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VISVESVARAYA TECHNOLOGICAL UNIVERSITY - BELAGAVI

A
Main Project report
on

"AI ENABLED SMART AGRICULTURE SYSTEM"

Submitted in the partial fulfillment for the award of
Bachelor of Engineering
in
Electronics and Communication Engineering

Submitted by

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DEPARTMENT
OF
ELECTRONICS AND COMMUNICATION ENGINEERING

2022-2023

GOVERNMENT ENGINEERING COLLEGE

HAVERI - 581 110

(Affiliated to Visvesvaraya Technological University)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Certificate

This is to certify that the Main project work entitled ***"AI ENABLED SMART AGRICULTURE SYSTEM"*** *carried out by* ***ANNADANESHWAR C 2GO19EC002, BHARATHKUMAR K 2GO19EC006, HEMANTH U 2GO19EC007, ROHIT B A 2GO19EC025*** *are bonafide students of Government Engineering College, Haveri in partial fulfillment for the award of Bachelor of Engineering in Electronics and Communication Engineering of the Visvesvaraya Technological University, Belgaum during the year 2022-2023. The Main project report has been approved as it satisfies the academic requirements in respect of the Main project work prescribed for the said Degree.*

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ABSTRACT

An AI-enabled smart agriculture system is a cutting-edge technology that utilizes artificial intelligence to enhance farming practices. It combines different AI techniques such as machine learning, computer vision, and natural language processing to automate and optimize various farming tasks. This project report describes the design and implementation of an AI-enabled smart agriculture system that utilizes deep neural networks for animal detection and convolutional neural networks for plant disease detection. The system includes a moisture detection system to monitor the soil's moisture level, enabling the farmer to irrigate the crops efficiently.

LIST OF FIGURES

ABBREVIATIONS

AI	-	Artificial Intelligence
DNN	-	Deep Neural Network
CNN	-	Convolutional Neural Network
IoT	-	Internet of Things
H-Bridge	-	Hybrid Bridge
SMS	-	Short message service

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CHAPTER – 1
INTRODUCTION

1.1 PREAMBLE

Food is a basic requirement for every living being. We depend on plants and animals for food. Ancient men began the cultivation of food in small areas and used certain procedures for their management and improvement. This art of cultivation of the crop is called agriculture.

In agriculture, there are certain parameters to be considered such as the type of crop, properties of soil, climate, etc. Depending upon these parameters, formers decide which crop is to be cultivated at what time of the year and place. Moreover, to yield a high-quality product, suitable soil, climate and season are not sufficient. It requires a set of procedures that needed to be followed. The measures which are followed to rise crops are called agricultural practices.

By smart agriculture we mean the use of digital techniques to re-invent, govern and optimize agricultural production processes. Digital transformation boosts human intervention in agriculture and helps reduce the workload, carry out specific measures, and guarantee and increase the harvest. It also helps to manage all those processes that enable or support agricultural production, including economic-administrative processes. The objective of smart agriculture is to offer solutions that can be applied to all formers.

So far, the benefits expected from introducing and integrating technological processes in agriculture have been attributed to greater production and quality efficiency, optimization of inputs, and minimization of environmental infects. According to analysts the global smart agriculture market, which was worth almost $10 billion in 2017, will exceed $23 billion in 2023.

The traditional methods which were used by the farmers were not sufficient enough to fulfill the requirements. Thus, new automated methods were introduced. These new methods satisfied the food requirements and also provided employment opportunities to billions of people. Artificial Intelligence in agriculture has brought an agricultural revolution. This technology has protected crop yield from various factors like climate changes, population growth, employment issues, animal attacks, and food security problems.

AI is an emerging technology in the field of agriculture. AI-based equipment and machines have taken today's agriculture system to a different level. This technology has enhanced crop production and improved real-time monitoring, harvesting, etc…

Deep learning is a subset of machine learning that uses neural networks to learn and make predictions from complex datasets. One of the key applications of deep learning in agriculture is crop yield prediction. By training deep neural networks on historical weather data, soil quality data, and crop performance data, farmers can accurately predict crop yields and plan their planting and harvesting accordingly. Another important application of deep learning in agriculture is weed detection and classification. Deep learning algorithms can be trained to identify and differentiate between different types of weeds, allowing farmers to use targeted herbicides and reduce the use of harmful chemicals. Deep learning can also be used for plant disease detection and classification. By training deep neural networks on images of diseased plants, farmers can quickly and accurately identify diseases and take necessary measures to prevent their spread.

The Internet of Things (IoT) is an advanced technology for monitoring and controlling devices worldwide. It can connect devices with living things. The Internet of Things is making a significant mark in many fields. Nowadays, the adaptive nature of IoT has transformed and can be utilized by ordinary users. Several methodologies that IoT has developed made man's life easier and more comfortable like smart education, cities, the e-health sector, and automation. Apart from man's comforts, these methodologies should be implemented on basic needs like food, which can be achieved from the agricultural fields.

IoT is ushering in a new era of smart farming to allow farmers to grow crops in a more controlled and productive manner, and facilitate better utilization of land throw proper crop selection and enhanced monitoring of soil, irrigation, temperature, weather monitoring, and other critical aspects that impact the yield.

1.2 PROBLEM STATEMENT

Agriculture is one of the major sources of economy in the country. There is a steady increase in demand for crops with population growth. Modernization in agriculture reduces dependency on individual human labor. In the traditional farming method, farmers are facing the problems like,

i. Crop damage caused by animals is one of the major threats in reducing crop yield. This leads to a huge loss for farmers.
ii. Diseases can damage crops in all stages of development and affect crop yield.
iii. Loss of moisture in the soil leads to less yield

Hence, there is a need to implement a smart agricultural system based on AI technology using machine learning for the protection of crops from animals, detecting leaf diseases in the early stage, and better production of the crops.

1.3 OBJECTIVES

The main objectives are:

1. Deploying animal detection system with night vision camera using Deep learning algorithm DNN.
2. Deploying leaf disease detection system with the camera using the Deep learning algorithm CNN.
3. Gather soil moisture information through sensors and send it to the user application.

CHAPTER – 2
LITERATURE REVIEW

In paper [1] the authors have described the conservation of crop fields. The animals are continuously attacking the crop field over the years and the protection of this crop field has become a main concern. The techniques that are already being used are ineffective, in this article the authors have presented a practical procedure by creating a system that studies the behaviour of the animal, detects the animal, and creates a different sound that irritates the animal, and also alerts the authorized person by sending a message. The authors also provide a multi-class classification by presenting zero false alarm rates and accurate species identification.

Agriculture is the primary source of livelihood for 70% of the population, and detecting plant diseases is crucial to prevent yield losses. However, manual observation of plant diseases is a challenging task that requires a lot of expertise, time, and labor. To address this issue, image processing, and machine learning models can be utilized for disease detection using plant leaf pictures[2]. Image processing can extract essential information from images, while machine learning algorithms can learn from large training datasets to make accurate predictions. By analyzing leaf color, damage, area, and texture, different plant leaf diseases can be identified with high accuracy. This approach is computationally efficient and more cost effective than traditional methods that rely on visual inspection or chemical processes. A computer vision-based system has been developed with an average accuracy of 93% and 0.93 F1 score, making it a useful tool for monitoring large fields of crops.

Integration of Internet technologies, particularly cloud computing and the Internet of Things (IoT), in the agriculture sector, leading to the emergence of smart farming. The authors in [3] present a cloud computing-based real-time agricultural monitoring and analysis system that enables farmers to collect and disseminate agricultural data in real time from anywhere. The paper highlights the benefits of using cloud computing service models for storing and accessing agriculture data from multiple sources, which greatly impacts performance in the offline and real-time environment. The authors emphasize the need for capacity-building and innovative technologies in the agricultural sector, particularly in countries like Pakistan with a large agricultural sector. They conclude by discussing future work on critical factors of cloud-based agriculture, such as precision agriculture, telematics, and data analytics, using artificial intelligence-based techniques**.**

The work in [4] proposes an embedded-based automatic irrigation system that utilizes Internet of Things (IoT) technology to improve crop productivity while minimizing the unmerited usage of water. The system employs smart sensors to monitor moisture and temperature variations in crop fields, which are controlled by a Raspberry Pi microcontroller and a cloud-based IoT system. The results of experimental tests indicate that the proposed system provides a complete solution to irrigation problems, improves crop production, and increases the overall productivity of agricultural fields. With the automation and real-time monitoring provided by this system, farmers can efficiently manage water resources and avoid human errors, thereby optimizing crop growth and yield**.**

Paper [5] presents a solution to the problem of animal attacks and crop destruction in rural India. The lack of proper safety measures and detection systems has resulted in the loss of both human and animal lives. The proposed system utilizes global system for mobile communication (GSM) and short message service (SMS) to keep away wild animals from farmlands, and provides surveillance functionality to distinguish between an intruder and an authorized person. The system includes RFID's, PIR sensors, and Haar feature based cascade classifiers for object detection, which trigger cameras to capture images and videos of intrusions. The recorded footage is stored on an SD card and in the cloud, which allows landowners to view the video on any smart device. This system is cost-effective, consumes less energy, and has the potential to prevent crop destruction, save farmers from significant financial losses, and increase crop yields, leading to their economic well-being. Overall, this project has great social relevance and aims to address a significant problem faced by rural farmers in India.

The paper [6] presents the development of the Internet of Things (IOT) and Machine learning technique-based solutions to overcome animal intrusion problem. Raspberry Pi runs the machine algorithm, which is interfaced with the ESP8266 Wireless Fidelity module, Pi Camera, Buzzer, and LED. Machine learning algorithms like Region-based Convolutional Neural Network and Single Shot Detection technology plays an important role to detect object in the images and classify the animals. Their experiment reveals that the Single Shot Detection algorithm outperforms than Region-based Convolutional Neural Network algorithm. Finally, the Twilio API interfaced software decimates the information to the farmers to take decisive action in their farm fields.

Paper [7] focuses on the detection and analysis of fruit diseases, particularly those affecting pomegranates, which cause significant production and economic losses in agriculture industries. The lack of sensors that can provide real-time diagnosis and analysis of fruit health is addressed through the proposed implementation of a smart farming system that utilizes advanced technology. Specifically, the paper proposes the use of image processing for automatic fruit disease detection and discusses various techniques for disease segmentation, feature extraction, and disease classification. The paper highlights the importance of accurately detecting and classifying plant diseases for successful crop cultivation and suggests the use of artificial neural network methods such as self-organizing feature maps, backpropagation algorithms, and support vector machines for disease classification.

CHAPTER – 3

DEEP LEARNING

3.1 INTRODUCTION TO DEEP LEARNING

Deep learning is a type of machine learning that has shown remarkable success in solving complex problems that were previously difficult to solve with traditional machine learning techniques. It is a subset of artificial intelligence that is based on neural networks and has been inspired by the structure and function of the human brain.

One of the key advantages of deep learning is its ability to learn directly from raw data without the need for human experts to engineer features. This means that deep learning algorithms can be trained on large and diverse datasets, and can automatically learn to recognize patterns and features that are difficult to identify through manual feature extraction.

Deep learning has been applied to various fields, such as computer vision, natural language processing, and speech recognition. For example, in computer vision, deep learning algorithms can be trained to identify objects in images, recognize faces, or even predict actions in videos. In natural language processing, deep learning can be used for machine translation, sentiment analysis, and text generation.

Deep learning algorithms typically require a lot of computational power to train effectively. This is because training a deep neural network involves updating a large number of parameters, and requires a large amount of memory and processing power. As a result, deep learning is often performed on specialized hardware such as graphics processing units (GPUs) or tensor processing units (TPUs).

Deep learning is a rapidly evolving field that continues to push the boundaries of what machines can do. It has the potential to transform many industries, including healthcare, finance, and transportation, and is likely to be a key technology in the development of future intelligent systems.

3.2 ABOUT NEURAL NETWORKS

Neural networks are a type of machine learning algorithm inspired by the structure and function of the human brain. They are widely used in a variety of fields, including computer vision, natural language processing, speech recognition, and robotics. Neural networks consist of interconnected nodes, or neurons, that process and transmit information in a way that allows the network to learn and make predictions.

Neural networks are built from layers of interconnected neurons, where each neuron is a mathematical function that takes in inputs and produces an output. The neurons are organized into layers, where the inputs to the network are fed into the first layer, the outputs from the first layer are fed into the second layer, and so on, until the final layer produces the network's output.

Each neuron in the network has a set of weights and biases that are learned during training. These weights and biases determine how the neuron processes its inputs and contributes to the overall output of the network. During training, the network is presented with examples of inputs and their corresponding desired outputs, and the weights and biases are adjusted to minimize the difference between the network's predictions and the true outputs.

There are several types of neural networks, each suited to different types of tasks. Feedforward neural networks, which propagate information in one direction from input to output, are commonly used for tasks such as classification and regression. Recurrent neural networks, which have connections that allow information to be fed back into the network, are used for tasks such as natural language processing and time series prediction. Convolutional neural networks, which have specialized layers for processing spatial data such as images, are used for tasks such as object recognition and image segmentation.

Neural networks have achieved impressive results in many areas, including computer vision, speech recognition, natural language processing, and game playing. However, they also have limitations, such as requiring large amounts of data for training and being prone to overfitting if not properly regularized. Nonetheless, as computing power and data availability continue to increase, neural networks are likely to remain a powerful tool for solving complex problems in a wide range of fields.

3.3 ABOUT DEEP NEURAL NETWORK

Deep neural networks (DNNs) are a type of neural network that have many hidden layers between the input and output layers. The number of hidden layers in a DNN can range from a few to hundreds or even thousands, depending on the complexity of the task. DNNs have become increasingly popular in recent years, thanks in part to the availability of large amounts of data and powerful computing resources that make it possible to train these networks effectively.

The primary advantage of DNNs is their ability to learn complex representations of data. By adding more layers to the network, DNNs are able to capture higher-level features and abstractions in the data, allowing them to model more complex relationships and patterns. This makes DNNs particularly effective for tasks such as image and speech recognition, natural language processing, and game playing.

Deep neural networks (DNNs) have revolutionized the field of artificial intelligence and machine learning in recent years, and for good reason. These powerful networks have shown remarkable abilities to learn and generalize from data, making them an excellent tool for a wide range of applications.

One of the primary advantages of DNNs is their ability to learn complex representations of data, allowing them to model highly nonlinear relationships between inputs and outputs. This makes them especially well-suited for tasks such as image and speech recognition, natural language processing, and autonomous control.

DNNs have also proven highly effective at transfer learning, which allows them to quickly adapt to new data sets or tasks after being trained on a different set of data. This makes them highly flexible and adaptable to a wide range of real-world applications.

Another key advantage of DNNs is their ability to scale up in size and complexity, allowing them to model increasingly complex and sophisticated behaviors. By adding more layers and neurons to the network, DNNs are able to learn higher-level features and abstractions in the data, enabling them to model more complex relationships and patterns.

Despite their complexity, DNNs have become increasingly accessible to researchers and developers, thanks to the development of powerful frameworks such as TensorFlow and PyTorch. These frameworks have made it easier than ever to build, train, and deploy DNNs in a wide range of applications.

Overall, DNNs represent a powerful tool for machine learning and have shown impressive results in many areas. They have the potential to transform many industries and applications, from healthcare and finance to autonomous driving and robotics. With ongoing research and development, it is likely that DNNs will continue to advance and become even more powerful in the years to come.

3.4 ABOUT CONVOLUTIONAL NEURAL NETWORK

Convolutional Neural Network, which is a type of deep neural network that is commonly used for image and video recognition, analysis, and processing. CNNs are designed to automatically and adaptively learn spatial hierarchies of features from input data, such as images. They do this by using convolutional layers that apply filters or kernels to the input image in order to extract various features. Each convolutional layer can detect different features at different levels of abstraction. For example, the first convolutional layer might detect simple edges or shapes, while later layers might detect more complex objects or patterns.

CNNs are often used in computer vision applications, where they excel at tasks such as image classification, object detection, and segmentation. One of the key features of CNNs is their ability to learn spatial hierarchies of features from input data, such as images. This is achieved through the use of convolutional layers, which apply filters or kernels to the input image in order to extract different features.

In addition to convolutional layers, CNNs may also include other types of layers, such as pooling layers, which reduce the dimensionality of the feature maps by downsampling them, and activation layers, which apply non-linear functions to the output of each layer to introduce non-linearity into the network.

One of the benefits of CNNs is that they are able to learn features automatically, without the need for manual feature engineering. This is particularly useful for image recognition and other computer vision tasks, where hand-crafting features can be challenging and time-consuming.

Another important feature of CNNs is their ability to perform transfer learning. This means that a CNN that has been trained on one task or dataset can often be re-purposed for a different task or dataset, by fine-tuning the weights of the network on the new data. This can significantly reduce the amount of data required for training and can lead to improved performance on the new task.

CNNs have been applied in a wide range of applications, from facial recognition and self-driving cars to medical image analysis and industrial quality control. They have achieved state-of-the-art performance on many benchmark datasets and are widely used in industry and academia.

Overall, CNNs are a powerful and versatile tool for analyzing and processing visual data, and their ability to learn features automatically has made them particularly well-suited for computer vision tasks. With ongoing research and development, it is likely that CNNs will continue to advance and become even more powerful in the future.

CHAPTER - 4

METHODOLOGY

4.1 COMPONENTS REQUIRED

4.1.1 HARDWARE REQUIRED:

- Raspberry Pi 3 model B
- Moisture Sensor
- H-bridge
- Buzzer
- Relay
- Camera
- Processor: Intel Core i5Processor
- RAM: 8GB
- Speed: 2.2GHZ

1. Raspberry Pi 3 Model B:

Fig 4.1: Raspberry pi 3 model B

The Raspberry Pi 3 Model B contains a wide range of improvements and features that will benefit the designers, developers, and even engineers who are looking to integrate Pi systems into their products. Here are some of the new Pi's specs:

- Quad core 64-bit processor clocked at 1.4GHz
- 1GB LPDDR2 SRAM
- Dual-band 2.4GHz and 5GHz wireless LAN
- Bluetooth 4.2 / BLE
- Higher speed ethernet up to 300Mbps
- Power-over-Ethernet capability (via a separate PoE HAT)

The table below shows the specs of the Raspberry Pi 3 B

Spec	Raspberry Pi 3 B
CPU type/speed	RASPBERRY PI Cortex-A53 1.2GHz
RAM size	1GB SRAM
Integrated Wi-Fi	2.4GHz
Ethernet speed	10/100 Mbps
PoE	No
Bluetooth	4.1

- **Boosts All Around**

  Thanks to the ever-increasing technological capabilities of electronics, this Raspberry Pi does not fall behind in any category, at least compared to other Pi computers. It either matches the old model's speed or significantly improves upon it. For example, the CPU has been clocked at 1.4GHz, which is 200MHz faster than the Pi 3 B, and the ethernet speed has been boosted from 100Mbps to 300Mbps

Fig 4.2: The heart of the Raspberry Pi 3 Model B

- **Physical Features**

While the mechanical layout of the Pi has not changed (GPIO location, drill holes, etc.), the PCB itself has clearly undergone some physical changes. The main processor is no longer housed in a plastic package. Instead, it has a metal package, which may be beneficial for those who want to keep the temperature of the Pi as low as possible (with the aid of a heat sink). The top side also shows fewer components, and a four-pin header (used for PoE) has been included in the top right of the PCB.

It is a small board computer, introduced by Raspberry Pi Foundation on 14th March 2018, and is the most recent version of the Pi boards.
It is a modified form of its predecessor Raspberry Pi 3 B that was introduced in 2016 and came with CPU, GPU, USP ports, and I/O pins. Both versions are almost the same in terms of functionality and technical specifications; however, there are some exceptions in the B+ model as it comes with USB boot, network boot, and Power over Ethernet option that are not present in the B model.

Technology has been evolved over time with the purpose of making lives easy and convenient. This device was a major development in the technology that made computer learning too easy that anyone with little effort can make their feet wet with the process.

In this tutorial, I'll discuss each and everything related to Raspberry Pi 3 B+, its main functions and features, benefits and everything you need to know, so you find all information in one place without wrestling your mind on web surfing. Let's dive right in.

- **Raspberry Pi 3 Model B+ pin diagram:**

40 Pin header is used to develop an external connection with the electronic device. This is the same as the previous versions, making it compatible with all the devices where older versions can be used.

Out of 40 pins, 26 are used as digital I/O pins, and 9 of the remaining 14 pins are termed as dedicated I/O pins which indicates they don't come with an alternative function.

Pin 3 and 5 come with an onboard pull-up resistor which is 1.8 kΩ and Pin 27 and 28 are dedicated to ID EEPROM. In the B+ model, the GPIO header is slightly repositioned to allow more space for the additional mounting hole. The devices that are compatible with the B model may work with the B+ version; however, they may not sit identically to the previous version.

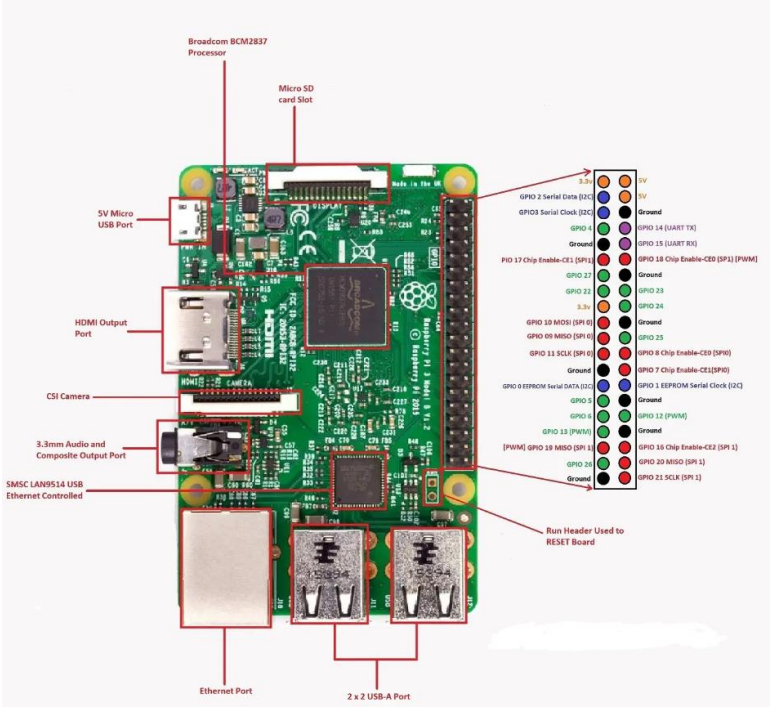


Fig 4.3: Raspberry pi 3 model B pin diagram

- CPU: The CPU is a brain of this tiny computer that helps in carrying out a number of instructions based on the mathematical and logical formulas. It comes with a capacity of 64 bit.
- Clock Speed and RAM: It comes with a clock speed of 1.4 GHz Broadcom BCM2837B0 that contains quad-core RASPBERRY PI Cortex-A53 and RAM memory is around 1GB (identical to the previous version)
- GPU: It stands for graphics processing unit, used for carrying out image calculation. Broadcom video core cable is added to the device mainly used for playing video games.
- USB Ports: Two more USB ports are introduced in this new version, setting you free from the hassle of using an external USB hub when you aim to join a number of peripherals with the device.

- Micro USB Power Source Connector: This connector is used for providing 5V power to the board. It draws 170 to 200mA more power than B model.
- HDMI and Composite Connection: Both audio output socket and video composite now reside in a single 4-pole 3.5mm socket which resides near HDMI. And the power connector is also repositioned in the new B+ model and lives next to the HDMI socket. All the power and audio video composite socket are now placed on one side of the PCB, giving it a clean and precise look.
- USB Hard Drive: The USB hard drive is available on the board that is used to boot the device. It is identical to the hard drive of a regular computer where Windows is used to boot the hard drive of the computer.
- PoE: B model comes with a facility of Power over Ethernet (PoE); a new feature added in this device that allows the necessary electrical current using data cables.
- Other Changes: The B+ version comes with little improvement in the features and poses a slightly different layout in terms of the location of the components. The SD memory slot is replaced by a micro-SD memory card slot (which works similarly to the previous version). The status LEDs now only contain red and green colors and are relocated to the opposite end of the PCB.

2. Moisture sensor:

Soil moisture sensor measures the water content in soil. It uses the property of the electrical resistance of the soil.

The sensor is set up by two pieces: the electronic board (at the right), and the probe with two pads, that detects the water content (at the left).

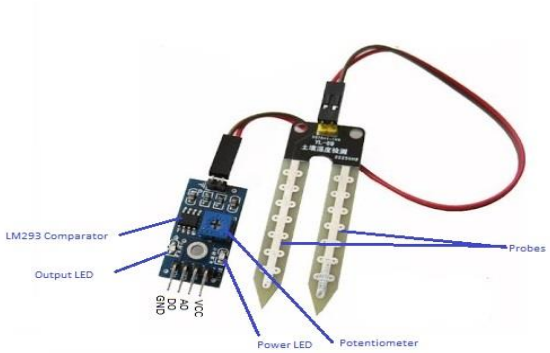


Fig 4.4: Moisture Sensor

The sensor has a built-in potentiometer for sensitivity adjustment of the digital output (D0), a power LED and a digital output LED, as you can see in the following figure.

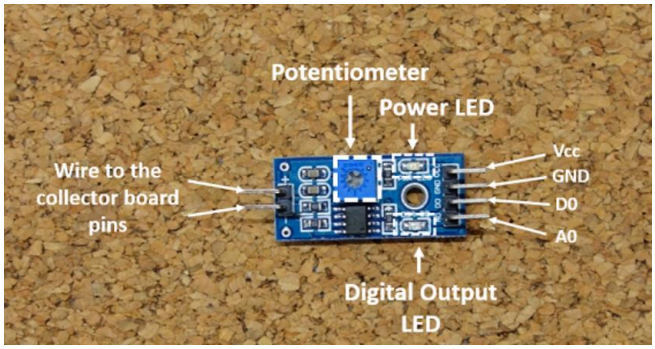


Fig 4.5: Moisture sensor module

When the soil is:

- **Wet:** the output voltage decreases
- **Dry:** the output voltage increases

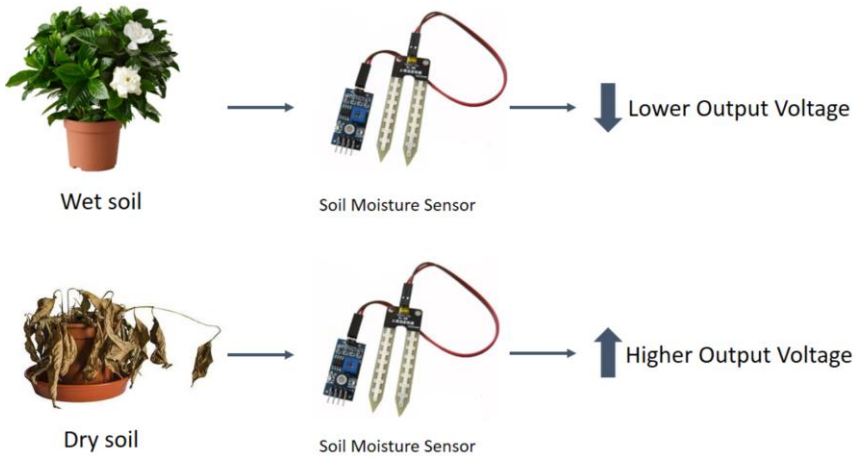


Fig 4.6: Voltage variation in Moisture sensor

The output can be a digital signal (D0) LOW or HIGH, depending on the water content. If the soil humidity exceeds a certain predefined threshold value, the modules outputs LOW, otherwise it outputs HIGH. The threshold value for the digital signal can be adjusted using the potentiometer. The output can be an analog signal and so you'll get a value between 0 and 1023

Here, it is used to sense the moisture in the field and transfer it to the microcontroller in order to take the controlling action of switching the water pump ON/OFF.

3. L293D:

A H-Bridge is nothing but an electronic circuit. using such circuit, we can supply current in two directions. The L293D is an h-bridge with two possible outputs.

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600 mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc, and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

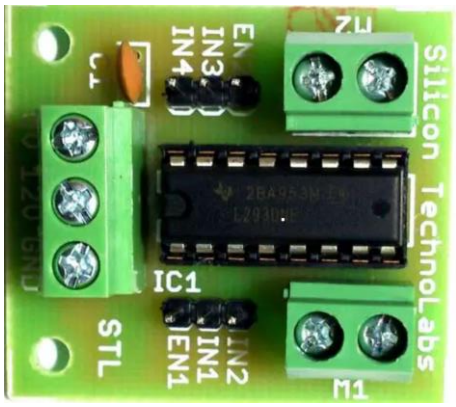


Fig 4.7: L293D

4. Buzzer:

An audio signalling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

The pin configuration of the buzzer is shown below. It includes two pins namely positive and negative. The positive terminal of this is represented with the '+' symbol or a longer terminal. This terminal is powered through 6Volts whereas the negative terminal is represented with the '-' symbol or short terminal and it is connected to the GND terminal.

Specifications: The specifications of the buzzer include the following.

- Color is black
- The frequency range is 3,300Hz
- Operating Temperature ranges from – 20° C to +60°C

- Operating voltage ranges from 3V to 24V DC
- The sound pressure level is 85dBA or 10cm
- The supply current is below 15mA

Fig 4.8: Buzzer

Piezoelectric: As the name suggests, the piezoelectric type uses the piezoelectric ceramic's piezoelectric effect & pulse current to make the metal plate vibrate & generate sound. This kind of buzzer is made with a resonance box, multi-resonator, piezoelectric plate, housing, impedance matcher, etc. Some of the buzzers are also designed with LEDs. The multi-resonator of this mainly includes ICs and transistors. Once the supply is given to this resonator, it will oscillate and generates an audio signal with 1.5 to 2. kHz. The impedance matcher will force the piezoelectric plate to produce sound.

Buzzer Circuit Diagram: The circuit diagram of the water level indicator using the buzzer is shown below. This circuit is used to sense or detect the water level within the tank or washing machine or pool, etc. This circuit is very simple to design using few components such as a transistor, buzzer, 300K variable resistor, and power supply or 9V battery.

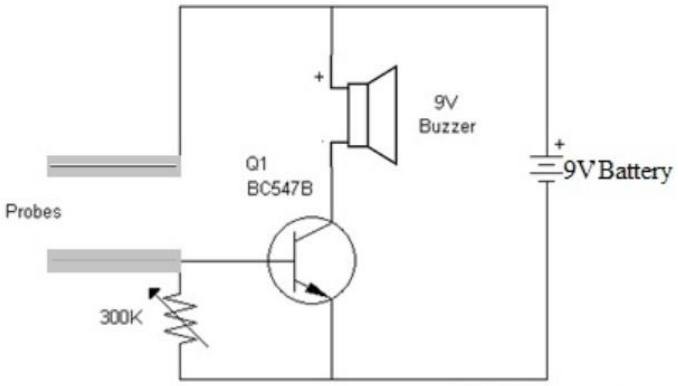


Fig 4.9: Buzzer circuit diagram

Once the two probes of the circuit are placed in the tank, it detects the level of water. Once the water level exceeds the fixed level, then it generates a beep sound through a buzzer connected

to the circuit. This circuit uses a BC547B NPN transistor however we can also use any general-purpose transistor instead of using 2N3904/2N2222.

5. Relay:

A Relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism, but other operating principles are also used. Relays find applications where it is necessary to control a circuit by a low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays found extensive use in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly drive an electric motor is called a contractor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device triggered by light to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protection relays".

Fig 4.10: Relay

Advantages of relays:

- Relays can switch AC and DC; transistors can only switch DC.
- Relays can switch high voltages, transistors cannot.
- Relays are a better choice for switching large currents (> 5A).
- Relays can switch many contacts at once.

6. Camera:

- Inbuilt sensitive microphone and image sensor quality CMOS Sensor.
- Image resolution interpolated to 25 megapixels with 6 light sensors.
- Image control colour saturation, brightness, sharpness and brightness is adjustable.
- Snapshot switch for taking still pictures. Focus Range 4cm to infinity. Anti-flicker 50Hz, 60Hz or outdoor.
- Resolution hardware: 500K pixels.
- Image quality: RGB24 or I420

Fig 4.11: Camera

4.1.2 SOFTWARE REQUIRED:

- Raspberry pi OS
- Python
  - Open CV
- SMS
- Code Editor: VS Code
- Operating System: Windows 10, Linux

1. Raspberry pi OS:

Raspberry Pi OS was first developed by Mike Thompson and Peter Green as Raspbian, an independent and unofficial port of Debian to the Raspberry Pi. The first build was released on July 15, 2012. As the Raspberry Pi had no officially provided operating system at the time, the Raspberry Pi Foundation decided to build off of the work done by the Raspbian project and began producing and releasing their own version of the software.

Raspberry Pi OS is highly optimized for the Raspberry Pi line of compact single-board computers with ARM CPUs. It runs on every Raspberry Pi except the Pico microcontroller.

Raspberry Pi OS uses a modified LXDE as its desktop environment with the Openbox stacking window manager, along with a unique theme. The default distribution is shipped with a copy of the algebra program Wolfram Mathematica, VLC, and a lightweight version of the Chromium web browser.

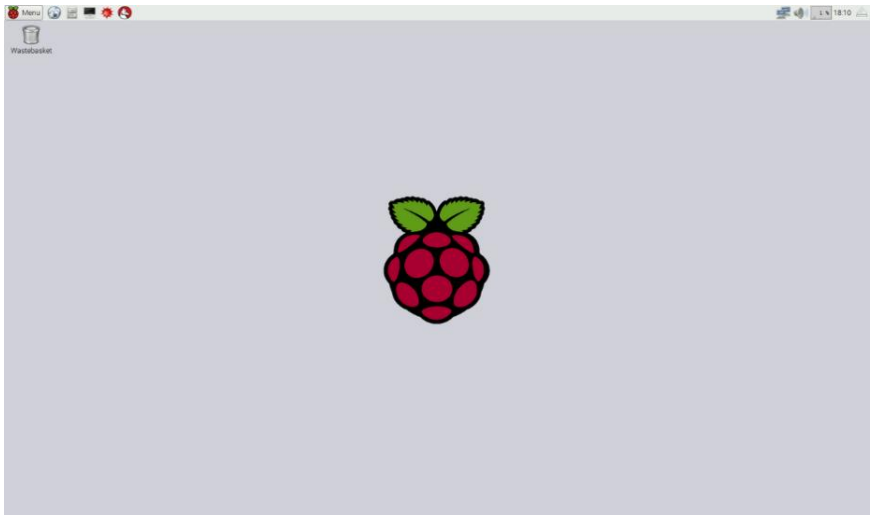


Fig 4.12: Raspberry pi user interface

User interface: Raspberry Pi OS has a desktop environment, PIXEL, based on LXDE, which looks similar to many common desktops, such as macOS and Microsoft Windows. The desktop has a background image. A menu bar is positioned at the top and contains an application menu and shortcuts to a web browser (Chromium), file manager, and terminal. The other end of the menu bar shows a Bluetooth menu, Wi-Fi menu, volume control, and clock. The desktop can also be changed from its default appearance, such as repositioning the menu bar.

Package Management: Packages can be installed via APT, the Recommended Software app, and by using the Add/Remove Software tool, a GUI wrapper for APT

- PCManFM is a file browser allowing quick access to all areas of the computer and was redesigned in the first Raspberry Pi OS Buster release (2019-06-20).
- Raspberry Pi OS originally used Epiphany as the web browser but switched to Chromium with the launch of its redesigned desktop.
- Raspberry Pi OS comes with many beginner IDEs, such as Thonny Python IDE, Mu Editor, and green foot. It also ships with educational software like Scratch and Bookshelf.

Steps to Install Raspberry Pi OS

Step 1: Download the Required Software and Files

Step 2: Get the SD Card and the Card Reader

Step 3: Check the Drive in Which the SD Card Is Mounted

Step 4: Format the SD Card Step 5: Write the OS on the SD Card

Step 6: Eject the SD Card

- Once Raspberry Pi Imager has finished writing the files to the SD card, it will verify that the image on the SD card is identical to the image file used to burn the image. This usually takes less than a minute but could take longer.
- When the verification process is complete, a notification window will open letting you know that the write was successful and that it's now safe to remove the SD card.

2. Python:

Python is a high-level, interpreted, general-purpose programming language. Its design philosophy emphasizes code readability with the use of significant indentation. Python is dynamically-typed and garbage-collected. It supports multiple programming paradigms, including structured (particularly procedural), object-oriented and functional programming. It is often described as a "batteries included" language due to its comprehensive standard library.

Fig 4.13: Python logo

The project is programmed using Python. Python is an Interpreted, object-oriented, high-level programming language with dynamic semantics. Its high-level built-in data structures, combined with dynamic typing and dynamic binding, make it very attractive for Rapid Application Development, as well as for use as a scripting or glue language to connect existing components together. Python's simple, easy-to-learn syntax emphasizes readability and therefore reduces the cost of program maintenance. Python supports modules and packages, which encourages program modularity and code reuse. The Python interpreter and the extensive standard library are available in source or binary form without charge for all major platforms and can be freely distributed. Often, programmers fall in love with Python because of the

increased productivity it provides. Since there is no compilation step, the edit-test-debug cycle is incredibly fast. Debugging Python programs is easy: a bug or bad input will never cause a segmentation fault. Instead, when the interpreter discovers an error, it raises an exception. When the program doesn't catch the exception, the interpreter prints a stack trace. A source-level debugger allows inspection of local and global variables, evaluation of arbitrary expressions, setting breakpoints, stepping through the code a line at a time, and so on. The debugger is written in Python itself, testifying to Python's introspective power. On the other hand, often the quickest way to debug a program is to add a few print statements to the source: the fast edit-test-debug cycle makes this simple approach very effective.

2.1 Open CV:

Computer vision is a part of Artificial Intelligence (AI), that enables computers to gain meaningful insights from the data provided to it (the data can be in the form of images, videos, or any other visual input) and make relevant decisions based on the knowledge it acquired from the given data. Computer vision provides the computer with the ability to see the world around them as humans do. It enables them to possess the intelligence to distinguish physical features and recognize objects.

OpenCV stands for Open-Source Computer Vision (Library). It is the most common and popularly used, well-documented Computer Vision library. OpenCV is an open-source library that incorporates numerous computer vision algorithms. OpenCV increases computational efficiency and assists with real-time applications. One of the major goals of OpenCV is to provide an accessible and easy-to-use computer vision infrastructure that helps people build sophisticated computer vision applications quickly.

Fig 4.14: Open CV logo

Why Open CV:

OpenCV is a robust library and an efficient tool for image processing operations and accomplishing computer vision tasks.

- It supports a wide range of programming languages which include C++, Java, Python, etc.
- OpenCV-Python is the Python API version for OpenCV which combines the best features of OpenCV C++ API and Python programming language.
- This is a cross-platform library that supports Windows, Linux, macOS, Android, and iOS.
- It plays a major role in real-time image processing and computer vision tasks which is a necessity for modern applications. OpenCV makes use of NumPy, which is a highly optimized Python library for numerical computations. All of the OpenCV array structures are converted to and from NumPy arrays.

OpenCV Modules:

OpenCV has packages that include numerous shared or static libraries. The major modules available are as follows:

1. Core Functionality (core): It is a compact module that defines basic data structures, multi-dimensional arrays, and functions used by other modules.

2. Image Processing (imgproc): This module provides the necessary tools for image enhancement or information extraction purposes.

3. Video Analysis (video): Video analysis modules include the algorithms for motion detection, background removal, and object detection or recognition and localization.

4. Camera Calibration and 3D Reconstruction (calib3d): This module includes algorithms that assist in the camera calibration process and in capturing the shape and appearance of real objects.

5. 2D Features Framework (features2d): Framework to describe elementary characteristics of an image or video as the shape, color, texture, or motion, among others, and to recognize important patterns.

6. Object Detection (objdetect): This module locates objects using predefined input.

3. SMS:

SMS is a device that is used to control or operate appliances from a longer range of distances. SMS (Global System for Mobile Communications, originally Group Spécial Mobile) is a

standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones.

The SMS modem can be tested by connecting it to a PC. The modem is equipped with an RS232 cable. Just use a Serial to USB converter and connect it to the PC. Now you can proceed with sending the commands to the modem using any serial communication program like Hyper terminal, mini com, etc. Ensure the serial parameters are configured to 8N1 and the baud rate is set to 9600bps.

For each command you send the modem acknowledges with a message Example: Just try sending "AT" to the modem. It sends back a result code "OK" which states that the modem is responding. If it's not working fine, it sends "ERROR". The SMS module is a breakout board and minimum system of SIM900 Quad-band/SIM900A Dual-band SMS module. It can communicate with controllers via AT commands (SMS 07.07,07.05, and SIMCOM-enhanced AT Commands). This module supports software power-on and reset.

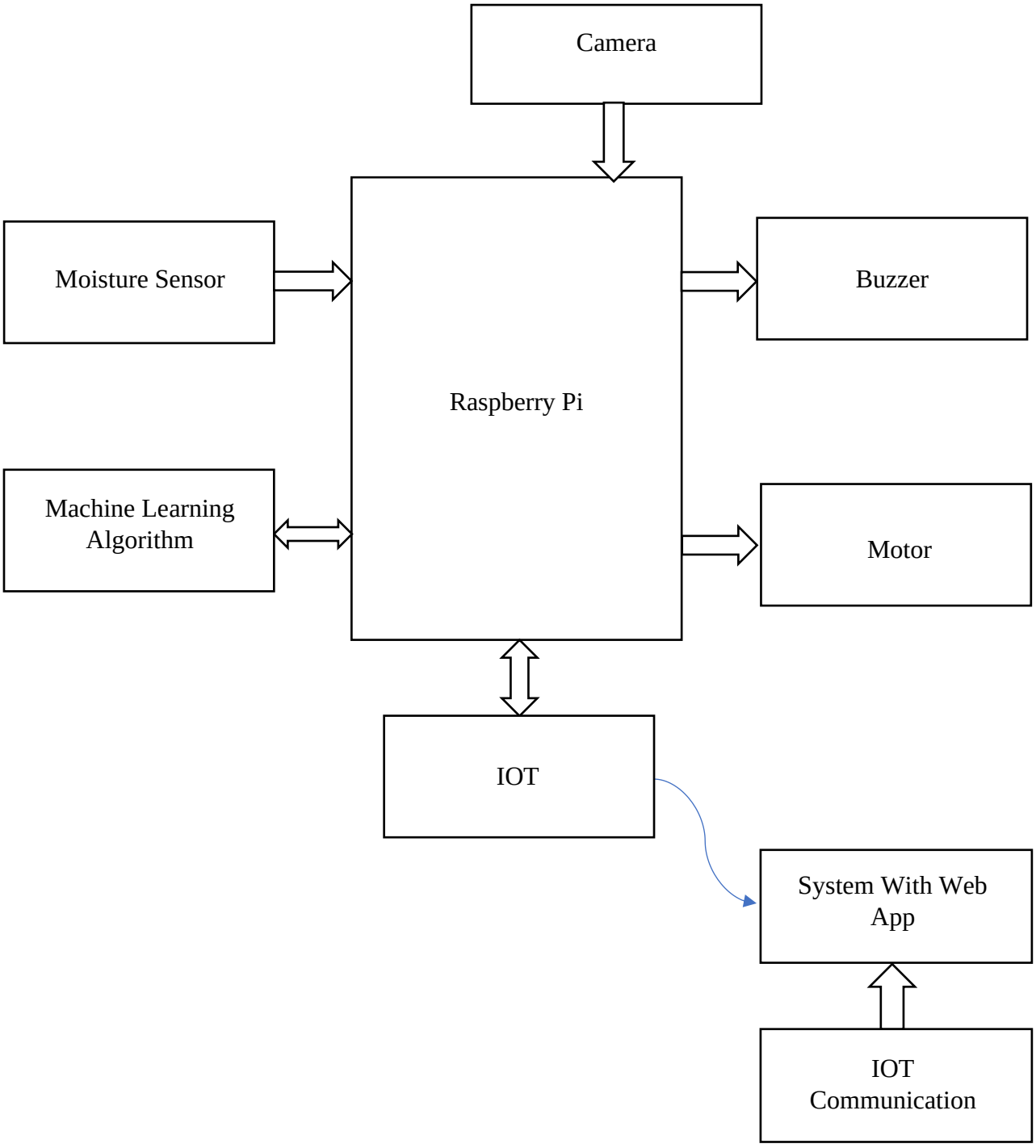
SMS modem specifications:

- Operating Voltage +12v DC
- Weight <140g

Features:

- Dual band SMS/GPRS 900/1800MHz
- Configurable baud rate.
- SIM card holder.
- Built in network status LED.
- Inbuilt powerful TCP/IP protocol stack for internet data transfer over GPRS.
- Quad-Band 850/ 900/ 1800/ 1900 MHz
- Dual-Band 900/ 1900 MHz
- GPRS multi-slot class 10/8GPRS mobile station class B
- Compliant to SMS phase 2/2+Class 4 (2 W at 850/ 900 MHz)
- Class 1 (1 W at 1800/1900MHz)
- Control via AT commands (SMS 07.07 ,07.05 and SIMCOM enhanced AT Commands)
- Low power consumption: 1.5mA (sleep mode)
- Operation temperature: -40°C to +85 °C

4.2 BLOCK DIAGRAM



Basically, the project is having two units. One unit, implemented in the agricultural land, has advanced processor Raspberry Pi. It is interfaced with different sensors like soil moisture sensors for measuring the water content in the soil, weather monitoring detecting leaf diseases,

electronic fencing to avoid animals entering inside an agricultural land and IoT for linking the information of the farm to the farmer.

Another unit is the web-based IoT-enabled smart farmer-friendly app with which the farmer can control his agricultural land at any time and even he can access any data at any time. The system allows automatic irrigation system with soil moisture value.

The animal detection is done through the camera using image processing and intimate the farmer using IOT. The disease in the leaf can be identified with the trained model for different diseases and it will also be intimated to the farmers.

4.3 FLOW CHART

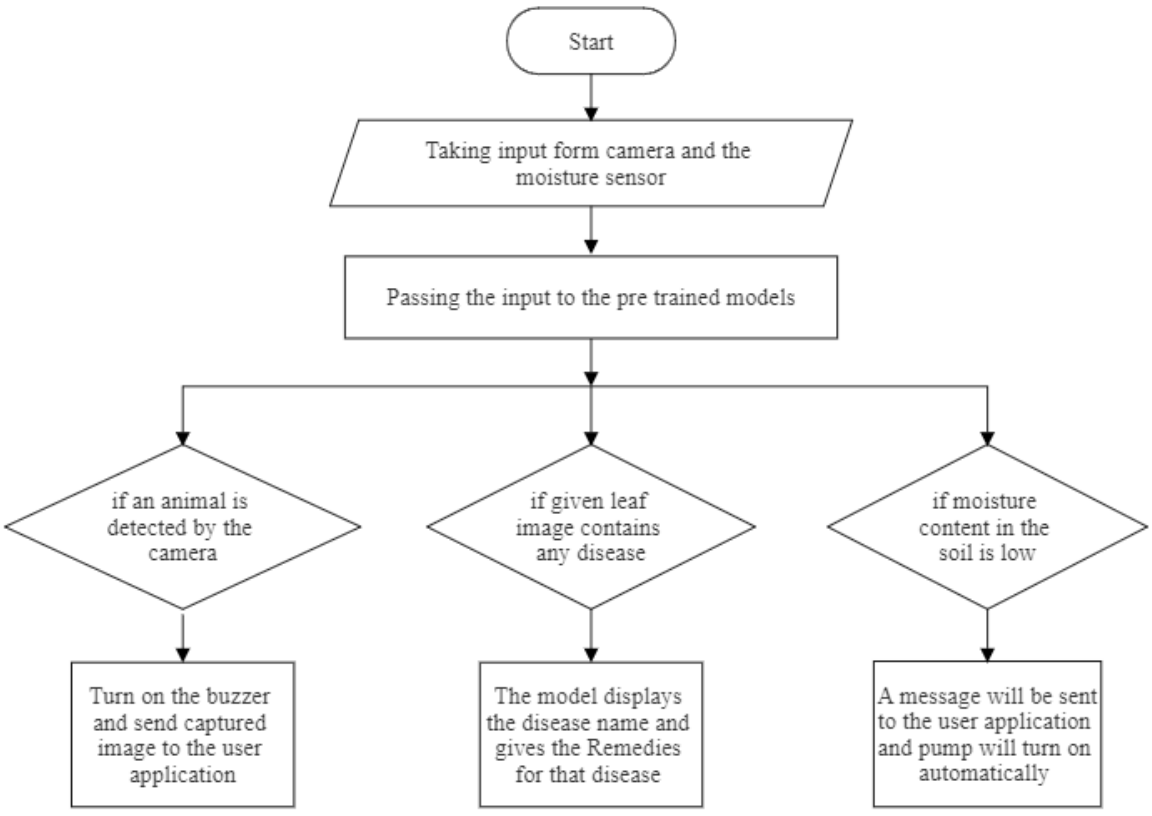


Fig 4.15: Flow chart

4.4 CIRCUIT DIAGRAM

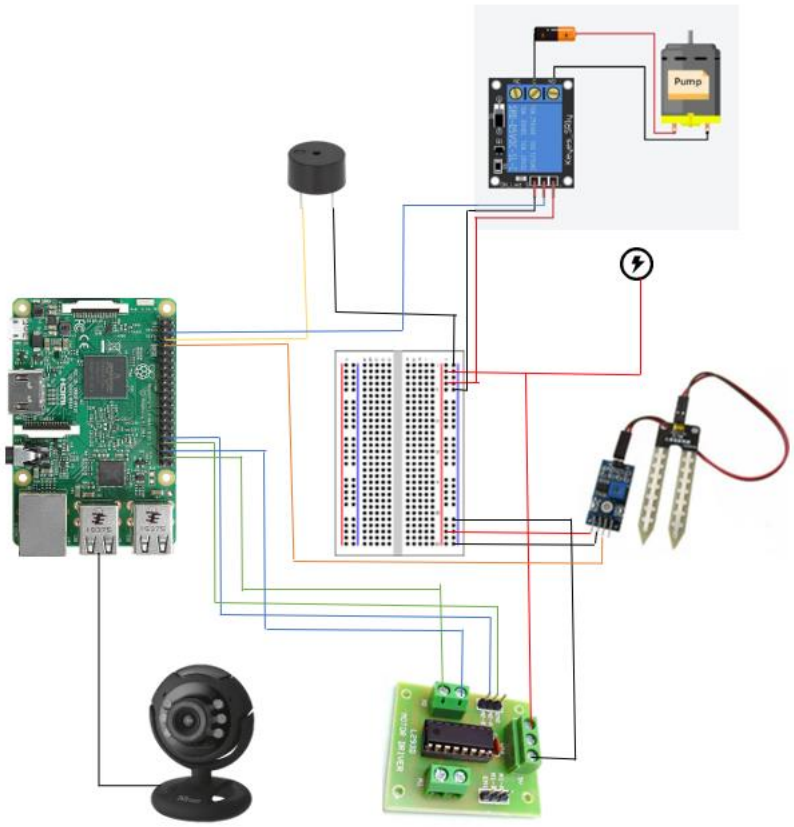


Fig 4.16: Circuit diagram

4.5 WORKING PRINCIPLE:

4.5.1 WORKING OF MOISTURE SENSOR:

The soil moisture sensor will measure the moisture content in the soil. If the moisture content is low then a message will be sent to the user and the pump will automatically turn on and water will be pumped to the required field.

4.5.2 WORKING OF ANIMAL DETECTION SYSTEM:

The animal detection system consists of Buzzer, Camera

The camera is used to collect datasets either video or image from the real-time environment for detecting animals with the help of image processing techniques.

Deploying animal detection system

To obtain (correct) predictions from deep neural network we first need to pre-process our data. In the context of deep learning and image classification, these pre-processing tasks

Open CV's deep neural network module contains two functions that can be used for pre-processing images and preparing them for classification via pre-trained deep learning models.

Algorithm:

Step 1: Image/video acquisition from the camera

Step 2: Convert video to frames.

Step 3: Store images of each animal as a database which is used as a training set for our program

Step 4: Compare camera-captured frames with the database.

Step 5: Use the misread function to read the image and Preprocessing is done on that image. Perform Blob detection on the frame and blobs are matched with images from training database images.

Step 6: And check if it is matching or not.

Step 7: To identify of that animal is desired or not. An array is created and a program is written for each animal to be identified.

Step 8: Intimation will be sent to the farmer.

CAPTURING PHASE:

To detect motion, we first have to capture live images of the area to be monitored and kept under surveillance. This is done by using the camera.

COMPARING PHASE:

Comparing the current frames captured with previous frames to detect motion: for checking whether any motion is present in the live images, we compare the live images being provided by the webcam with each other so that we can detect changes in these frames and hence predict the occurrence of some motion.

PRE-PROCESSING:

Pre – Processing Is heavily dependent on the feature extraction method and input image type. Some common methods are:

- Denoising: applying a Gaussian or simple box filter for denoising.
- Contrast enhancement: if the gray level image is too dark or bright.
- Downsizing to increase speed.
- Morphological operations for binary images.
- Scaling by some factor.

Image Segmentation:

In image research and application, images are often only interested in certain parts. These parts are often referred to as goals or foreground (as other parts of the background). In order to identify and analyze the target in the image, we need to isolate them from the image. Image segmentation refers to the image being divided into regions, each with characteristics and extracting the target of interest in the process.

The image segmentation used in this is threshold segmentation. To put it simply, the threshold of the grey scale image segmentation is to identify a range in the image compared with the threshold, and accordingly, to the results, the corresponding pixel is divided into two categories, the foreground, and background.

Threshold segmentation has two main steps:

- Determine the threshold T
- Pixel value will be compared with the threshold value T

In the above steps to determine the threshold value is the most critical step in the partition. In the threshold selection, there is a best threshold based on different goals of image segmentation. If we can determine an appropriate threshold, we can correct the image for segmentation.

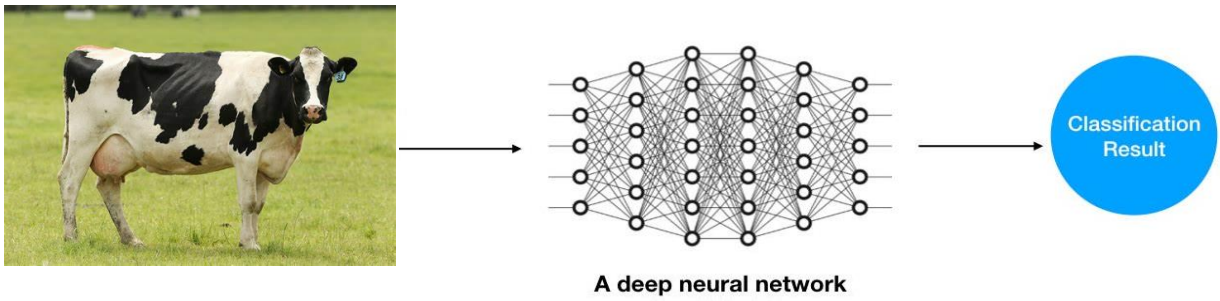


Fig 4.17: Animal detection using DNN

4.5.3 WORKING OF PLANT DISEASE DETECTION SYSTEM:

The figure 3 shows the plant disease detection system. Here we can see that the leaf image input is fed into the leaf disease detection system, in which it is pre-processed, then features are extracted. Then the extracted features are fed to the softmax classifier which is the last part of CNN.

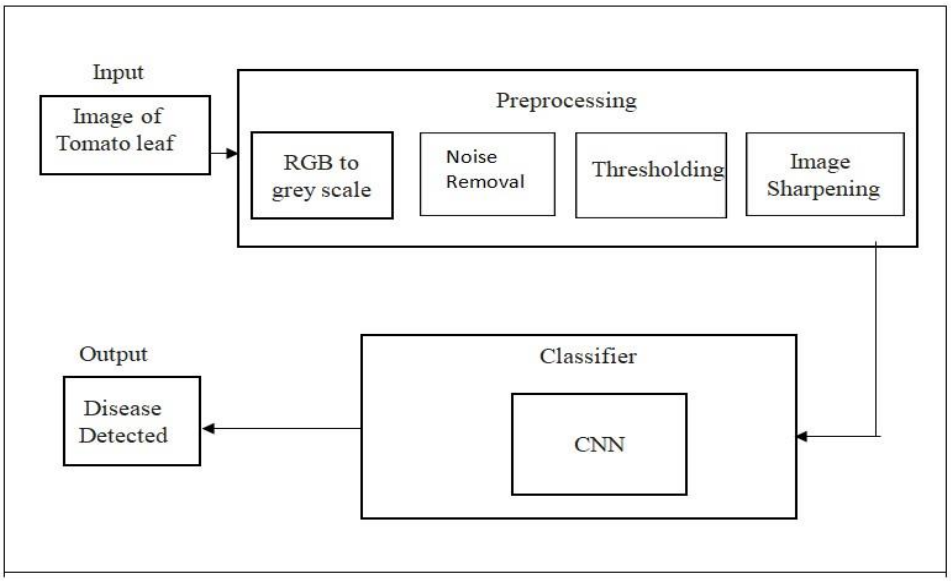


Fig 4.18: A working flow of the plant disease system

The input image is pre-processed and converted to a grey scale image to find the Threshold value based on the input image. Based on the Threshold value further image sharpening is done, then the further process is carried out.

The proposed system has the following steps for the detection of disease:

1. RGB to greyscale
2. Noise Removal
3. Thresholding
4. Image Sharpening
5. Feature Extraction and Classification

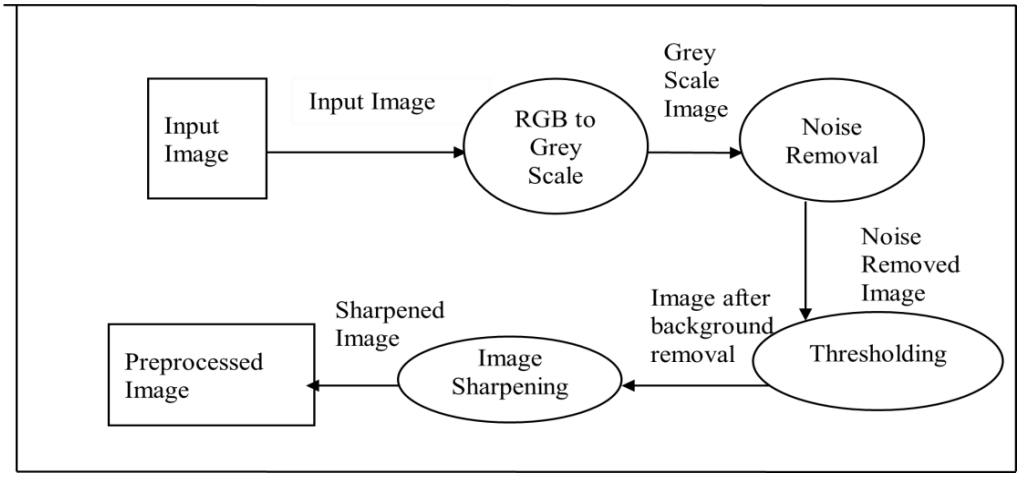


Fig 4.19: Data Flow Diagram for the pre-processing module.

1. RGB to Grey Scale:

- In the first step of the proposed approach, store a single-color pixel of an RGB colour image we will need 8*3 = 24 bits (8 bits for each color component)
- Only 8 bit is required to store a single pixel of the image. So, we will need 33 % less memory to store a grayscale image than to store an RGB image
- Grayscale images are much easier to work with a variety of task In many morphological operations and image segmentation problems, it is easier to work with a single layered image (Grayscale image) than a three-layered image (RGB color image)
- It is also easier to distinguish features of an image when we deal with a single-layered image

Fig 4.20: Conversion of RGB to grayscale

2. Noise Removal:

Noise removal is the process of removing or reducing the noise from the image. The noise removal algorithms reduce or remove the visibility of noise by smoothing the entire image leaving areas near contrast boundaries.

Here we are making use of a Median Filter which is a Noise Removal Technique

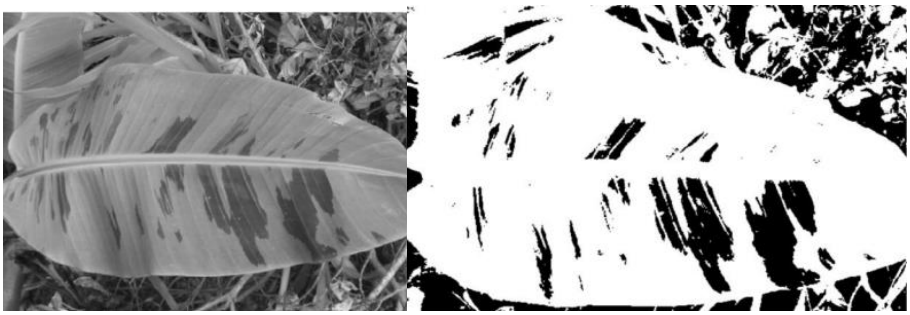
(A) (B)

Fig 4.21: (A) Noisy image (B) Noise removed image

Median Filtering: The median filter is a non-linear digital filtering technique, often used to remove noise from an image or signal. Here 0's is appended at the edged and corners to the matrix which is the representation of the greyscale image. Then for every 3*3 matrix, arrange elements in ascending order, then find the median/middle element of those 9 elements.

3. Thresholding:

Thresholding is a type of image segmentation, where we change the pixels of an image to make the image easier to analyze. Most frequently, we use thresholding as a way to select areas of interest in an image, while ignoring the parts we are not concerned with. We use Basic Global Thresholding.



(A) (B)

Fig 4.22: (A) Grayscale image (B) Threshold image

4. Image Sharpening:

Image sharpening refers to any enhancement technique that highlights edges and fine details in an image. Increasing yields, a more sharpened image. Image sharpening is done by adding to the original image a signal proportional to a high-pass filtered version of the image.

High-Pass Filtering: A high-pass filter can be used to make an image appear sharper. These filters emphasize fine details in the image

5. Feature Extraction and Classification:

Feature extraction is a process of dimensionality reduction by which an initial set of raw data is reduced to more manageable groups for processing. In the terminology of machine learning, classification is considered an instance of supervised learning, i.e., learning where a training set of correctly identified observations is available.

The corresponding unsupervised procedure is known as clustering and involves grouping data into categories based on some measure of inherent similarity or distance.

Convolutional Neural Networks:

In deep learning, a convolutional neural network (CNN, or ConvNet) is a class of deep neural networks most commonly applied to analyzing visual imagery. They are also known as shift-invariant or space-invariant artificial neural networks (SIANN), based on their shared-weights architecture and translation invariance characteristics. They have applications in mage recommender systems, image classification, medical image analysis, natural language processing, brain-computer interfaces, and financial time series.

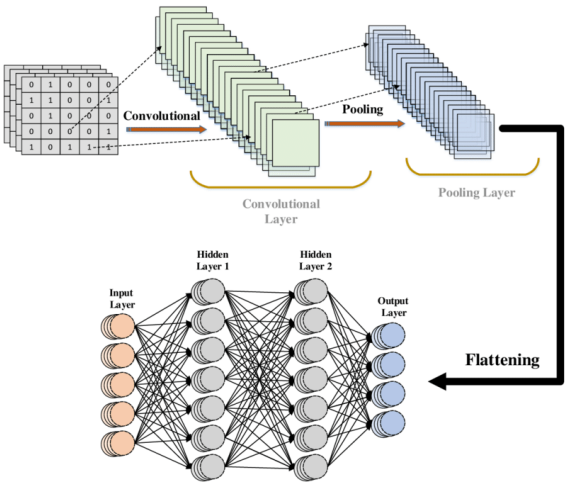


Fig 4.23: CNN Process

CNNs are regularized versions of multi-layer perceptrons. Multilayer perceptrons usually mean fully connected networks, that is, each neuron in one layer is connected to all neurons in the next layer. The "full connectedness" of these networks makes them prone to overfitting data. Typical ways of regularization include adding some form of magnitude measurement of weights to the loss function. CNNs take a different approach towards regularization: they take advantage of the hierarchical pattern in data and assemble more complex patterns using smaller and simpler patterns. Therefore, on the scale of connectedness and complexity, CNNs are on the lower extremity.

Data Flow Diagram of Classification using CNN:

In deep learning, a convolutional neural network (CNN, or ConvNet) is a class of deep neural networks most commonly applied to analyzing visual imagery. They are also known as shift-invariant or space-invariant artificial neural networks (SIANN), based on their shared-weights architecture and translation invariance characteristics

When CNN is used for classification, we don’t have to do feature extraction. Feature Extraction will also be carried out by CNN. We feed the pre-processed image directly to CNN classifier to obtain the type of disease if present. Figure 3.11 shows the Data Flow Diagram of Classification using CNN.

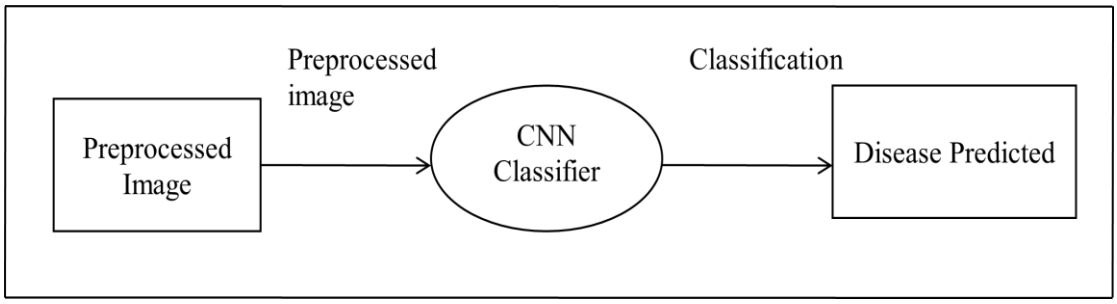


Fig 4.24: Data Flow Diagram of Classification using CNN.

CHAPTER – 5
RESULT AND DISCUSSION

Fig 5.1 shows the designed prototype for AI enabled smart agricultural system

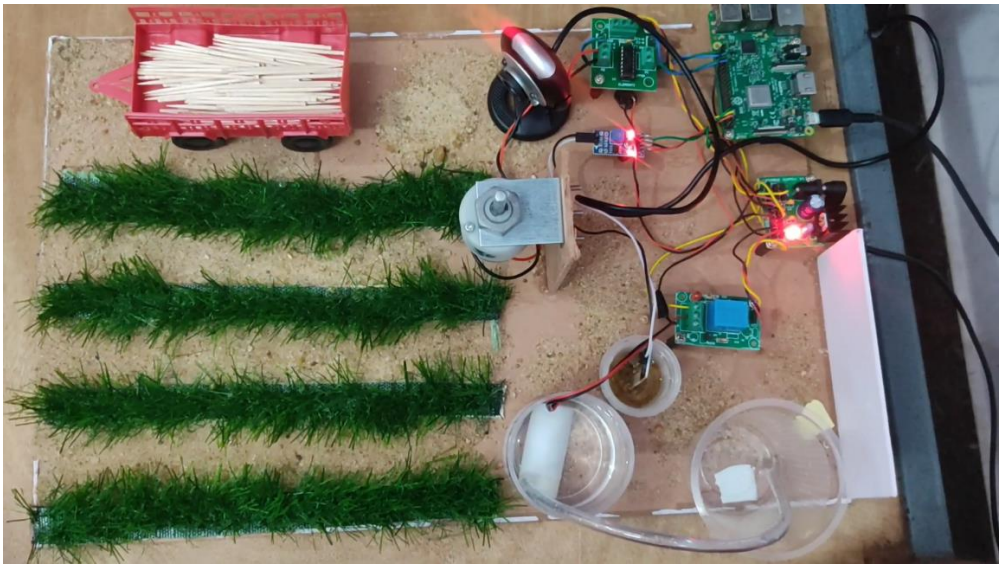


Fig 5.1: Designed Prototype

5.1 ANIMAL DETECTION PHASE:

In this phase, a system is developed to detect the animals which enter the agricultural land. The images of animals, as shown in Fig 5.2, entering the land are captured by the camera mounted in the fields. The captured images are processed with the help of a deep neural network. The image is only captured when the animal is detected.

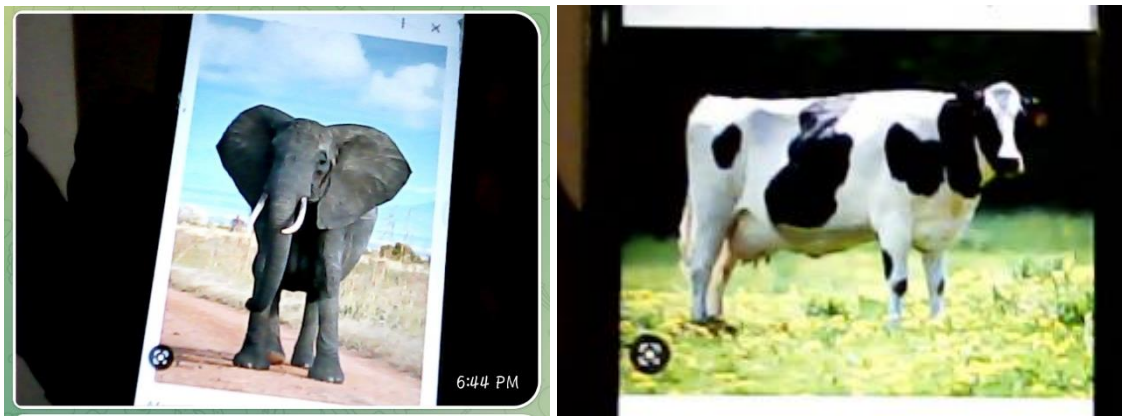


Fig 5.2: Animal Captured for processing

Alert message to the former's mobile:

When the animal is detected in the agricultural land it will automatically send the captured image as well as the name of the animal which has entered into the agricultural land to the user application which in this case is a Telegram. The images shown below are the images captured by the camera and sent to the user.

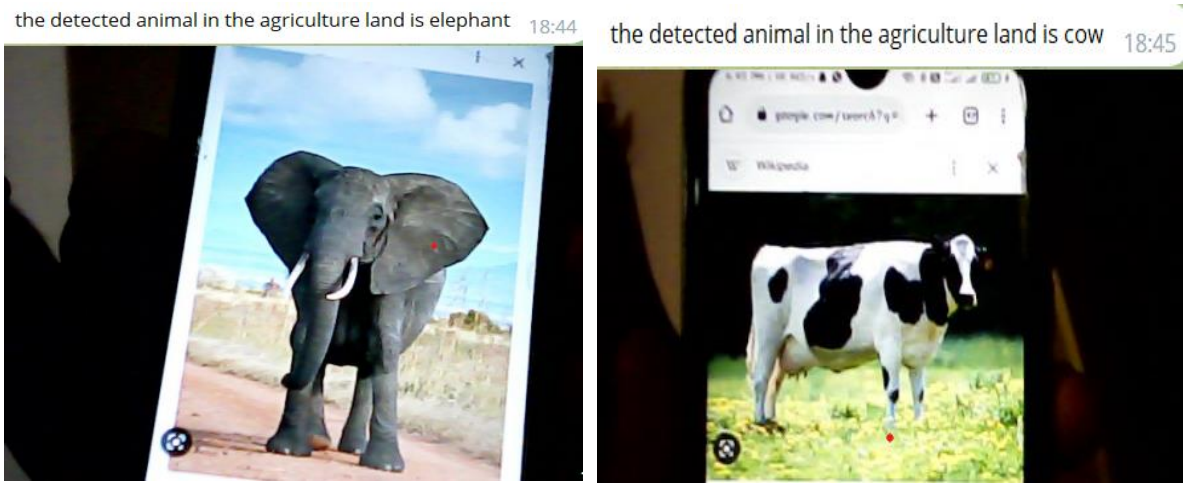


Fig 5.3: Images captured by the camera and sent to the user

5.2 MOISTURE CONTENT DETECTION PHASE

In this phase, the moisture content of the soil will be measured with the help of a soil moisture sensor. When the moisture content in the soil is low then a message is sent to the user as 'THE MOISTURE IS LOW, PUMP IS ON' and the relay will turn on the water pump to supply the water to the field. When the moisture content is maintained, the relay will be turned off after 2 seconds to stop the water pump. This process will be repeated whenever the moisture contentment is low.

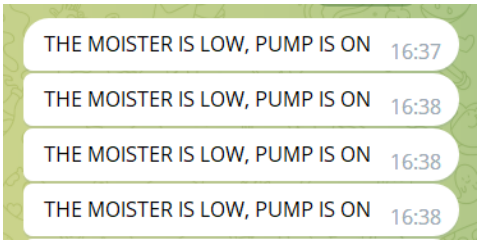
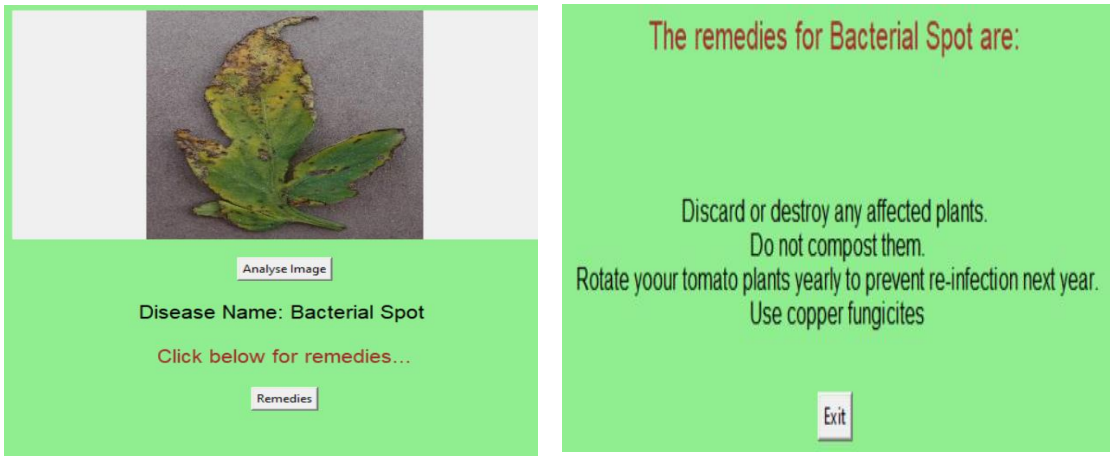


Fig 5.4: Message sent to the user about moisture content and pump status

5.3 LEAF DISEASE DETECTION PHASE

In this phase, a system is developed to detect the disease of a leaf. This system is developed with the help of a convolutional neural network which gives better performance. In this phase, the camera will be turned on to capture the image, and the captured image will be automatically saved in the specified folder. During execution, the captured leaf image is selected and analyzed using "Analyze Image" button in the GUI. After analysis, the disease of the leaf will be displayed and there is also another button 'Remedies' to Know the remedies for that disease.



(A) Disease Detected in Tomato Leaf (B) Remedies for disease

Fig 5.5: Figures A and B shows disease name of leaf and remedies for it

CHAPTER - 6

CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION:

This project contains three systems which are animal detection system, moisture content detection system, and leaf disease detection system. In which two systems are AI enabled systems which are animal detection system using deep neural network (DNN) and leaf disease detection system using convolutional neural network (CNN). due to insufficiency of time these systems are trained with limited datasets but also got better results with the given datasets

6.2 FUTURE SCOPE:

In the future this project developed by:

- Replacing the camera for better image capturing.
- Can be trained with more data sets to detect all animals.
- The sensors can also be replaced with the advance sensors.
- Disease detection can be implemented in the robot to protect crops in real-time and the process can be automated.
- The system can use machine learning to analyze past data on crop yield, weather patterns, soil conditions, and other relevant factors to predict the expected crop yield for a given season and minimize the usage of water.

APPLICATIONS, ADVANTAGES & DISADVANTAGES

1. APPLICATIONS:

- AI-based smart agriculture systems can be implemented in large agricultural fields.
- AI-based smart agriculture system helps in Solar powered irrigation.
- AI-based smart agriculture systems make Home Gardens Portable.
- AI-based smart agriculture system helpful to agricultural lands in rural areas.
- AI-based smart agriculture system helps in Forests development.

2. ADVANTAGES:

- It helps to increase productivity.
- It saves water and formers time.
- Compact and low cost.
- It operates the water pump automatically.
- It avoids the middlemen's interference.
- No need for human interaction in the field.

3. DISADVANTAGES:

- Advancement of this project leads to
- The model requires a continuous power supply to function properly.
- Internet interruptions can delay information delivery to users.

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