Journal of Advanced Research in Agriculture Science & Technology
Volume 6, Print Issue 1 - 2023, Pg. No. 23-30
Peer Reviewed Journal

Review Article

Autonomous Farming Robot for Plant Health Indication

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How to cite this article:
Hajare DG, Karvekar VV, Kamble PB, Patil AA. Autonomous Farming Robot for Plant Health Indication. *J Adv Res Agri Sci Tech* 2023; 6(1): 23-30.

Date of Submission: 2023-07-14
Date of Acceptance: 2023-07-29

A B S T R A C T

Artificial Intelligence is becoming more and more popular from manufacturing to software and industrial automation, Artificial intelligence is becoming more prevalent. However, the agricultural methods still in use today are far from ideal way because of the deployment of AI for the sake of. People continue to use outdated agricultural methods. A crop disease. This undertaking suggests the idea of using artificial Intelligence and robotics for agricultural operations including crop disease detection and analysis. The proposed project consists of a Robotic vehicle navigating through the field and determining the health status of the plants. If the plant is diseased the type of disease will be automatically detected using multilayer convolutional neural networks and automatically intimated to the farmer using Email or SMS. The application is developed for farmers which can be used by farmers to track the status of the field, the diseases as well as the data. Also, the solutions and proper corrective approach to kept the crops healthy from such disease the spraying system is implemented which will automatically spray the diseased location of the plants. The proposed system also implements AI based Harvest assistance. The robot moves over the field scanning if the agricultural produce is ready for harvesting. The robot moves over the field scanning if the field scanning if agricultural produce is ready for harvesting. The camera attached to the robotic vehicle detects If the agricultural harvest is ready. If it is detected to be ready for harvesting, the robotic arm present on the vehicle automatically harvests the produce and collects. Thus, the system provides automated harvesting for farmers. Thus, it is anticipated that the proposed initiative will solve complex agricultural problems by introducing artificial intelligence to agriculture.

Keywords: Crop Disease, Artificial Intelligence, Weed Detection, Spraying, Sowing, Cutting, Android App Iot, Robotics, Neural Networks, Human Intervention

Introduction

Agriculture is one of India's key economic sectors. The Indian agricultural sector employs over 50% of the labor force of the nation. The world's top producer of pulses, rice, wheat, spices, and spice-related products is believed to be India. The quality of the items that farmers create, which is dependent on plant growth and yield, determines how successful their businesses are. Villages are prevalent in India [1]. Despite this, agriculture is the primary industry in the majority of Indian villages, where it supports around 70% of the population. For a very long time, agriculture has been and will continue to be the foundation of the Indian economy. It must sustain nearly 17% of the world's people using only 2.3% of the planet's land and 4.2% of its water resources. Early 1990s economic changes implemented in the nation have raised the trajectory of economic growth. GDP growth has risen in recent years, rising from a low of about 6% in the early years of reform to above 8%. This was mostly brought on by the non-agricultural sector's explosive rise. Between 1980–1981 and 2006–2007, there was a very slight reduction in the proportion of the labor force working in agriculture, from 60.5 to 52 percent [2].

Thanks to possible uses and industrial efforts in robot development, research into agricultural robotics has increased over the past few years. Their role was examined for a variety of agricultural jobs, with a primary focus on improving the automation of traditional agricultural machinery and encompassing procedures like sowing, mowing, fertilizing, and harvesting. Particularly in an arable agricultural setting with transient crops, systematic, repetitive, and time-dependent jobs seem to offer the finest fields of use for robots. Robotic plant protection has also been researched, but may present the most difficult sustainability difficulties for researchers [3].

Since agriculture still uses antiquated practices, robotics in agriculture is still a subject of extensive research and has not yet been applied on a large scale. This not only reduces agricultural output but also puts farmers under a lot of physical and emotional stress. The Crops which are affected by diseases create another issue where in the farmer cannot make-out exact type of the disease which has affected the crops. This will significantly reduce agricultural productivity, and farmers will have to spend an increasing amount of money as a result. needs to spent by farmer without actually knowing the cure for disease. The crops or the agricultural produce is harvested manually which is again a hectic task to collect all vegetables and fruits. This project deal with the Autonomous Farming Robot for Plant Health indication.

Research

The most common disease in plants that manifests as a spot on the leaves is leaf disease. Despite the fact that plant diseases prevent plant growth, resulting in lower yields and a loss of vitality, healthy plants can withstand damage well. Utilizing image processing to identify the type of disease and spraying chemicals on crops in accordance with that disease allows farmers to avoid direct contact with dangerous fertilizers and chemicals while also saving money on labor costs and chemical costs.

Block Diagram

The figure [1] illustrate block diagram shows the working principle of the project. As shown in the endeavor consist of a robotic vehicle with capabilities to implement Artificial Intelligence in Agriculture. The project involves used of AI for the determination and analysis of crops to be harvested in the field. The proposed project consists of a Robotic vehicle which can move across the field, scan for the crops and then detect if the fruits and vegetables are ready for harvesting using computer vision and Artificial intelligence. The proposed set up consist triggered the robotic vehicle can be move autonomously thought the field. The overhead camera can scan the field of crops and use deep learning system to determine if the plants contain fruits or vegetables ready for harvest. If the fruit or vegetable is ready for harvesting the robotic vehicle captures the coordinates of the detected fruit or vegetable and send it to the robotic arm based harvesting system. The robotic arm present on the harvesting robot will use forward kinematics equation to move to exact coordinates of the detected fruits and harvest the fruits/vegetables if it is ready for harvesting. Additionally, the developed system is capable of detection of the plant diseases and notification system. Another deep learning model deployed on the system will capture the camera frames while the system is moving and predict the diseases in the plants. If the system finds the diseases plants the notification will be sent to the farmers as well as the Sprayer will be activated by the controller for performing autonomous spraying on the diseased plants

The following methodology is implements through the course of the project. The entire project is carried out in different steps so that errors cam be minimized at the end the Methodology towards the conduct of the project is given below in terms of different phases

- Problem Definition: In this phase the over all problems faced in harvest analysis are outlined. This phase involves doing a market study of current harvesting procedures.
- Literature Review and Scope determination: This phase involved studying the literature review on technology implements in agriculture and number of national as well as international research papers to find the current problems faced.

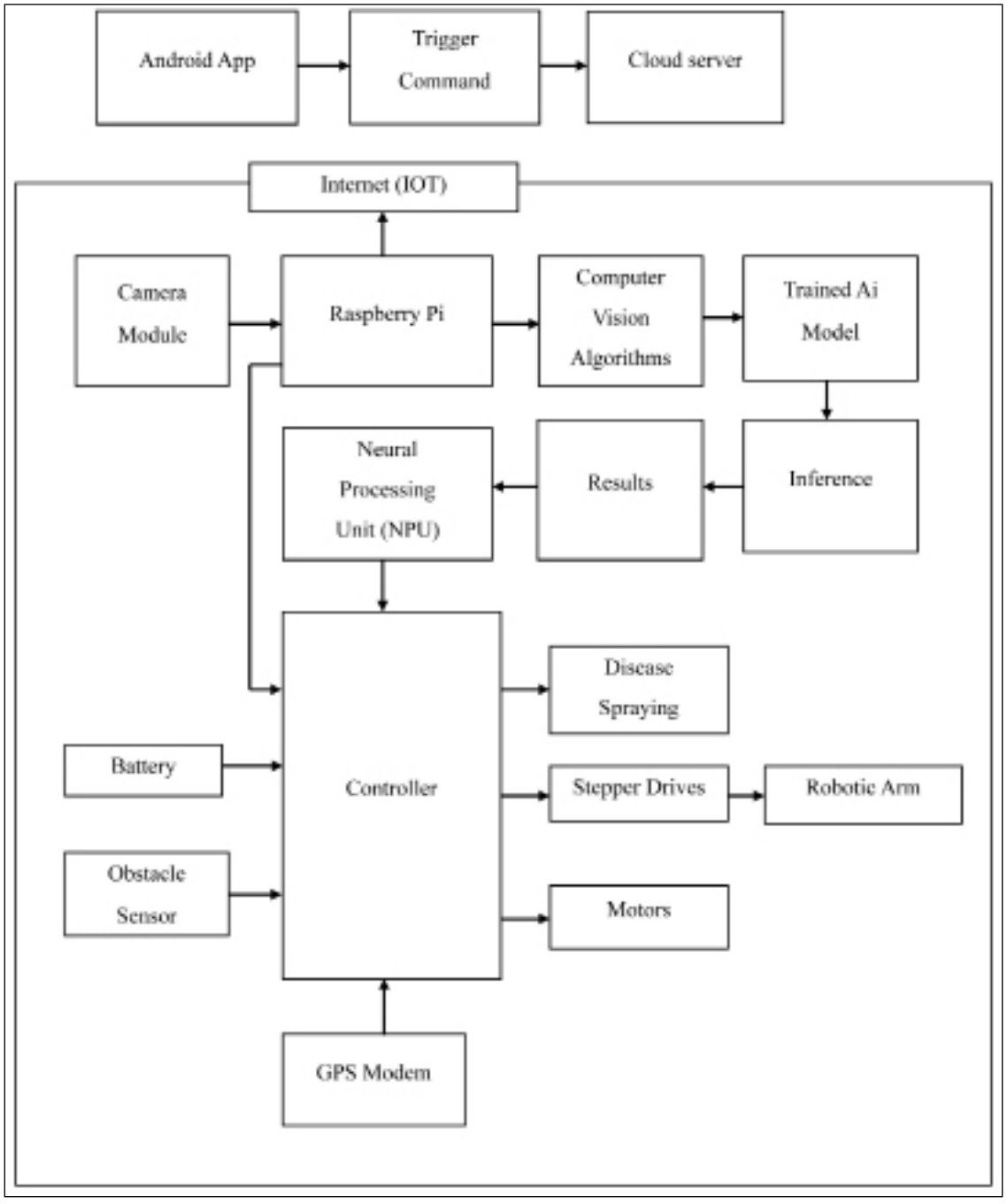

Figure 1.Block Diagram

- Market Survey and Market Study: This phase involves carry out the material survey of different materials suitable for the project.
- Hardware Selection: This phase involves selection of different material suitable the for the project.
- Fabrication of Robotic Vehicle: - In this phase the robotic vehicle is fabricated which will form as a base of the entire project.
- Data input and feeding to neural Networks: The preprocessed data is feed to the neural networks for training and classification purposes. This involves development of python modules for feeding the data to neural network. This involves collection of harvest data which can be used for the training of neural network model using transfer learning approach.
- Training the Deep learning-model: In this phase a deep learning model is develops in python which can recognize different fruits and vegetables and can predict if they are ready to be harvested. The model is responsible for processing the data from the camera module and check if the plant contains fruit/vegetables and if it is ready for harvesting.

- The Python program development: The python program is developed which will perform inference on the trained model to detect the fruits/vegetables to be harvested in the video feed from the camera.
- Retrain and Reliability Predication: This phase involves retraining the AI model for performance optimization and is usually done after the first bench test.
- Development of Robotic Arm for harvesting: This phase involves development of precise robotic arm which can move to the location of the detected fruit/vegetables to harvest it. This involves implementation of forward kinematics to position and navigate the robotic arm to the harvesting location and then performing the harvesting operation.
- Development of plants disease detection, spraying and notification system: This phase involves implementation of spraying system on the robot which will be used to spray the diseased plants. The camera interfaced on the system is capable of recognizing diseased and normal plants and if the plants is diseased the notification system will be used to send the notification to send the farmers. This phase also involves development of spraying system which will be used to spray on the diseased plant getting rid of the disease.

Components

Hardware Used

Neural processing Unit (NPU)

An artificial neural network (ANN) or random forest (RF) are two examples of prediction models that can be used by neural processing units (NPUs) to accelerate machine learning algorithms.[4] It also goes by the name "neural processor. "Simply put, an AI Accelerator is a customized circuit that incorporates all the control and arithmetic logic required to carry out machine learning algorithms, generally by working with predictive models like artificial neural networks or random forests. NPU's bed costs 7200 RS.

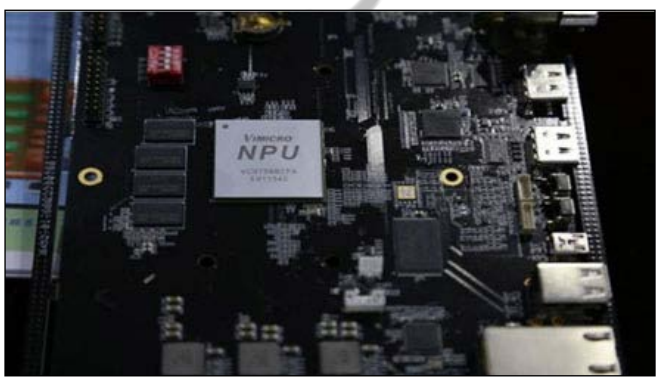

Figure 2.Neural Processing Unit

Proximity Sensor

One of the photoelectric switch sensors is the E18-D80NK Adjustable IR Sensor Proximity switch 3-80cm Range, which consists of transmitters and receivers. According to demand, the detection distance can be changed. The sensor has a 3-80 cm detecting range.[5]

Figure 3.Proximity Sensor

The Adjustable Infrared Sensor Switch is a versatile device that may be utilized in a variety of applications, including industrial assembly lines, interactive media, and many more. It is compact, affordable, simple to use, and straightforward to construct.

Depending on the obstructions, different switching signal outputs are produced. When there are no impediments, it stays high, and when there are difficulties, it stays down. Behind the probe, there is a bright light that can be used to detect anything from 3 cm to 80 cm.

Connections

- Yellow wire: Digital output
- Green wire: GND
- Red wire: +5v
  OR
- Black wire: digital output
- Blue wire: ground;
- Brown wire: +5v

Stepper Motor

A brushless DC electric motor that divides a whole rotation into equal steps is referred to as a stepper motor. Without a position sensor to provide input, the motor position can then be programmed to move and hold at any one of these specific phases.

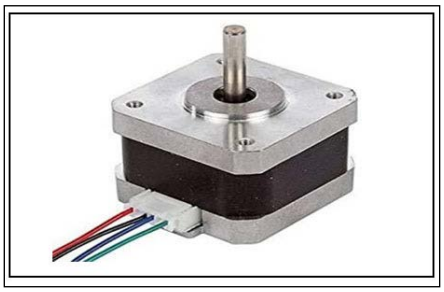

Figure 4.Stepper Motor

Stepper Motor driver

A professional stepper motor driver that is simple to use and can run a two-phase stepping motor is the TB6600 Arduino Stepper Motor Driver. It works with microcontrollers like the Arduino and others that can generate 5 volt digital pulse signals.

With a 6DIP switch, you may adjust the output current and micro step. In total, there are 8 different types of current control and 7 different types of micro ateps (0.5A, 1A, 1.5A, 2A, 2.5A, 2.8A, 3.0A, 3.5A). All signal terminals use high-speed optocoupler isolation to improve their ability to block high-frequency interference. It can drive 57, 42-type two-phase, four-phase, and hybrid stepper motors as a professional device.

Figure 5.Stepper Motor Drive

Relay Module

Relays are straightforward electromechanical switches. Relays are switches that link or disconnect two circuits, similar to how regular switches are used to manually close or open circuits. However, a relay makes use of an electrical signal to control an electromagnet, which in turn connects or disconnects another circuit, as opposed to a manual process.

Relays come in a variety of forms, including electromechanical and solid state. Relays with an electromechanical design are widely utilized. Before learning how this relay operates, let's examine its interior. Although there were many different types of relays, they all functioned the same.[6]

Figure 6.Relay Module

Working

Every electromechanical relay consists of an consists of an

1. Electromagnet
2. Mechanically movable contact
3. Switching points
4. Spring

Electromagnet is constructed by wounding a copper coil on a metal core. The two ends of the coil are connected to pins of the relay as shown. These two are used as DC supply pins.

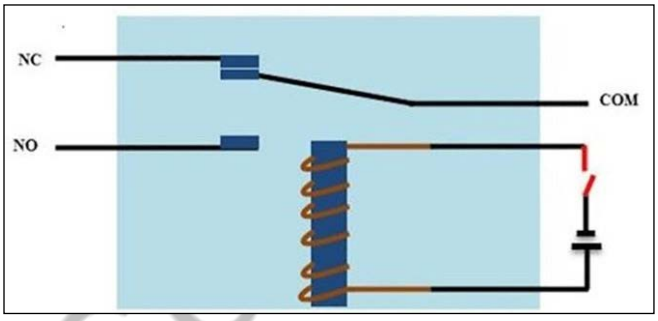

Figure 7.Working of the Relay Module

GPS Modem

- Global positioning system, or GPS, can be used to find your location, the time, and your speed if you're moving.[7]

Figure 8.GPS Modem

This module includes an internal EEPROM and an external antenna.

- RS232 TTL interface
  5V to 5V power supply
- 9600 bps is the default baud rate
- Standard NMEA phrases are supported.
- VCC, RX, TX, and GND are the four pins on the NEO-6M GPS module. The wiring couldn't be easier because the module and Arduino communicate via serial communication utilizing the TX and RX pins.

- VCC VIN RX TX pin specified in the software serial TX RX pin specified in the software serial GND NEO-6M GPS Module Wiring to Arduino UNO

Battery

The system as a whole receives the necessary power from the battery or power supply unit. Since the project's goal was to make the trolly automated and portable, it was important to select a power system that could provide the necessary quantity of electricity for the entire system. The 12V 1.2AH battery was selected for this project.

This has a one-hour continuous 1.2Amp current supply capacity.

DC geared Motors

The DC Motor and reduction gear boxes are part of the driving train of the robotic seed-planting machine. The combination of parts that supply power to the driving wheels of a motor vehicle—the drive train—helps the robot navigate its environment. This does not include the power-generating engine or motor. The drive train and the engine or motor together make up the power train according to the contract. The drive train's job is to connect the driving wheels, which use the mechanical power produced by the motor, to the motor. The proper gear ratio must be chosen since the working speeds of the engine and wheels differ.

The technical specifications of the motors are as shown below

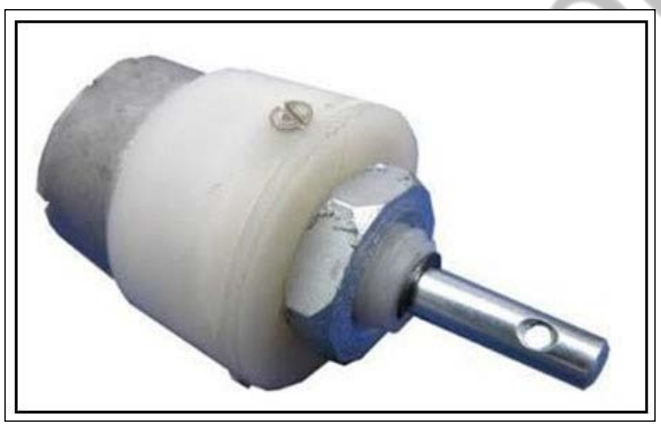

Figure 9.DC geared Motors

Sr. No	Parameter	Value
1.	Voltage	12
2.	Current	800 mA
3.	Shaft size	6 mm
4.	Gear Type	Heavy duty metal
5.	Weight	300 gms
6.	Speed	30 Rpm

Hybridge Motor Driver

Hybridge is a straightforward electrical circuit that enable in either direction to a load by applying voltage. It frequently appears in robotic a program for controlling DC motors. By utilizing Hybridge, DC motors can be operated either clockwise or counterclockwise. Inverters can also generate alternating waveforms using this circuit.[8]

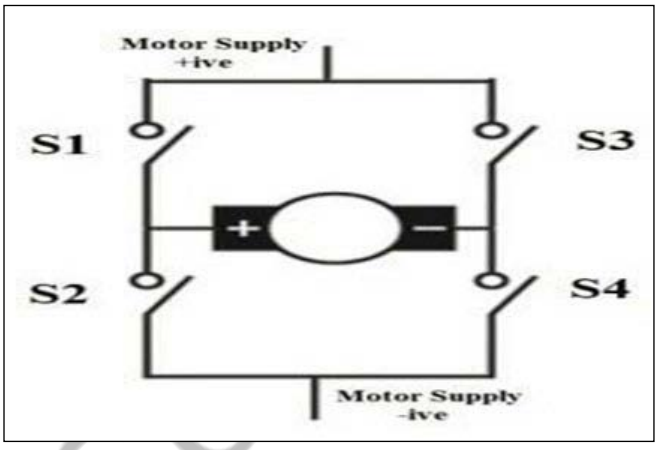

Figure 10.Hybridge Motor Driver

When switches S1 and S4 are switched on, motor runs in clockwise direction.as shown in figure 11.

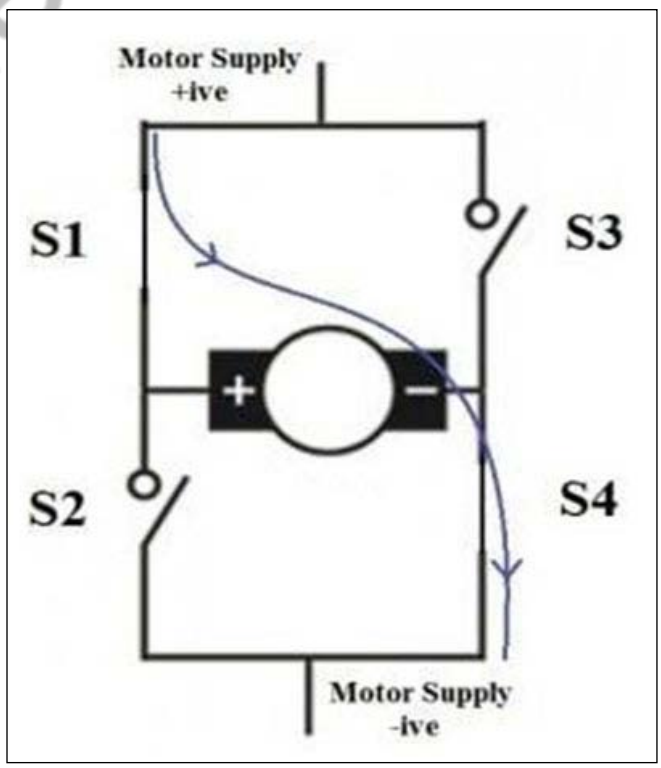

Figure 11.Switches S1 and S4

When S2 and S3 are switched on, motor runs in anticlockwise direction. As shown in fig [12].

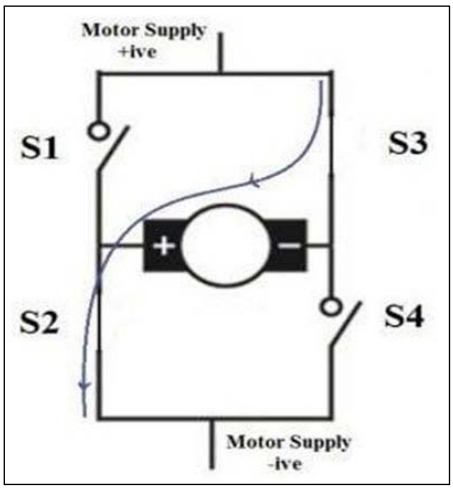

Figure 12.Switches S2 and S3

Maximum Motor Current = IL

- Ib=IL/beta, which is the required minimum input current to flow IL through the active portion of the bread.
- To ensure that the transistor operates in the saturation area, set Ib' = 10xIb.
- Take Vbe = 0.7V; Rin= (Vin- Vbe)/Ib;

Buzzer: - Fig [13]

The buzzer has an outside housing and two pins for connecting to power and ground. There is a piezo element inside, which consists of a metal (typically bronze) vibration disc surrounding a core ceramic disc.

The ceramic disk contracts or expands when current is applied to the buzzer. Then, changing the casus the disc in its vicinity to vibrate. You can hear the sound. here. By altering the rate at which the buzzer, the speed, the speed of the Changes in vibration alters the resulting sound's pitch [9,10].

Figure 13.Buzzer

Software Used:

1. Thony IDE
2. Anaconda Navigator
3. Android Studio
4. Android IDE
5. WAMP server

Outcomes

The above project deals with the concept of AI based automated harvesting and plant disease detection using agricultural robot which can be used by farmers for automated harvesting as well as day to day operations. The proposed project is expected to provide the farmers with an advanced tool using AI which can be used to automatically detect the fruits/vegetables to be harvested and use precision robotic arm with coordinate positioning system to harvest it if required. The proposed project is also expected to perform disease detection using camera mounted on the robotic vehicle. The proposed project can move across the field to scan the plants. If the diseased plant is found the smart system developed is expected to notify the farmer regarding the same and automatically perform spraying on the diseased plants.

Advantages and Applications

1. The proposed project can automatically detect the different fruits/vegetables to the harvested using deep learning and camera by autonomously moving in the farm reducing the burden on farmers.
2. The proposed project implements deep learning to determine the fruits/vegetables to be harvested which is accurate.
3. The Developed robotic vehicle can also run autonomous mode, thus completely eliminating manual intervention.
4. Since the proposed project uses Deep learning models to predict the fruits/vegetables.
5. The system is IOT controlled and can be triggered by the farmers from the comfort of their homes.
6. The proposed project can be used for detection of plant diseases and notifying the farmers as well as performing autonomous spraying on the diseased plants.
7. The propose system help us implement Robotics and AI in agriculture, thus taking Indian Agriculture eco-system to future [11].

Conclusion

The most common plant diseases that manifest as patches on the leaves are leaf diseases. Despite the fact that plant diseases prevent plant growth, resulting in lower yields and a loss of vitality, healthy plants can withstand damage well. By using an image processing technique, determine the type of illness, and then spray the appropriate chemical on the crop in accordance with that illness.

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