Conceptual development of a precision-based robot design for Green Field agricultural applications using IoT, Artificial Intelligence & Machine Learning techniques

[1]Riddhi Athreya, [2]Dr. Suhasini V. Kottur, [3]Ishani Mishra, [4]Dr. Prasad M.R., [5]Dr. Pavithra G., [6]Dr. T.C.Manjunath

[1]Software development engineer, Setu Company, # 2, 2nd Floor, Embassy Icon, Road, Vasanth Nagar, Bengaluru, Karnataka-560001 & Ex. UG (BE) Student, Dept. of ECE, Dayananda Sagar College of Engineering, Bangalore-560111
[2]Professor & Principal, MCA Dept., Bharati Vidyapeeth's Institute of Management & Tech. Sector 8, CBD Belapur, Navi Mumbai, Mumbai-400614, Maharashtra State, India
[3]Senior Assistant Professor, Department of Electronics & Communication Engg., New Horizon College of Engineering, Outer Ring Rd., Marathalli, Kaverappa Layout, Kadubeesanahalli, Bangalore-560103, Karnataka
[4]Associate Professor, Computer Science & Engineering Department, Vidya Vardhaka College of Engineering, Gokulam, Mysore, Karnataka
[5]Associate Professor, Electronics & Communication Engineering Department, Dayananda Sagar College of Engineering, Kumaraswamy Layout, Bangalore-560111, Karnataka
[6] Professor & Head, Electronics & Communication Engineering Department, Dayananda Sagar College of Engineering, Kumaraswamy Layout, Bangalore-560111, Karnataka

Emails : riddhi400@gmail.com suhasini.kottur@gmail.com ishanimishra.phd@gmail.com
Emails : dr.pavithrag.8984@gmail.com tcmanju@iitbombay.org

Abstract: For many years, agriculture has played a vital role in the Indian economy, contributing significantly to the nation's Gross Domestic Product (GDP), with the agricultural sector accounting for 18% of India's GDP. Robotics and the Internet of Things (IoT) present a promising solution for advancing precision agriculture. Particularly, the selective harvesting of crops such as tomatoes and apples demands more precise and efficient methods. Conventional farming involves labors individually handpicking the ripened fruits which requires immense manpower to perform selective farming. We propose a robot that assists farmers in various labour-intensive tasks such as selective crop harvesting, qualitative segregation and also concurrently provide information of crop health, soil nutritional status and crop shelf-life detection. The collected information is analysed, processed and sent to the farmer via android application. Later, quality of the particular harvested crop is inspected by checking the weight, color, health to grade them. The graded fruit is then transferred to the assigned container. Spoiled or over ripened fruits/vegetables would be plucked and dropped so that it would not affect the growth of the plant. Proposed robot would have a harvesting arm which reaches the fruit/vegetable to pluck it from the plant or a tree which would later transfer the fruit to respective container. User would be able to assign a specific task to the device according to his requirement with the help of the app. Selective harvesting, segregation and crop health monitoring requires image processing through camera. It also detects diseases using image processing. We are doing the pre-processing and image segmentation. The guided, supervised, and advanced machine learning technique known as k-nearest neighbors (KNN) is employed to develop solutions for both classification and regression problems. Agriculture automation is a major concern and a hot topic in all countries. Given how quickly the world's population is expanding, there is an urgent demand for food. Farmers must use harmful pesticides more frequently because their current approaches cannot keep up with the rising demand. The soil is harmed by this. The land remains unproductive and barren as a result, which has a substantial impact on agricultural practises. IOT, wireless connectivity, AI & ML and deep learning are just a few of the automation methods that can be used. This provides the farmer with effective data that plays a vital role in selection of pesticides, herbicides and right kind of fertilizers required for increased yield.
Keywords: Agriculture, AI, ML, IoT, Yields

1. A Brief Review

The guided, supervised, and advanced machine learning technique known as k-nearest neighbors (KNN) is harnessed to address both classification and regression challenges. In the realm of precision agriculture, often referred to as artificial intelligence systems, significant strides are being made to enhance the overall quality and precision of harvests. AI technology plays a pivotal role in identifying and mitigating issues such as pests, plant diseases, and nutrient deficiencies on farms. Utilizing artificial intelligence (AI) sensors, weeds are identified and targeted before selecting the appropriate herbicide for the area.

So, how do these advanced agricultural robots function with such precision? These robots navigate fields, execute assigned tasks such as weed control, insecticide application, and crop harvesting, and employ navigation systems for self-localization. Moreover, they utilize cameras to differentiate healthy plants from the ground. Additionally, AI systems in agriculture perform soil and crop health monitoring, offer fertilizer recommendations, monitor weather conditions, and assess crop quality. These multifaceted advantages of AI in agriculture empower farmers to make informed decisions and practice efficient farming.

Agriculture stands as an indispensable pillar in the economic sectors of every nation. With the world's population steadily increasing, the demand for food continues to surge, surpassing the capacity of traditional farming methods. To meet these demands and provide abundant career opportunities within this sector, a multitude of innovative automation techniques has been devised. Artificial Intelligence has emerged as a pivotal technology, influencing numerous domains, including education, banking, robotics, and, notably, agriculture. In agriculture, AI plays a transformative role, addressing challenges posed by climate change, population growth, employment concerns, and food safety. Thanks to AI, modern agriculture has reached new heights, enhancing crop production, enabling real-time monitoring, optimizing harvesting, processing, and marketing. Various cutting-edge computer-based systems have been developed to assess critical parameters such as weed detection, yield estimation, crop quality, and more. This revolution is redefining the agriculture industry.

2. Introduction

Since a long time ago, agriculture has been a significant part of the Indian economy. 18% of India's gross domestic product is produced by the agriculture sector (GDP). A better answer for precision agriculture is provided by robotics and the internet of things. Selective harvesting is necessary when picking fruits or vegetables like tomatoes and apples. In traditional farming, each fruit is hand-picked by a worker, requiring a huge amount of labour to carry out selective farming. We suggest a robot that helps farmers with a variety of labor-intensive chores, such as selective crop harvesting and qualitative segregation, while also simultaneously providing data on crop health, soil nutritional status, and crop shelf-life detection. An android application is used to analyse, process, and send the obtained data to the farmer. Later, the weight, colour, and health of the particular crop are checked to grade its quality. The fruit is subsequently moved into the designated container after being graded. Spoiled or overripe fruits and vegetables would be plucked and dropped so as not to interfere with the plant's growth. A harvesting arm on the proposed robot would reach the fruit or vegetable and pick it from the plant or tree. The declining number of agricultural employees and rising cost of fruit picking are only two of the issues facing the agriculture sector. In order to solve these issues, agriculture must be scaled up and labour costs reduced. For labor-saving and industrial-scale agriculture, agriculture automation has advanced recently. However, physical labour is still used extensively in the sector of fruit harvesting. The creation of a robotic fruit harvester is a workable answer to these issues.

Two significant duties are involved in a robot's autonomous fruit harvesting:

(1) Using computer vision and a sensor, find and locate fruit on trees.

(2) The end effector of the robot arm moves to the location of the recognised fruit and harvests it without harming the target fruit or its tree.

Human cognitive capabilities have encountered their boundaries in light of technological advancements, prompting endeavors to amalgamate the attributes of a biological brain with those of an artificial counterpart. The quest for this fusion has given rise to the emerging realm of artificial intelligence. It is the means through which individuals craft machines endowed with intelligence.

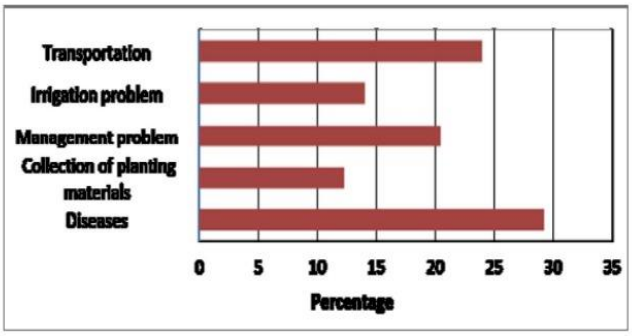

Fig 1: Intensity of various factors effecting productivity

Introduction

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Significant Works Done

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(2) The end effector of the robot arm moves to the location of the recognised fruit and harvests it without harming the target fruit or its tree [18].

The evolution of technology has pushed the boundaries of our human cognitive capacities. As a response to this, we are currently exploring the integration of the functionalities of the human brain with those of artificial intelligence. This ongoing exploration has given birth to the burgeoning field of artificial intelligence (AI), which provides a method for imbuing machines with intelligence [3]. As demonstrated, among the many factors that affect productivity, crop diseases receive the majority of the credit. It demonstrates how early disease detection and identification is crucial for boosting business margins. Satellite farming, which supports the management of farm activities by going site-specific, is specifically related to precision farming. It is mostly built on using technology to track, gauge, and analyse crop productivity. It is regarded as one of the fundamental components of the contemporary agricultural revolution. By the end of 2050, the world's population may total 9.6 billion people. To feed every individual, this would necessitate double output. Precision agriculture is developing mostly in line with two themes, Big Data & advanced analytics and robotics, claims McKinsey. Aerial photography, sensor technology, and accurate local weather forecasts with GPS capabilities are all included [4].

Precision Farming

Precision farming is more concerned with preserving environmental sustainability, industrial profitability, and machinery effectiveness. The farmers rotate their crops to increase crop health and variety, and they keep an eye on irrigation rates to prevent salt buildup from destroying their crops [17]. Additionally, adding fertilisers, water, seeds, and other agricultural inputs in order to grow a range of crops in various soil environments is a wonderful technique followed by the majority of farm managers. Additionally, it includes other components like computer-based applications, GPS soil sampling, variable rate technology (VRT), and remote sensing [5].

AI stands as a distinct branch of computer science that focuses on the capacity to perceive and adapt to its surroundings, with the aim of enhancing its chances of success. AI systems should be capable of performing tasks that rely on prior learning. Notable domains, such as deep learning, CNN, ANN, and machine learning, have been instrumental in advancing machine capabilities and paving the way for more sophisticated technology. IoT, or the Internet of Things, signifies a form of communication where devices interact directly with one another, referred to as "thing-to-thing" communication [6].

Three Important Goals in Farming

The three key goals are system cost reduction, automation, and communication. Medical science, education, finance, industry, security, and many more fields have all been affected by AI. AI implementation involves the machine learning process. This brings us to the "Machine learning" sub-section of this AI area. Machine learning serves the primary aim of providing the computer with historical data and statistical information so that it may carry out the work that has been set to it—solving a specific problem. Today's uses range from speech and face recognition to data analysis using historical data and experience. Numerous studies have looked into fruit localization and detection on trees using computer vision, and the majority of these works have been compiled in the review by Gongal et.al [7].

These techniques frequently employ cameras that are colour, spectral, or thermal. It is challenging to identify a fruit that is cast in shadow by another fruit when using a spectral camera. Based on the temperature difference between the fruit and the background, a thermal camera can identify fruit. The size of the fruit and its exposure to direct sunlight have an impact on this procedure. Fruit detection with a colour camera uses a variety of different features [16]. To segment an apple, Bulanon employed brightness and the RGB colour difference. analysed texture to find an apple. Linker combined a number of factors to increase the precision of fruit detecting techniques [9].

Using a colour camera, several image classification techniques for fruit detection can also be carried out. K-mean clustering was employed by Bulanon to detect apples. KNN clustering was used by Linker et al. and Cohen et al. to classify apples. Kurtulmus also classified apples using an artificial neural network [15]. For apple detection, Qiang employed a Support Vector Machine classification technique. However, because the colour information cannot be sufficiently collected, these approaches are challenging to employ in varying lighting circumstances. Fruit detection should be carried out using several features, such as colour, shape, texture, and reflection, to improve accuracy and get around problems like clustering and fluctuating lighting [8].

3. Automated Farming Approaches

For the purpose of automating fruit harvesting with a robot, the present study proposes the utilization of "fruit detection and localization" in conjunction with "robotic harvesting using a specialized manipulator capable of harvesting fruit without causing harm to either the fruit or its tree." To establish the fruit's position in a two-dimensional (2D) plane, we have employed a color camera combined with the Single Shot MultiBox Detector (SSD), a commonly used object detection method based on Convolutional Neural Networks (CNN) [14]. However, to command the robot arm effectively, it is imperative to ascertain a three-dimensional (3D) position. This is achieved by measuring the position of the fruit, detected by the SSD, in three-dimensional (3D) space using a stereo camera [10].

In order to determine the path taken by the robot arm, we used inverse kinematics. Based on inverse kinematics, we moved the robot arm to the position of the fruit. The harvesting robot's hand served as our end effector. By grasping and turning the fruit, the robot hand collects it without hurting the fruit or its tree. The UN Food and Agriculture Organization projects that by 2050, there will be a 2 billion rise in population. Only 4% more land will, however, be under cultivation by that time. Utilizing modern technical advancements to increase farming efficiency continues to be one of the most important requirements in this context [11].

While artificial intelligence (AI) has many practical applications in many other fields, it has the potential to fundamentally alter how we now view farming. Artificial intelligence-driven solutions will not only assist farmers in achieving higher yields with fewer resources but also enhance crop quality and ensure a faster time to market. The use of drone-based image processing techniques, the landscape of precision farming, the future of agriculture, and upcoming problems are all topics we'll cover in this essay [12].

As shown in the Fig. (1), among various factors that effects the productivity, majority of the credit is taken by diseases that comes to crops. It shows that detection and identification of the diseases in earlier stage plays a vital role in increasing the profit margin. Satellite farming, which supports the management of farm activities by going site-specific, is specifically related to precision farming. It is mostly built on using technology to track, gauge, and analyse crop productivity. It is regarded as one of the fundamental components of the contemporary agricultural revolution. By the end of 2050, the world's population may total 9.6 billion people. To feed every individual, this would necessitate double output. Precision agriculture is developing mostly in line with two themes, Big Data & advanced analytics and robotics, claims McKinsey. Aerial photography, sensor technology, and accurate local weather forecasts with GPS capabilities are all included.

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AI, a field within computer science, possesses the capacity to perceive and adapt to its surroundings, increasing the likelihood of achieving success. AI can excel in tasks reliant on prior learning. Various domains, such as deep learning, CNN, ANN, and machine learning, contribute to the enhancement of machine capabilities and the advancement of technology. IoT, or "thing-to-thing" communication, is defined as a key aspect, with primary objectives of reducing system costs, automating processes, and facilitating communication. AI's influence extends to diverse sectors, including medical science, education, finance, industry, security, and more. AI implementation centers around the machine learning process, leading us to delve into the "Machine learning" subsection of this AI field. Machine learning serves the primary aim of providing the computer with historical data and statistical information so that it may carry out the work that has been set to it—solving a specific problem. Today's uses range from speech and face recognition to data analysis using historical data and experience. Numerous studies have looked into fruit localization and detection on trees using computer vision, and the majority of these works have been compiled in the review by Gongal et al.

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In order to carry out automatic fruit harvesting by a robot, the current study suggests "fruit detection and localization" and "fruit harvesting by a robot manipulator with a hand which is able to harvest without hurting the fruit and its tree." We employed a colour camera and a Single Shot MultiBox Detector (SSD) to identify the fruit's position in two dimensions (2D). The Convolution Neural Network (SSD) is one of the common object detection techniques (CNN). Te SSD can make accurate judgements based on colour and shape. To give the robot arm a command, one must first establish a three-dimensional (3D) position. The fruit detected by the SSD is measured using a stereo camera in its three-dimensional (3D) position. In order to determine the path taken by the robot arm, we used inverse kinematics. Based on inverse kinematics, we moved the robot arm to the position of the fruit. The harvesting robot's hand served as our end effector. By grasping and turning the fruit, the robot hand collects it without hurting the fruit or its tree. The UN Food and Agriculture Organization projects that by 2050, there will be a 2 billion rise in population. Only 4% more land will, however, be under cultivation by that time. Utilizing modern technical advancements to increase farming efficiency continues to be one of the most important requirements in this context. Although artificial intelligence (AI) finds practical applications across various domains, its potential to revolutionize the agricultural landscape is noteworthy. AI-driven solutions have the capacity to not only increase agricultural productivity while conserving resources but also elevate crop quality and expedite time-to-market. The use of drone-based image processing techniques, the landscape of precision farming, the future of agriculture, and upcoming problems are all topics we'll cover in this essay..

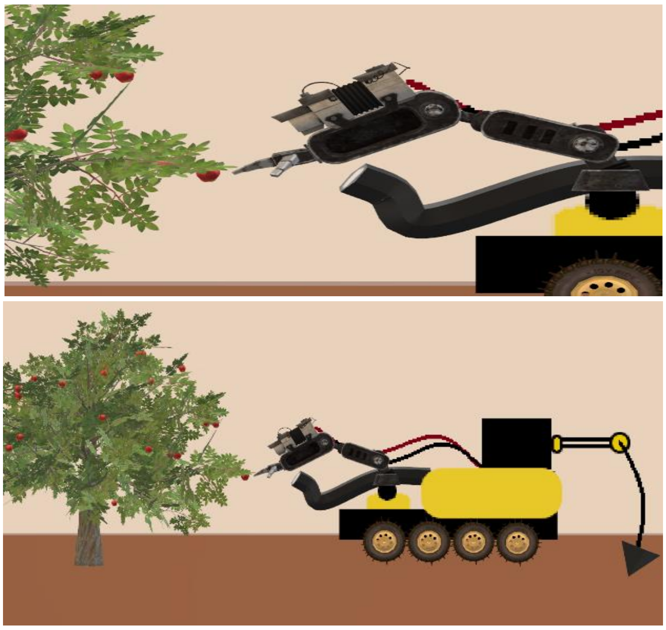

Fig 2: The pictorial representation of model.

4. Scopes & Objectives

Due to lack of knowledge and also due to the lack of viability in farming profession there is a huge labour shortage and also the farmer has to grow different crops in a year Keeping this problems in mind we have developed our robot such that it should be able to perform Selective harvesting and segregation of the ripened fruits , and also it should be able to detect the plant health disease detection and send a notification to the farmer along with the parasites presents in the plant . also this robot would be able to do soil monitoring thought the farm and valuable data like Temperature, Humidity, N, P, K, pH values and be able to predict the right crop for growing in the field . and the mobile application development to act as interface between robot and the farmer.

5. Proposed Methodology

Selective harvesting - A stereo camera and a robot arm will be part of the harvest robot's setup. The algorithm entails three steps: determining the apple's 3D position, determining the fruit's 2D position, and calculating the inverse kinematics.

The detection and harvest portions of these steps were separated. Each technique is described in the sections that follow. Method for detecting fruit position. The fruit's 2D position was discovered in the initial step of the detection process. From the stereo camera, we received one image, and we identified the locations of the apples in the image. To find the apple positions, we employed the SSD. The SSD is a method based on CNN that use a single deep neural network to identify items in a picture. Other detection techniques include You Only Look Once, Faster R-CNN, and others. The VGG net is used in the SSD's initial stage to extract the feature maps. Using tiny convolutional filters applied to the feature maps, the SSD's core predicts the category scores and the box offsets for a defined set of default bounding boxes.

The SSD makes predictions of various scales from feature maps of various scales and explicitly divides predictions by aspect ratio in order to achieve high detection accuracy. Due to these design elements, end-to-end training is made simple, accuracy is good even on low quality input images, and the speed vs. accuracy trade-off is improved. Because the SSD is faster and more accurate than other options, we used it here. Using the SSD, we can identify bounding boxes at the locations of the 2D fruit in the image. We chose a fruit that was closest to the robot arm from fruits that the SSD recognised. The stereo camera's point cloud data and the pixel at the chosen 2D apple position were both received. To create a 3D reconstruction, we employed the stereo camera. In order to determine the 3D position of each pixel in the image, the stereo camera triangulated the parallax between the right and left images. The distance between the stereo camera and the apple can then be calculated..

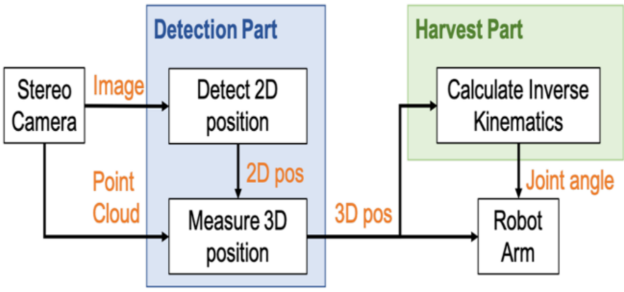

Fig 3: Working of selective harvesting.

The robot hand attached to the robot arm must be moved into position p and posture R in order to harvest the fruit as instructed. The position and posture of the hand (p, R) in a robot arm with vertical articulation are dictated by the angles q of each joint. It is necessary to define the relationship between the hand coordinate system, which represents the position and posture of the hand, and the joint coordinate system, which represents the joint angle of the robot arm. An inverse kinematics problem is one where the angles of each joint must be calculated from the hand position and posture. The robot arm mechanism and configuration are specified by the inverse kinematics problem, which tries to discover a nonlinear function f 1 for the equation. Model for inverse kinematics We assumed that the robot arm's inverse kinematic issue comprised six links.

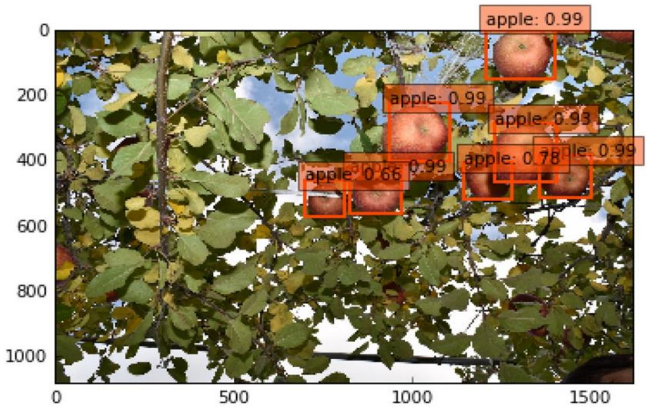

Fig 4: Ideal representation of depicted ideology

Fig 5: 2D positioning of the fruit

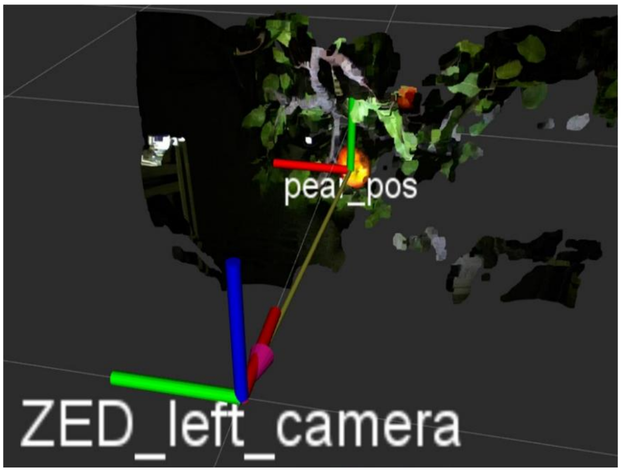

Fig 6: 3D positioning of the fruit

Leaf Disease Detection

The process begins with the capture of various leaf images using a digital camera or similar device. These images serve as the foundation for identifying damaged areas within the leaves. Subsequently, a series of image-processing techniques are employed to extract essential features for subsequent analysis. The proposed image recognition and segmentation algorithm is presented below in a step-by-step fashion:

Image Acquisition: The initial phase necessitates capturing an image using a digital camera.

Preprocessing: The input image undergoes preprocessing to enhance image quality and eliminate undesired distortions. The leaf image is cropped to isolate the region of interest. Additionally, image smoothing is performed using a smoothing filter to enhance contrast and improve image quality.

Green Pixel Suppression: In this stage, pixels primarily composed of green are suppressed. A threshold value for these green pixels is computed, and pixels whose green component intensity falls below this threshold have their red, green, and blue components set to zero.

Masking Cell Removal: The masking cells within the infected clusters are removed, allowing for more accurate analysis.

Feature Extraction: Pertinent information required for categorizing leaf diseases is collected, and a genetic algorithm is employed to segment these components.

Disease Identification: Image segmentation techniques are employed to identify diseases present in the leaves.

Soil Nutrient Monitoring: Soil moisture sensors are used to measure soil moisture content, an essential aspect of plant health. In addition, humidity sensors are utilized as vital tools for detecting and monitoring humidity levels in various applications.

Upon gathering all relevant plant information, the background Python code facilitates data storage in the database before making it accessible to the farmer through a mobile application.

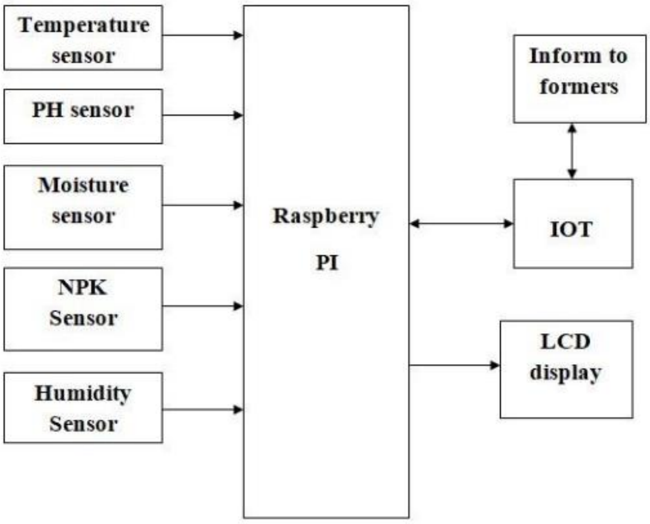

Fig 7: Working model of soil nutrient monitoring.

6. Literature Survey

A comparison of the different methods used in the robot is presented first. It is then followed up with an in-depth review of algorithms used for selective harvesting and other task, including the development of android an app.

Selective Harvesting & Segregation

Selective Harvesting refers to the practice of harvesting only ripe fruit while leaving unripe ones untouched. This review paper offers an overview of the current state of selective harvesting robotics within three distinct production systems: greenhouse, orchard, and open field. The paper does not present a specific methodology but rather focuses on the application scenarios of selective harvesting. It serves as a conceptual exploration of current trends in agricultural robotics.

In this review, the authors also provide recommendations for further advancements in this domain. They suggest concentrating on Automated Visual Fruit Detection for Harvest Estimation and Robotic Harvesting, as emphasized in another study [2]. This proposed study introduces a fully automated semi-supervised system based on object learning models for identifying unique object instances in previously unobserved images. To enhance single object instance detection within clusters, it offers two approaches for segregating clusters into individual object instances. The model employs a cascade classifier with AdaBoost, using binary patterns as local feature descriptors, which prioritizes gradient information over color data by comparing pixel intensity regions in grayscale images. It should be noted that this system is semi-supervised and does not utilize neural networks. Additionally, it primarily focuses on grayscale image processing, reliant on the intensity of light.

To realize automated fruit harvesting by robots, an alternative study [7] suggests a method that involves "fruit detection and localization" combined with "fruit harvesting by a robot manipulator equipped to collect fruit without causing harm to either the fruit or its tree." This approach employs a robotic hand to collect apples upon detecting their location. The effectiveness of this method depends on factors such as fruit size and exposure to sunlight. Fruit detection via a color camera employs various features, including brightness and RGB (red, green, and blue) color differences. The proposed fruit harvesting algorithm estimates that it takes approximately 16 seconds to harvest a single fruit, but new Single Shot MultiBox Detector (SSD) algorithms can substantially improve efficiency. Convolutional neural networks (CNNs) play a central role in achieving this.

In the realm of vegetable quality inspection, human experts traditionally conduct quality assessments [3]. However, this manual sorting process by human inspection is time-consuming and vulnerable to issues of inconsistency and accuracy discrepancies across different human inspectors. The automation of the quality identification process is anticipated to reduce labor costs while enhancing sorting efficiency and accuracy. Instead of employing R-CNN, this approach utilizes Faster R-CNN. The key advantage of Faster R-CNN is its elimination of the need to separately train the network for classification and localization. These alterations result in reduced overall training time and enhanced accuracy when compared to Spatial Pyramid Pooling (SPP) networks, due to the end-to-end learning of CNNs.

Plant Disease Detection

Within this category, we compared various algorithms and constraints such as methods of training robot, camera resolution etc. Plant disease is a significant factor in crop yield. The detection of plant diseases using the KNN classifier and GLCM (Gray level co-occurance matrix) algorithm is the basis of the study work in [4]. The image is used as the input for the proposed method, after which the GLCM algorithm is used to analyse the textural features, K-means clustering to segment the image based on regions, and a KNN classifier to predict the presence of a disease. The method is suggested for identifying plant diseases. The following phases make up the plant disease detection methods: 1. Pre-processing phase: The input image is initially converted to a grayscale image in the first phase, which takes place after the input image. 2. Analysis of textural features: The GLCM algorithm is used to analyse the textural features of the input image. For the purpose of calculating texture features, this technique performs statistical texture analysis on the observed combinations of intensities. The intensities at specific locations within an image that are related to one another are used in this calculation. MATLAB is used to simulate the suggested modal.

Additionally, a database of about 40 photos of potato leaves is compiled from the freely available dataset "Plant Village" and used to assess the suggested technique. The database utilised for conducting experiments has images of 10 healthy leaves and 30 sick leaves. During the experiments, the entire database is divided into 2 distinct sets. The training set has 24 photos (or 60% of the total number of images), whereas the testing set contains 16 images (or 40% of the total number of images), yet the accuracy was only 93%. Accuracy can be improved by using more datasets and training. Many paper uses the ANN ‘Feed Forward neural network’ which involves all the nodes in the processing and is time consuming. But the proposed system uses CNN which is a better in terms of speed and processing. Vision Sensors. While many papers suggest the use the Matlab as coding language, the proposed system uses Python. Excysting methodology uses the Back Propagation Algorithm which has drawbacks like getting stuck easily in local minima and slow speed of convergence whereas the proposed system uses the CNN which overcomes all the drawback of Back Propagation Algorithm.

The proposed algorithm uses the Back Propagation Algorithm which has drawbacks like getting stuck easily in local minima and slow speed of convergence whereas the proposed system uses the CNN which overcomes all the drawback of Back Propagation Algorithm. With respect to camera, uses the mobile camera with a resolution of 2MP for the capture of the image, the proposed system uses raspberry pi camera with the resolution of 5MP.] uses the 5 layer Convolution Neural Network and has gained the efficiency of 75% whereas the proposed model uses the VGG16 which uses 16 layers of CNN, training the model repeatedly, hence giving an enhanced functionality in training accuracy in turn the model accuracy. Less number of epoch are used in previous methods, thus giving the validation accuracy of 0.0389 whereas the proposed system runs an epoch for 50 times achieving a validation accuracy of 0.9578.Also uses the SVM for the training purpose which is not accurate since it is found to achieve very less accuracy even for a good dataset, this proposed system uses the CNN algorithm for the model training which is improved model in terms of accuracy and speed. Most of the papers uses major axis and minor axis of the leaf for the classification purpose whereas the proposed system uses the canny edge detection method which is a Gaussian based operator computing second order derivative of the digital image.

We have referred the following methodologies, compared these and have selected the best.

Feedforward Neural Network (FNN) is a type of neural network where information flows unidirectionally from various input nodes to the output node. These networks can be designed with or without hidden layers, making their behavior more predictable. FNNs are trained to process a considerable amount of noise and have applications in facial recognition and computer vision.

Recurrent Neural Network (RNN) is another category where the output of the processing model is stored and fed back into the model. This feedback loop enables RNNs to learn from previous predictions and adjust their output. Each node in an RNN serves as a memory cell. These networks are commonly used in text-to-speech applications.

Convolutional Neural Network (CNN) is a computational model comprising one or more convolutional layers, which generate feature maps to analyze image regions, subsequently breaking them into rectangles that can be connected or pooled. CNNs are well-known for their applications in image recognition, including AI-based facial recognition on mobile phones and text digitization, as well as natural language processing with virtual assistants like Alexa and Siri.

Deconvolutional Neural Network works in reverse, aiming to find features or signals initially deemed unimportant by CNN. These networks are used in image analysis.

Modular Neural Network involves multiple neural networks that work independently, without interfering with one another's computations. They excel in solving complex computational processes efficiently and accurately.

Among these options, CNN is particularly advantageous for our application. It is a deep neural network designed for structured array processing, extensively employed in computer vision and regarded as the state-of-the-art for various visual applications, such as image classification and natural language processing for text classification. CNNs are adept at recognizing patterns in input images, making them well-suited for computer vision tasks. They operate directly on raw images without requiring preprocessing and typically consist of up to 20 or 30 layers. In CNNs, convolution layers are stacked on top of one another, each with the capability to identify intricate shapes. This design mirrors the structure of the human visual cortex, with hidden layers typically composed of convolution layers followed by activation and pooling layers.

SOIL NUTRIENT MONITORING

In [6], a proposed smart irrigation and monitoring system aims to efficiently manage water usage and automate irrigation in large crop areas, reducing water waste. The system primarily keeps track of how air temperature, air humidity, and soil moisture behave.

This includes the traditional approach, which entails collecting soil samples, determining the temperature, humidity, and NPK values, and then comparing the results to the pre-calculated conditions in the standard table, such as dry soil and wet soil. This approach doesn't provide greater precision because soil nutritional status varies owing to soil erosion; it would be preferable to obtain samples in the field. Precision farming robot[8] It meets all of the fundamental requirements of farming, including measuring soil moisture content, minerals in the soil, etc., using sensors. Crops are planted in the soil based on data collected from fertility and moisture sensors, accounting for the farm's size. Additionally, a separate set of sensors, functioning like fertility sensors, assesses the crop type and genome for infections. Basic irrigation is initially conducted, followed by a thorough examination of the fields for diseases and pesticide infections. When necessary, pesticides and insecticides are applied.

With a pre-installed arrangement, agricultural practises like sprinkler irrigation and drip watering are also carried out automatically. This circuit arrangement uses an Arduino Uno R3, a microcontroller based on applications, as the kind of Arduino.

Android Application

Through Bluetooth they are getting the information about the working of agribot. we are doing selective harvesting using robotic arm and soil nutrition check as well as suggestion to the farmer based on the nutrition app to give the choice to user to select what he wants the robot to do after user selects one task automatically the code for that button will run and robot will do that task

7. Conclusions and Future Directions

In this project report, we are developing a prototype of precision farming robot. A summary of the project work that is going to be done in the final year of 7th & 8th semester of the UG-BE course is presented. Extensive literature survey was carried out in this exciting field w.r.t. various algorithms that can be used in selective harvesting, segregation & during this period, all the relevant papers from various sources were collected & studied in greater depth, made a thorough analysis and the project problem was finalized.

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