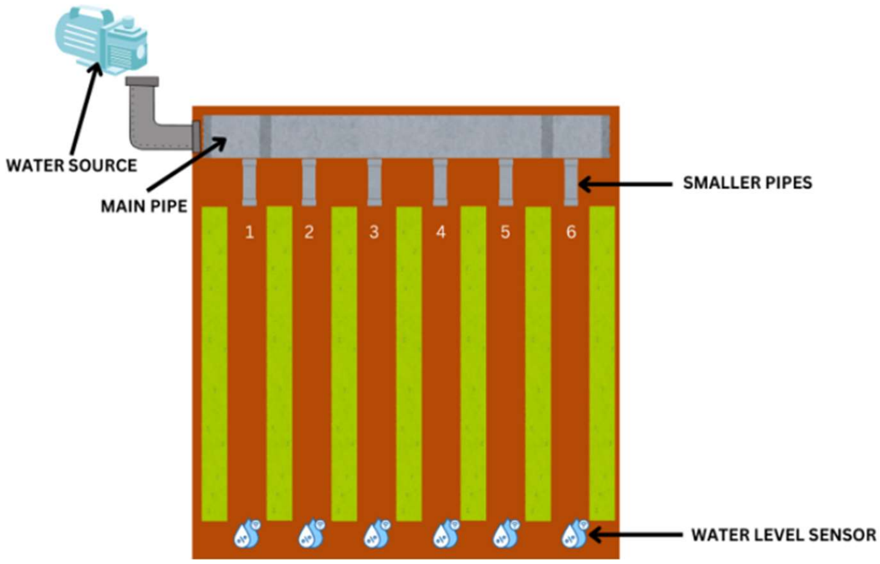

Fig. 3.1.1 Water irrigation system diagram

3.2 Animal Intrusion Detection and Prevention

Animal infiltration is a major issue for many farmers, often resulting in crop damage and financial losses. **Krushi Mitra** addresses this issue by implementing a real-time animal identification system based on deep learning and a USB camera connected to a laptop [14]. The USB camera captures live photos from the farm, which are saved in a folder. A pre-trained deep learning model, trained to recognize specific species such as oxen, cattle, and pigs, analyzes these captured images in real time.

When an animal is identified, a request is sent to the Raspberry Pi, which activates a buzzer using Flask. The buzzer emits a loud sound to repel the animals without injuring them. This non-invasive approach ensures that the animals are deterred without the need for physical barriers or harmful prevention techniques [15]. Although the detection is performed on the laptop, the system effectively integrates the buzzer activation on the Raspberry Pi, ensuring the crops remain protected. This module provides farmers with a reliable, humane solution for securing their crops without requiring physical fencing or constant human intervention.

3.3 Crop and Fertilizers Recommendation

The third module of **Krushi Mitra** focuses on precision farming using real-time soil nutrient measurement. This module makes use of soil sensors to detect the amounts of important nutrients such as nitrogen (N), phosphorus (P), and potassium (K), all of which are necessary for crop growth [16]. The sensors feed data to the system's central processing unit, which analyzes it to determine the soil's fertility.

Using the nutrient data, the algorithm determines which crops are most suited to the current soil conditions. This advice is based on historical data, environmental conditions, and the nutrient requirements of diverse crops. In addition to crop prediction, the system also suggests appropriate fertilizers to address any nutrient deficiencies, ensuring that the soil remains fertile and supports optimal plant growth [17].

The real-time aspect of this system allows farmers to continuously monitor soil health and make informed decisions on crop rotation, fertilizer application, and planting strategies. By tailoring crop choices and fertilizer use to the soil's current condition, this module helps in maximizing productivity while maintaining long-term soil health, contributing to sustainable farming practices.

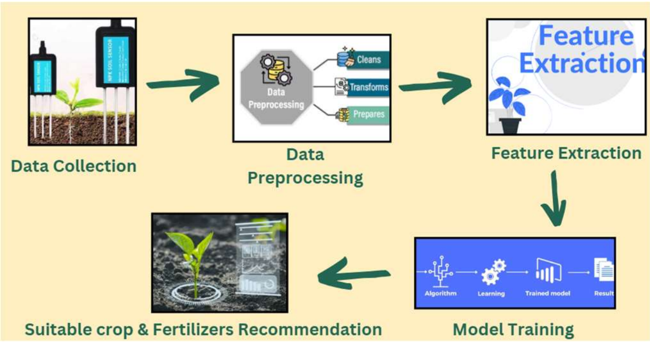

Fig. 3.3.1 Flowchart of Crop and Fertilizers Recommendation

4. Brief Literature Review

The integration of technology in agriculture has been a growing area of research, particularly with advancements in IoT, sensor networks, and machine learning. Several studies have explored how these technologies can enhance farming efficiency, improve yield, and promote sustainable practices.

4.1 Literature Review for Water Irrigation System

In [18], the blog illustrates the water level monitoring system using ESP8266. It utilizes an ESP8266 Wi-Fi module connected to an ultrasonic sensor to measure water levels. The data is transmitted to the Blynk app, allowing users to monitor levels remotely on their smartphones. It highlights practical applications in agriculture and home automation, emphasizing the importance of effective water management.

The tutorial on Last Minute Engineers explains how to interface a water level sensor with an Arduino to detect water levels [19]. It guides users through the wiring, coding, and working principles of the sensor, which uses resistance between probes to determine the water level. The tutorial also provides an example code to monitor and display water levels in real time. However, the sensor may experience reduced accuracy in dirty or contaminated water, and its durability might be affected by long-term exposure to moisture, potentially leading to corrosion.

The tutorial in [20] explains how to use a water level sensor with an Arduino. The sensor measures water levels up to 40mm and provides analogue values ranging from 0 to 1024. The tutorial covers wiring the sensor to the Arduino, finding analogue values, and using a simple code to read and display water levels. However, the sensor has a limited range (up to 40mm), and its accuracy decreases as the water approaches maximum level. It may not be suitable for deeper water applications.

4.2 Literature Review for Animal Intrusion Detection and Prevention

Multiple machine learning models such as SVM and KNN are used in [21] for detecting wild animals. They used the standard camera-trap dataset for experimentation and assessing the system performance The dataset contains 20 species of animals with around 100 image sequences for each species. The images are fed to the machine learning algorithms and feature extraction takes place. The classification results showcase dominant performance demonstrating recall of 0.9825, precision of 0.91625, and F-score of 0.9476. However, the pre-processing of the images is absent which can hinder the accuracy of the models.

YOLOv3, RetinaNet R-50-FPN, Faster R-CNN R-50-FPN, Cascade RCNN R-50-FPN models are used in [22] to detect big animals such as “Bear”, “Fox”, “Dog”, “Horse”, “Goat”, “Sheep”, “Cow”, “Zebra”, “Elephant”, “Giraffe” on images with road scenes. The YOLOv3 model was pre-trained on ImageNet. We used only a pre-trained backbone. Since we did not use the entire network, but only the backbone, the rest of the network is initialized with random weights. The remaining models were pre-trained on the COCO 2017 train. YOLOv3 showed a better performance than any other models. However, YOLOv5 can be used for the detection for better performance.

The proposed method uses the YOLO object detection model to ascertain the presence of wild animals in images [23]. The model is fine-tuned for identifying six different entities – humans, and five different types of animals (elephant, zebra, giraffe, lion and cheetah). Once detected, the animal is tracked using CSRT to determine its intentions, and based on the perceived information, notifications are sent to alert the concerned authorities. The design of a prototype for the proposed solution is also described, which uses Raspberry Pi devices equipped with cameras. The proposed method achieves an accuracy of 98.8% and 99.8% to detect animals and humans respectively. One of the drawbacks of the approach presented here is when multiple cameras detect the same individual animal – it might result in multiple notifications being sent and would appear as though more than one animal is detected when in reality there is only one.

4.3 Literature Review for Crop and Fertilizers Recommendation

The models namely Support vector machine, XGBoost, Random forest, KNN, and Decision Tree were trained using yields of individual data sets of 11 agricultural and 10 horticultural crops, as well as combined yield of both agri-horticultural crops in [24]. The study aimed to predict the selection of crops based on several factors, including NPK fertilizer, soil pH, and climatic factors, using regression algorithms. The data was initially pre-processed and the pre-processed data is then fed to the machine learning models. The extracted features are classified based on agricultural, horticultural, and mixed crops. Comparing the five ML models, the XGBoost demonstrated the highest level of accuracy. The precision rates of XGBoost for recommending agricultural crops, horticultural crops, and a combination of both were 99.09 % (AUC 1.0), 99.3 % (AUC 1.0), and 98.51 % (AUC 0.99), respectively. Moreover, the outcomes of the study can be utilized to design a user-friendly tool for a crop recommendation system that optimizes crop yield by taking into account the prevailing local environmental conditions.

A system is described that recommends the crops suitable for a particular region based on crop yield history of the last three years in that region and the fertilizers suitable for specific crops based on soil measurements to farmers [25]. The data is fed to the Random Forest model. The system predicts suitable crops for the field under consideration based on the region in Maharashtra state of India and the type of soil. The random forest algorithm is used as the accuracy is found to be higher than the ID3 algorithm for a given dataset. However, particular performance metrics are not used in the study.

IoTSNA-CR model is proposed to classify soil nutrients and recommend crops for precision agriculture [26]. The IoTSNA-CR model involves different processes, namely data acquisition using sensors, storage in the cloud, MSVM-based classification with FFO-based parameter optimisation, and crop recommendation. The data is initially pre-processed and it is fed to a multiclass Support Vector Machine (SVM). The extracted features are used to recommend crops. The proposed algorithm achieved 97.3% accuracy on the real-time data. A potential limitation of the proposed IoTSNA-CR model and MSVM-DAG-FFO algorithm is the reliance on consistent and accurate real-time data collection from sensors. In rural or resource-limited areas, farmers may face challenges with maintaining reliable internet connectivity or dealing with sensor malfunctions, which could hinder the consistent collection of soil data and impact the accuracy of crop predictions.

5. Requirement Analysis and Design

5.1 Class Diagram

Class diagrams are essential in software development as they provide a visual representation of the system's structure by defining the classes, their attributes, methods, and the relationships between them [27]. These diagrams help developers understand the static view of the system and the overall design, making it easier to organize the codebase and manage complexity.

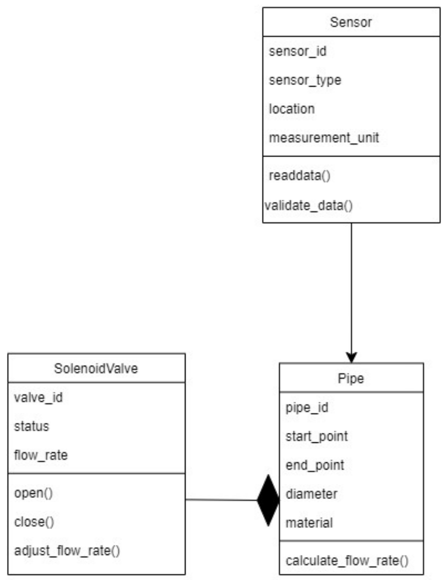

Fig. 5.1.1 Class Diagram of Water Irrigation System

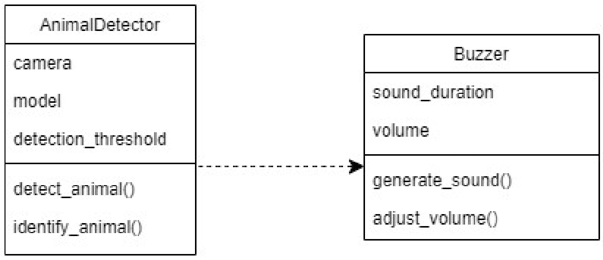

Fig. 5.1.2 Class Diagram of Animal Intrusion Detection and Prevention

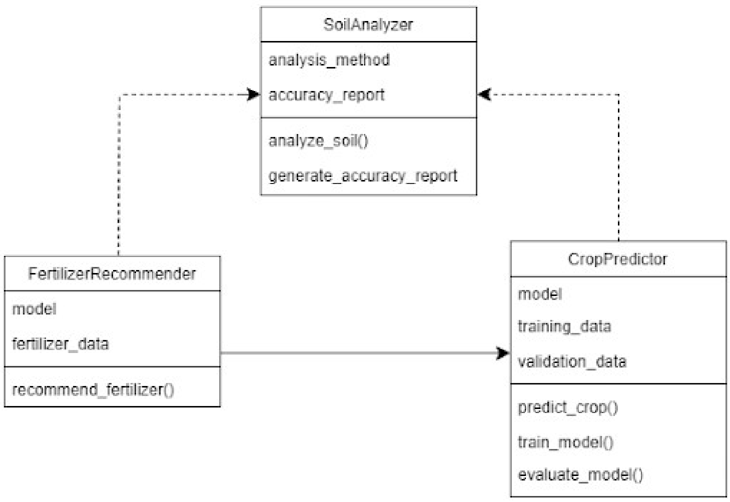

Fig. 5.1.3 Class Diagram of Crop and Fertilizers Recommendation

5.2 Activity Diagram

Activity diagrams are crucial for visualizing the workflow or sequence of activities within a system [28]. They represent the dynamic aspects of a system by illustrating the flow of control from one activity to another, which can help developers and business analysts understand the logic and processes involved. These diagrams are particularly valuable for identifying bottlenecks, inefficiencies, and potential areas for improvement within a process.

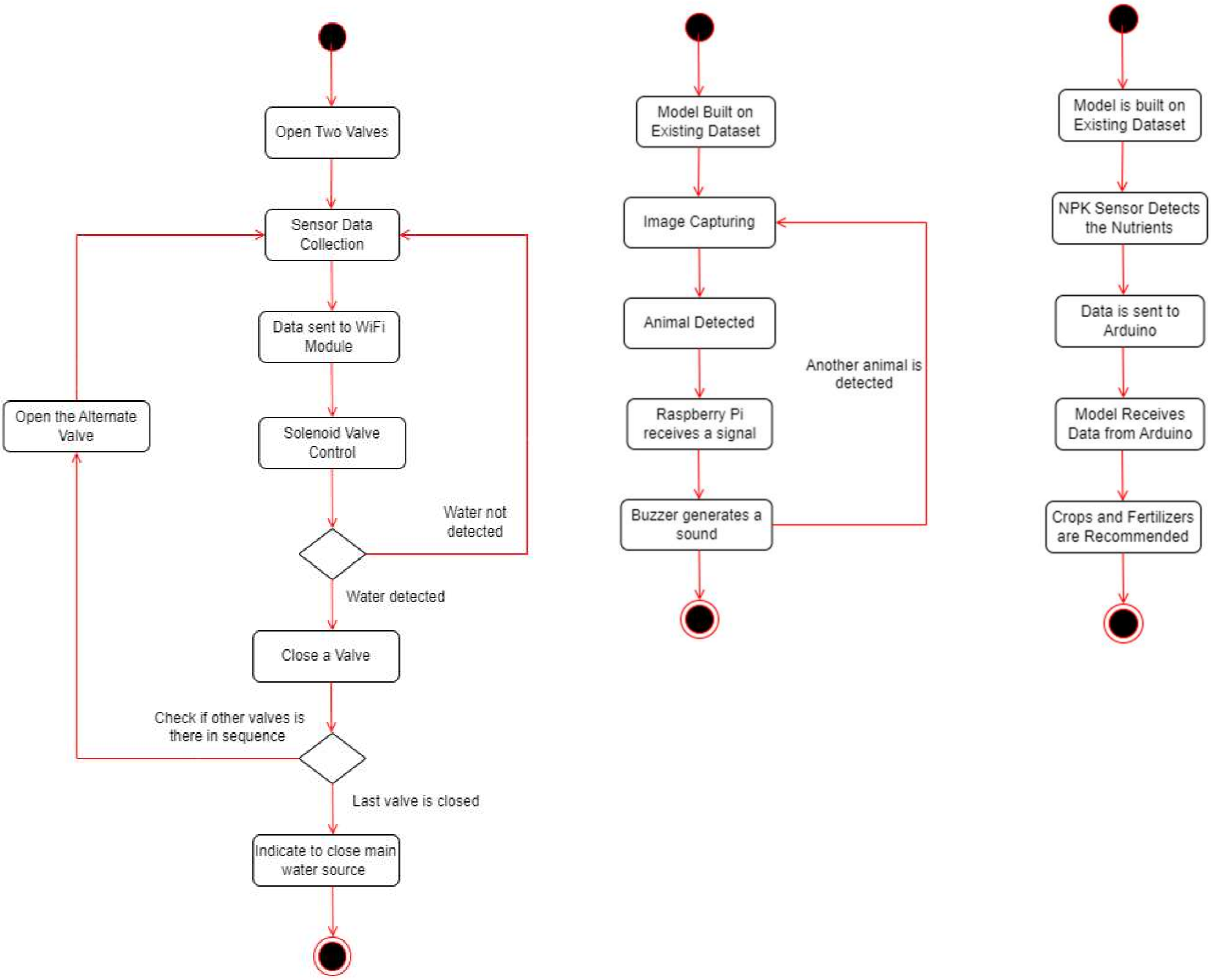

Fig. 5.2.1 Activity Diagrams of **Krushi Mitra**

5.3 Sequence Diagram

Sequence diagrams play a significant role in modelling the interaction between different objects over time [29]. They depict how objects collaborate by showing the order in which messages or events are exchanged, highlighting the dynamic behaviour of the system. Sequence diagrams are particularly useful for understanding the timing and sequence of operations, making them essential for designing real-time systems, complex interactions, and communication between components.

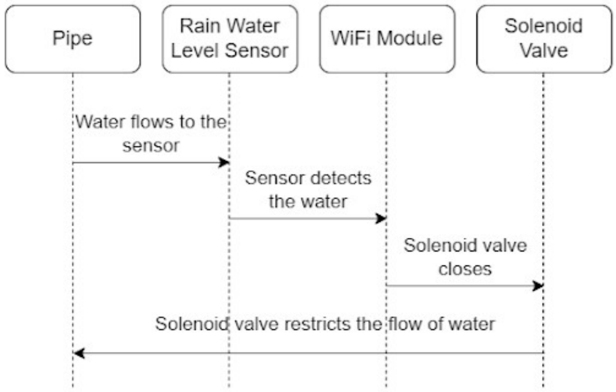

Fig. 5.3.1 Sequence Diagram of Water Irrigation System

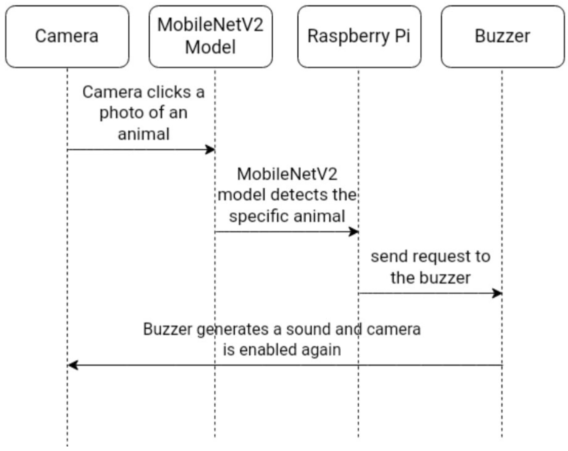

Fig. 5.3.2 Sequence Diagram of Animal Intrusion Detection and Prevention

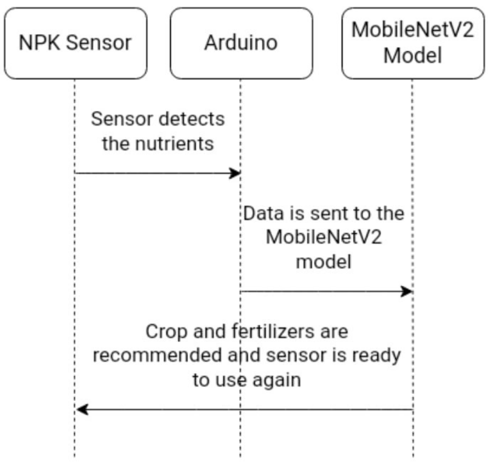

Fig. 5.3.3 Sequence Diagram of Crop and Fertilizers Recommendation

5.4 Use – Case Diagram

Use-case diagrams are valuable tools for capturing the functional requirements of a system by illustrating how users (or actors) interact with the system's features [30]. These diagrams help identify the various ways in which the system will be used, making it easier to define the system's functionality from the user's perspective. Use-case diagrams are particularly important during the early stages of software development as they help stakeholders, developers, and clients understand what the system is expected to do.

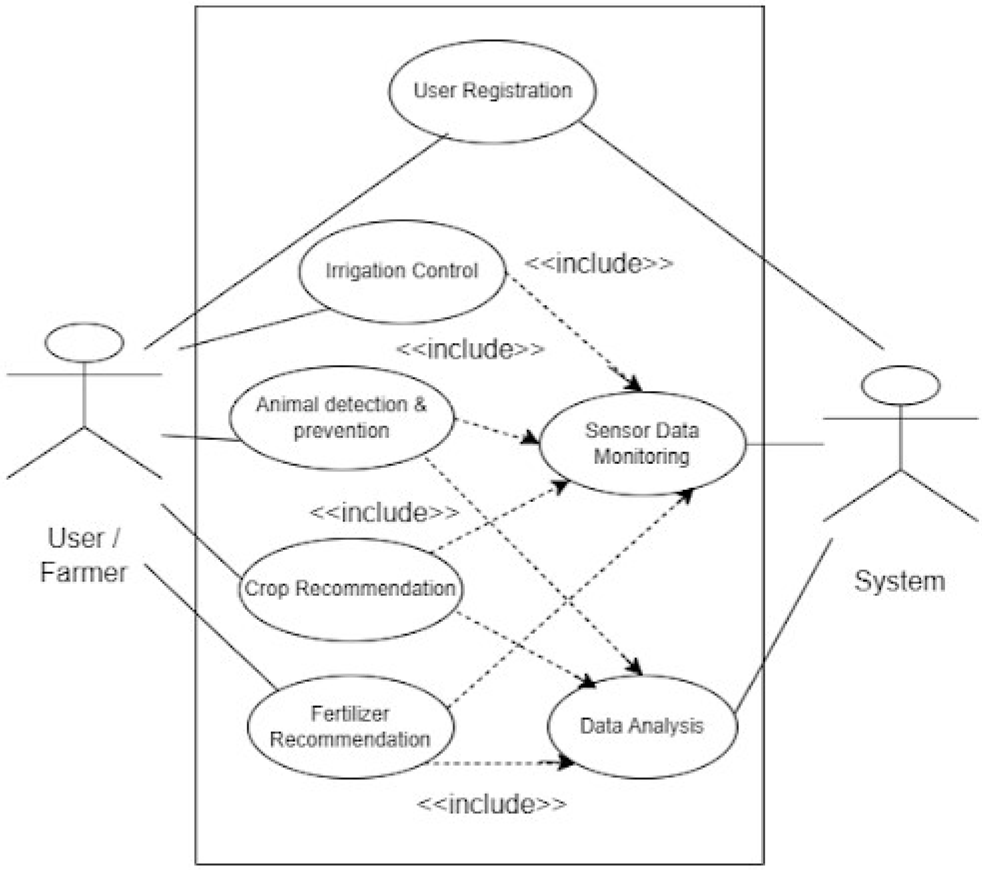

Fig. 5.4.1 Use case diagram of **Krushi Mitra**

6. Materials and Methods Used

6.1 Water Irrigation System

The materials used for the water irrigation system are given below:

- Solenoid Valve - Controls the flow of water in the irrigation system based on sensor data.
- Pipe - Channels water to different parts of the farm field.
- ESP8266 (WiFi Module) - Enables wireless communication for real-time data transmission and remote control.
- Arduino - Acts as the central microcontroller for integrating sensors and managing system operations.
- Rainwater Level Sensor - Detects water when it reaches the end of the field and sends the signal to close the solenoid valve.
- Relay - Detects rain and adjusts the irrigation system to conserve water
- Wires - Connect the hardware components for power and signal transmission
- Power Source - Provides the necessary electrical energy for the system to function.
- Arduino IDE - Software used to program the Arduino and manage system logic.

These materials provide extensive knowledge and help us to smoothly build the water irrigation system [31-36].

The main method to accomplish this system is given below:

- Initially, the water will flow from the source to the main pipe. Smaller pipes are fitted perpendicularly on the main pipe.
- At first, the first 3 smaller pipes will be opened for the water to flow through the fields using solenoid valves.

- At the end of the field, there are water level sensors that will detect the water and the ESP8266 is used to close the solenoid valve to restrict the water from overflowing.
- Next, after these 3 pipes have been shut, the next 3 pipes will be opened and the same procedure will occur until all the fields have received optimal water.

6.2 Animal Intrusion Detection and Prevention

The main components used in this module are:

- Arduino - A powerful microcomputer used to send signals to the buzzer.
- Arduino IDE - Software configuration to enable the Arduino.
- Wires - Software configuration to enable the Raspberry Pi for image processing and system control.
- USB Camera - Captures video for monitoring the farm field and detecting animals.
- Buzzer - Emits sounds to scare animals away from the field once detected.
- Power source - Provides the necessary electrical energy for the system to function.

These components help in building a perfect model for detecting and deterring animals from the farm fields [37-40].

The main method used to complete this module is:

- A USB camera is connected to a laptop to capture live images of the farm field. The images are continuously saved in a folder for further processing.
- A deep learning model deployed on the laptop analyzes the captured images in real time to detect animals such as oxen, cows, and pigs.
- Upon detecting an animal, a request is sent from the laptop to an Arduino. The Arduino, connected to a buzzer, activates the buzzer, which emits high-frequency sounds to deter the animals from entering the field.
- The system is powered by appropriate wires and power sources to ensure seamless communication between the laptop and Arduino, ensuring continuous operation of the camera, laptop, and buzzer. This method efficiently protects crops by integrating

real-time image processing with physical deterrence, reducing the need for physical barriers and minimizing crop damage.

6.3 Crops and Fertilizers Recommendation

The main components used in this module are:

- NPK Sensor - Measures soil levels of nitrogen, phosphorus, and potassium for nutrient analysis.
- Arduino - Acts as the central microcontroller for integrating sensors and managing system operations.
- RS485 Modbus - facilitates communication between the NPK sensor and the Arduino.
- Power source - Provides the necessary electrical energy for the system to function.

The above components provide the base for making a well-working crop and fertilizer recommendation system [41-44].

The method used in this module is:

- The NPK sensor, connected to the Arduino, measures essential soil nutrients, including nitrogen (N), phosphorus (P), and potassium (K). This real-time data collection is crucial for understanding the nutrient profile of the soil, which directly influences crop health and productivity.
- The collected nutrient data is stored in the Arduino's memory. This allows for immediate access to historical and current readings.
- The RS485 Modbus protocol facilitates reliable communication between the NPK sensor and the Arduino. This robust communication method ensures that data transfer occurs seamlessly, allowing for efficient monitoring of nutrient levels.
- Utilizing the sensor readings, the system analyzes the nutrient data to predict the most suitable crops for the given soil conditions. It also recommends appropriate fertilizers that can enhance soil fertility and correct any nutrient deficiencies, thereby optimizing crop yields.

7. Gantt Chart

A Gantt chart is a visual project management tool used to represent the timeline of tasks or activities in a project [45]. It displays tasks along a horizontal timeline, showing their start and end dates, durations, and dependencies between tasks. Each task is represented by a horizontal bar, and the length of the bar corresponds to the task's duration. Gantt charts help in tracking progress, allocating resources, and ensuring that the project stays on schedule. They are especially useful for identifying task overlaps, deadlines, and critical paths, providing a clear overview of the entire project timeline, and making it easier to manage and coordinate activities effectively.

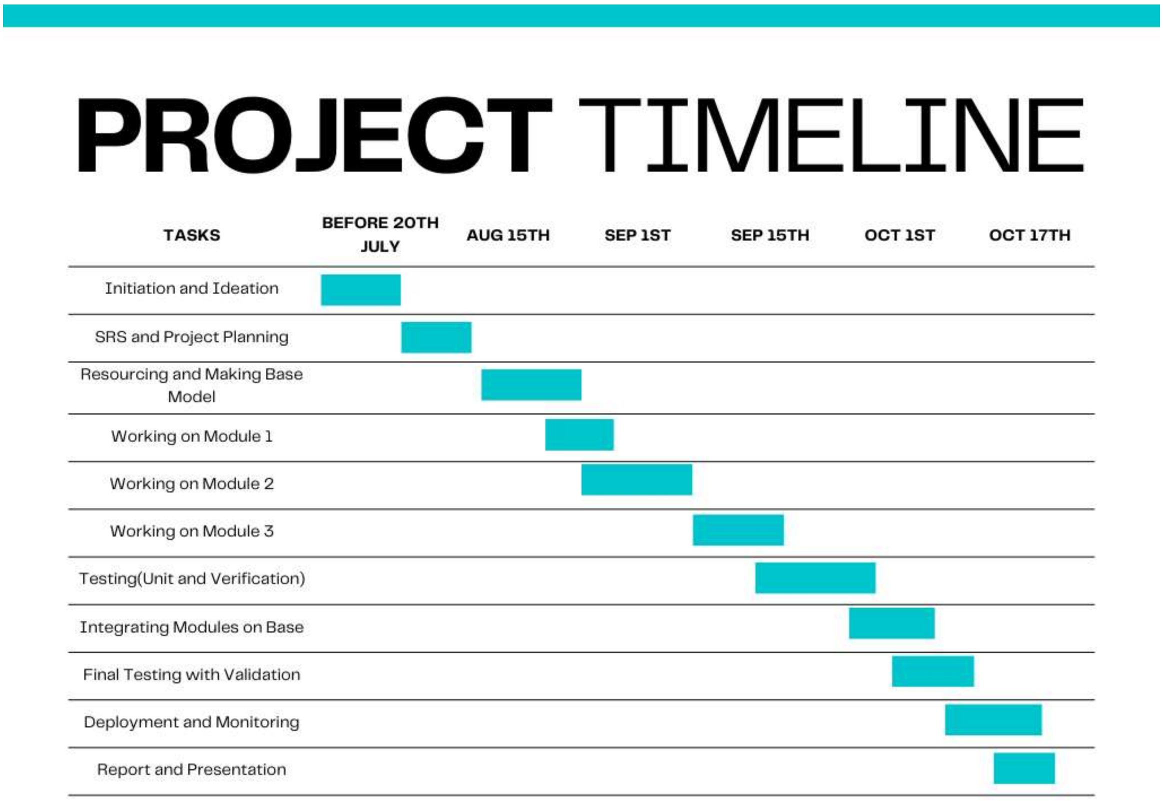

Fig. 7.1 Project Timeline of **Krushi Mitra**

8. Outcome and Discussion

8.1 Water Irrigation System

8.1.1 Outcome

The automatic irrigation system properly distributed water throughout the farm field. The system used rainwater level sensors, Arduino, relay, and solenoid valves to manage water flow through a network of pipes. The rainwater level sensors properly identified water when it reached the end of the field, and the solenoid valves were turned off using ESP8266 to prevent overflow of water. This resulted in huge water savings and guaranteed that crops received an adequate amount of water. The device ran autonomously and could be monitored remotely, providing farmers with ease while also assuring effective water use.

8.1.2 Discussion

The results show that the IoT-based irrigation system successfully automated water management. The integration of soil moisture sensors with solenoid valves provided real-time control over irrigation, improving water conservation. However, the system's efficiency may vary depending on soil topography and sensor placement. Future improvements could involve incorporating additional environmental sensors like humidity or temperature to further optimize water management. The system proved to be scalable, making it applicable for both small and large farm fields, contributing to sustainable agricultural practices.

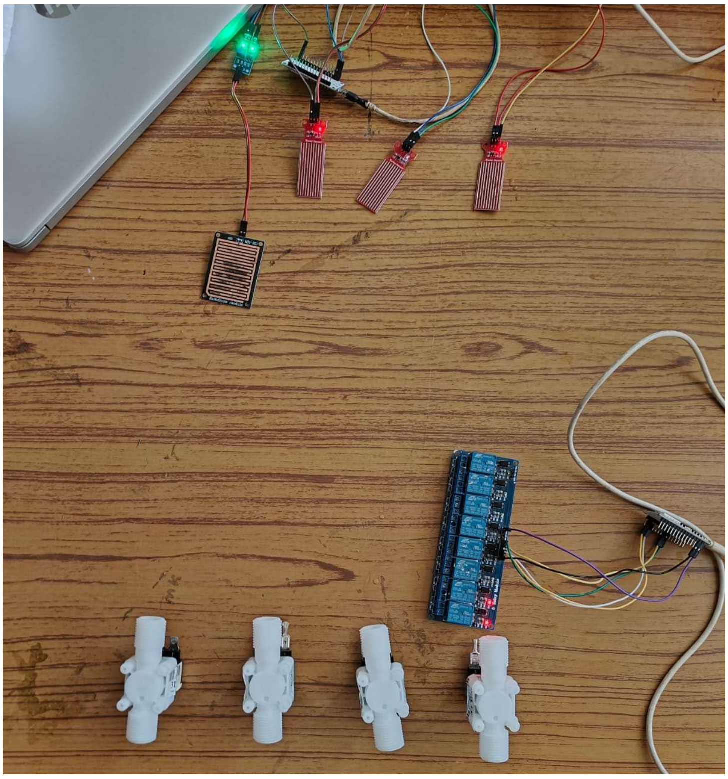

Fig. 8.1.2.1 Connection of Water Irrigation System

8.2 Animal Intrusion Detection and Prevention

8.2.1 Outcome

The animal detection and prevention module successfully implemented a system where a USB camera connected to a laptop captured live images of the farm. These images were processed using a pre-trained deep-learning model to detect animals like pigs, oxen, and cows. When an animal was detected, a request was sent to the Raspberry Pi, which activated a buzzer via a Flask-based web service [41]. This setup provided effective animal detection, and the buzzer successfully deterred animals without causing harm, ensuring crop protection. The system worked as intended, demonstrating a functional integration of image detection and automated deterrence.

8.2.2 Discussion

The solution effectively addressed the challenge of animal intrusion by combining image capture, deep learning-based detection, and hardware-based deterrence [42]. Although real-time processing was achieved through the laptop instead of the Raspberry Pi, the approach proved feasible. The use of Flask to send requests from the laptop to the Raspberry Pi worked efficiently, enabling a smooth transition between detection and deterrence.

However, the system's reliance on external hardware (the laptop) and network communication to trigger the buzzer introduces potential points of failure, such as network latency or disruptions in communication. Future improvements could focus on making the system more self-contained by migrating the detection process entirely onto the Raspberry Pi or an edge computing device. This would reduce dependencies and make the system more robust. Additionally, the accuracy of detection in low-light or extreme weather conditions could be improved by employing more advanced object detection algorithms [43]. Despite these limitations, the system provided a reliable and humane method for protecting crops from animal intrusion.

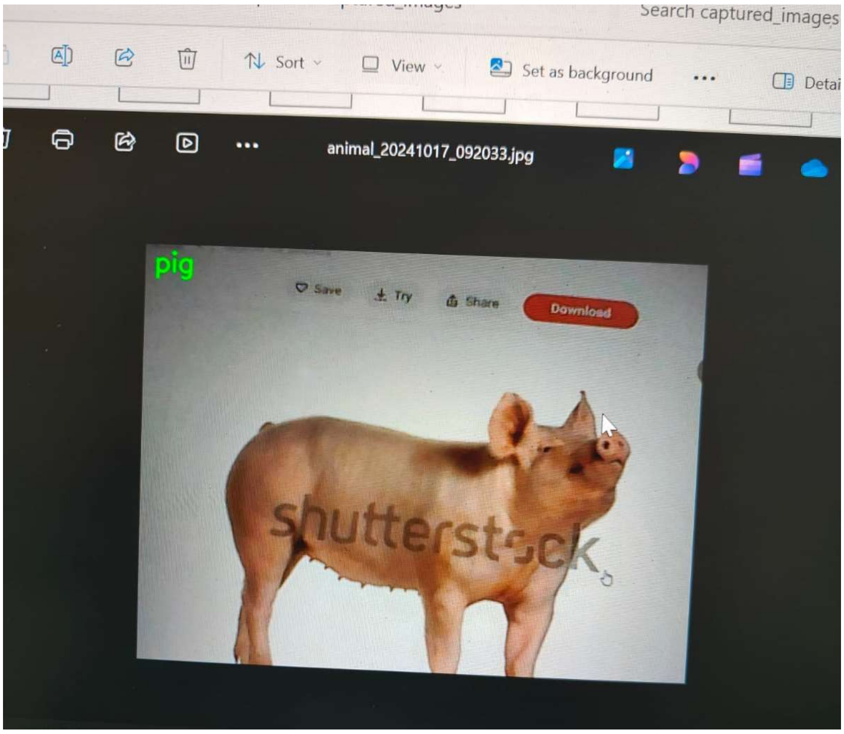

Fig. 8.2.2.1 Detection of an animal

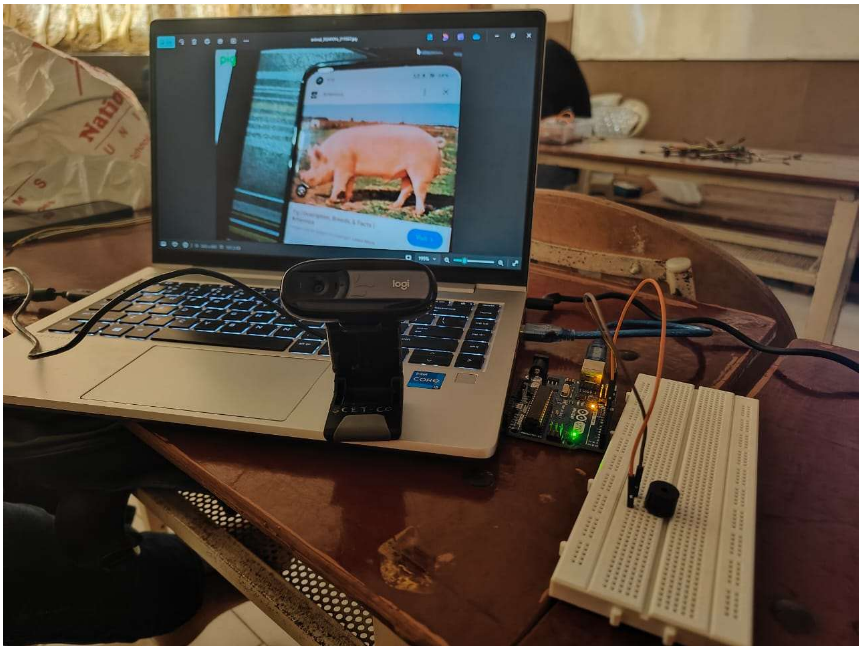

Fig. 8.2.2.2 Connection of Animal Intrusion Detection and Prevention

8.3 Crop and Fertilizers Recommendation

8.3.1 Outcome

The crop and fertilizer recommendation module successfully implemented a machine learning model trained on an existing dataset [44]. This model provided accurate recommendations for suitable crops and fertilizers based on the data available, considering various factors like soil nutrient levels. However, since the NPK sensor was not available, real-time soil nutrient data could not be integrated into the system. The model functioned effectively in its current state, offering reliable crop and fertilizer suggestions based on historical data, but lacked the dynamic capability to respond to real-time soil conditions.

8.3.2 Discussion

The development and training of the machine learning model for crop and fertilizer recommendation marked a significant step toward precision agriculture. The model demonstrated strong performance with the existing dataset, providing valuable insights into optimal crop selection and fertilizer use based on historical data. However, the absence of the NPK sensor limited the system's ability to offer real-time recommendations, which is crucial for dynamic and responsive agricultural practices. Once the sensor is integrated, the system can further improve by providing up-to-date nutrient information, allowing for more precise and timely recommendations.

The current system shows promise but highlights the importance of integrating real-time data for effective decision-making in agriculture. Future iterations should focus on incorporating NPK sensors to enable continuous monitoring of soil health, which would make the system more adaptable and beneficial for farmers in varying environmental conditions [45]. Despite the current limitations, the model has laid a strong foundation for the crop and fertilizer recommendation system, which will become more robust with the addition of sensor data.

```
Missing values:
 N        0
P        0
K        0
label    0
dtype: int64
Accuracy: 87.10%

Classification Report:
               precision    recall  f1-score   support

      grapes       0.85      0.96      0.90        24
       mango       0.74      0.94      0.83        18
    mulberry       0.95      0.90      0.93        21
 pomegranate       0.90      0.82      0.86        22
      potato       0.94      0.65      0.77        23
        ragi       0.89      1.00      0.94        16

    accuracy                           0.87       124
   macro avg       0.88      0.88      0.87       124
weighted avg       0.88      0.87      0.87       124

Recommended crop for N=130, P=40, K=200: pomegranate
Fertilizer required: Urea (N), DAP (P), MOP (K)
```

Fig. 8.3.2.1 Output of the recommendation model

9. Conclusion and Future Work

9.1 Conclusion

The **Krushi Mitra** project successfully integrates three essential modules to improve farming efficiency and sustainability. The automated irrigation system efficiently manages water distribution throughout the farm field reducing water wastage. The animal detection module effectively safeguards crops by utilizing deep learning algorithms to detect and deter animals such as oxen, cows, and pigs from entering the fields. Finally, the nutrient analysis module provides farmers with accurate soil nutrient information, helping them make informed decisions about suitable crops and fertilizers, which leads to optimized yields and better soil health.

9.2 Future Work

9.2.1 Water Detection System

- Future improvements could include enhancing the accuracy of the rainwater level sensor for better detection of water levels in different soil types or terrains.
- Integrating mobile notifications or alerts when the solenoid valve is triggered would allow farmers to monitor the water flow system remotely.
- An antenna can be used to successfully connect the rainwater level sensors and WiFi module in a large farm field

9.2.2 Animal Intrusion Detection and Prevention

- Implementing more advanced algorithms like YOLOv5 or Faster R-CNN could improve accuracy under varying lighting and weather conditions.
- Incorporating visual deterrents like flashing lights or automated barriers would offer more robust protection against animals.
- Integrating cloud-based monitoring could enable real-time alerts and remote field management for farmers.
- Using edge computing devices like Google Coral could enable faster, on-device processing, reducing reliance on external systems.

9.2.3 Crop and Fertilizers Recommendation

- The nutrient analysis system could be upgraded by integrating more soil parameters like moisture and pH, providing a broader view of soil health.
- The system could be expanded to monitor and analyze soil carbon levels, helping farmers adopt sustainable farming practices. This would contribute to global efforts in reducing carbon emissions through enhanced soil carbon sequestration techniques.
- Implementing machine learning algorithms could allow the system to analyze historical soil data, crop cycles, and weather conditions to provide dynamic, season-specific recommendations for crop rotation and fertilizer use. This would help maintain soil fertility over the long term while maximizing crop output.

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