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IoT and Wireless Sensor Network Based Autonomous Farming Robot

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Abstract: ***In recent years, there has been an increasing demand for smart farming solutions to optimize crop production while reducing the need for manual intervention. Internet of things (IoT) is an emerging technology that shows the future of computing and networking. Agricultural monitoring from a remote location is one of the essential applications of IoT based wireless sensor networks. The IoT based wireless sensor network faces problems due to the dynamic changes in the environment. The number of required sensor nodes increases for monitoring of the vast area. By introducing mobility of all nodes in the IoT based wireless sensor network, we can decrease the number of nodes and thus reducing the cost of the overall system. In this project, an IoT based farming robot network is proposed for farming applications. Robots are also equipped with an infrared sensor for avoiding obstacles during navigation. We developed automatic plant watering system also. These robots can be used for harvesting pesticide spraying, controlling weed and many other applications. The proposed system provides an efficient and cost-effective way to manage crops, while reducing the need for manual labor.***
Keywords: Weed Control, Harvesting And Picking, Phenotyping.

I. INTRODUCTION

Indian agriculture is diverse ranging from traditional farming practices to utilizing modern agricultural technologies. Agriculture plays a vital role in the economic growth of a country. Agriculture is a primary occupation for the support of humankind. The agricultural industry is the backbone of economics worldwide, providing food and raw materials for a variety of industries. Thus, the security and improvement of farming are essential. There are numerous yet to be tackled issues in the field of agriculture as the more significant part of the methods utilized by the farmers are outdated, and they do not meet the reasonable yield. With an increasing demand for food, the world population growth and a shortage of manual labor, it has become essential to develop new technologies to optimize crop production and reduce the impact of farming practices on the environment. Technology in agriculture is growing day by day and showing us good results. In recent years, the development of smart farming solutions using Internet of Things(IoT) and Wireless Sensor Network(WSN) technologies has shown great promise in this regard. IoT plays a major role in the evolution of agriculture towards technology. One such solution is the autonomous farming robot, which is a self-contained system that can monitor and control various environmental parameters to optimize crop growth. The IoT is a technology where it is possible to use a mobile device to control the system's functioning. With the support of IoT, interconnecting, and communicating with objects mounted at various locations that are remote from users would not be a problem. IoT is a type of network technology that senses data from various sensors and makes it possible to link to the Bluetooth to exchange information. IoT may also be used to exchange the device's status. The system utilizes the WSN technology to collect data from the sensors and transmit it to a central server for analysis and decision making. Robots in agriculture sector with its implementation based on precision agriculture concept is the newly emerging technology. The main reason behind automation of farming processes are saving the time and energy required for performing repetitive farming tasks and increasing the productivity of yield by treating every crop individually using precision farming concept. Designing of such robots is modeled based on particular approach and certain considerations of agriculture environment in which it is going to work. These considerations and different approaches are discussed in this project. Also, prototype of an autonomous agriculture robot is presented which is specifically designed for seed sowing, digging and other tasks.

One of the significant applications of the autonomous robot is agricultural monitoring or work in an environment where a human cannot work. It can move quickly in the field without any human intervention and monitor the environmental parameters with the help of sensors mounted on it. For covering large areas, many autonomous mobile robots will be required and connected through a wireless sensor network. The mobile wireless sensor network will help in improving system capability and flexibility to perform multiple applications.

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One of the significant applications of the autonomous robot is agricultural monitoring or work in an environment where a human cannot work. It can move quickly in the field without any human intervention and monitor the environmental parameters with the help of sensors mounted on it. The farming robot even identify the leaf disease and even suggest the pesticide required for it and spray pesticide for the affected area. The leaf disease can be identified for a particular leaf or any leaf we need. The disease can be identified without any human intervention or the leaf can be examined by human and give commands to the robot to spray pesticide. For covering large areas, many autonomous mobile robots will be required and connected through a wireless sensor network. The mobile wireless sensor network will help in improving system capability and flexibility to perform multiple applications.

A. Objective

1) The objective of agricultural robot is to help the sector in its efficiency and the profitability of the processes.
2) In other words mobile robots works in the agricultural sector to improve productivity, profitability and environmental sustainability.

B. Proposed System

1) Agriculture activities can be done automatically.
2) Robot will do some of the operations without any human interventions.
3) Robot will perform some farming functions such as digging, seed sowing, leveling, water sprinkling, pesticide sprinkling and leaf disease detection.
4) Leaf disease can be identified by Python using SVM(Support Vector Machine) algorithm.
5) SVM Algorithm will give the disease name and the pesticide to be used.
6) Robot can be operated in solar based.

II. METHODOLOGY

1) The system consists of wheeled mobile robots i.e. Master and Slave node.
2) The master robot is equipped with all sensors can navigate independently in field and it has also the capability of distinguishing weeds.
3) The master robot is responsible of formation of portable remote sensor network through wireless protocol and it has the ability to acquire the channel physically.
4) The other robots/slaves can join the network by choosing same frequency channel. Subsequently joining the system, the slave robot sends the sensor data to master node
5) The master node collects information from separate sensor nodes and then uses the Node MCU module to transfer the accumulated information to IoT.
6) Master robot is equipped with image acquisition camera for possible detection of weed and leaf disease.

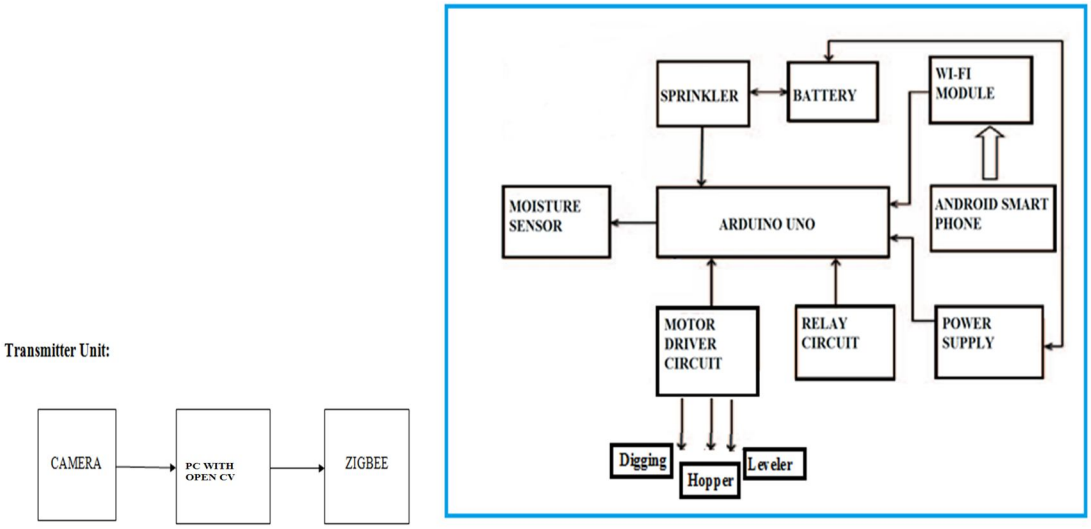


Fig 1- Block Diagram Of System

III.HARDWARE REQUIREMENTS

1) *Microcontroller:* A robot microcontroller is basically the brain of the robot. It is used to collect the information from various input devices such as sensors, switches and others. Then it executes a program and in accordance with it controls the output devices such as motors, lights and others.

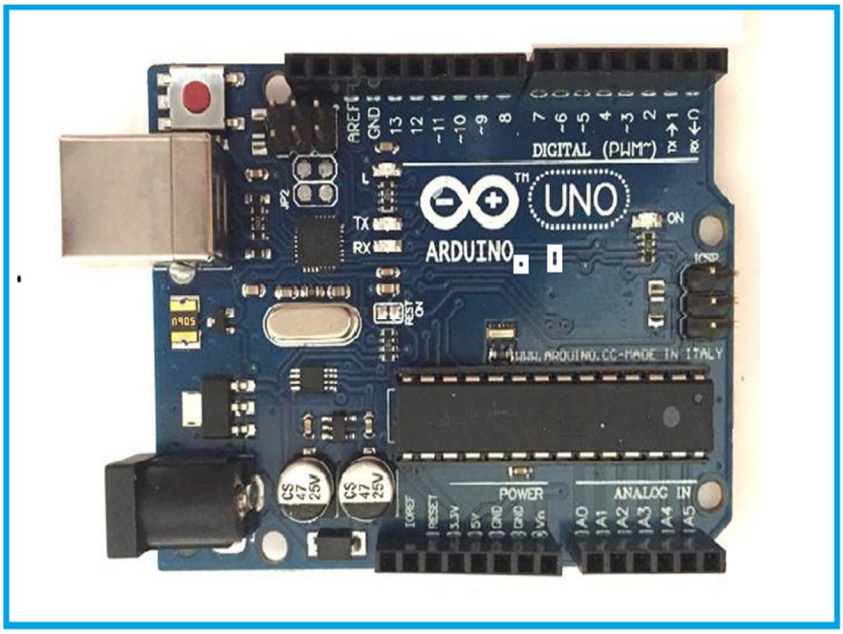


Fig 2- Diagram of Arduino Board

2) *Water Pump:* Water Pumps are used to provide high irrigation efficiency by supplying proper amount of water to every corner of the field to gain speed in cultivation. Output voltage of this 5v.
3) *Soil Moisture Sensor: (FC-28):* Soil moisture sensor measure the water content in the soil and can be used to estimate the amount of water in the soil Horizon. Output voltage is 5V.
4) *Pesticide Pump:* It is used in agriculture used to spray liquids like water, insecticides and pesticides in agriculture.
5) *H- Bridge (L293D):* A H-Bridge is an electronic circuit that allows a voltage to be applied across a load in any direction. It is a typical motor driver IC which allows the DC Motor to drive on any direction.
6) *DC Motors:* A DC motor is an electrical machine that converts electrical energy into mechanical energy. In a DC motor, the input electrical energy is the direct current which is transformed into the mechanical rotation.

IV.SOFTWARE REQUIREMENTS

1) *Arduino Suite:* The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board. This software can be used with any Arduino board. There are currently two versions of the Arduino IDE, one is the IDE 1.x.x and the other is IDE 2.x. The IDE 2.x is new major release that is faster and even more powerful to the IDE 1.x.x. In addition to a more modern editor and a more responsive interface it includes advanced features to help users with their coding and debugging.
2) *Embedded C:* Embedded C is the most popular programming language for developing electronic gadgets that build with a set of functions where every function is a collection of statements that are used to implement some particular tasks. Embedded C programming plays a key role in performing a specific function by the processor. The C programming language provides Embedded C Programming Language is an extension of C Program Language that is commonly used in designing Embedded Systems. It uses the same syntax and grammar as the key function variables, loops, data type declaration, functions, statements etc.
3) *Flash Magic:* Flash Magic is a PC tool for programming flash-based microcontrollers from NXP using a serial, Ethernet, CAN bus or SWD while in the target hardware. Five simple steps to erasing and programming a device and setting key options Automatically program checksums. The Flash Magic Production System NET comes with a LabVIEW 32-bit VI for erasing, programming and verifying NXP Cortex Devices. Perfect for integrating into existing test and production engineering systems.

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V. RESULTS AND DISCUSSION

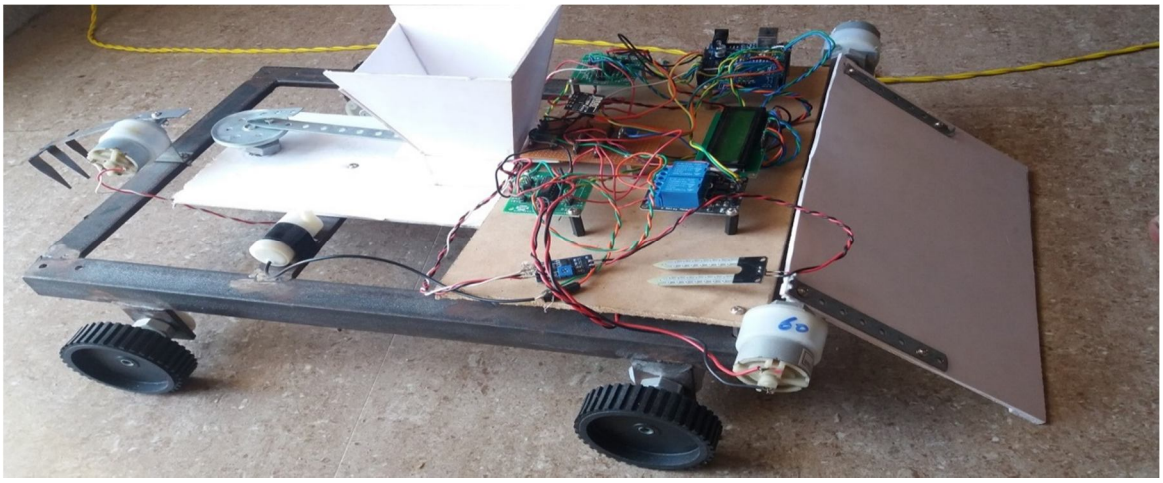


Fig 3 – Final output Of Our Model

The agricultural robot will be using a chassis as a base to connect and assemble everything on it will be consisting of four motors. Two of which are toy motors and the other being gear motors. The robot is capable of doing three separate functions.

- Digging
- Hopper
- Leveler

These will be working in different modes. Programming of different modes will be done separately the different modes .The LCD will be displaying the input given to the robot by the user the measurements of the length and breadth of the field are to be given in feet.

1) Mode 1: Digging

Here obtained a new technology for sowing the seeds in a particular order. The seeds are placed with some specific gap between them and which is different for every crop. So in order to overcome the problem, robot which will itself dig the soil and place the seeds. Table 4.2 explains placement of seeding.

2) Mode 2: Hopper

Hopper is used to carry seeds and to drop the seed at a particular hole that is being dig by agribot.

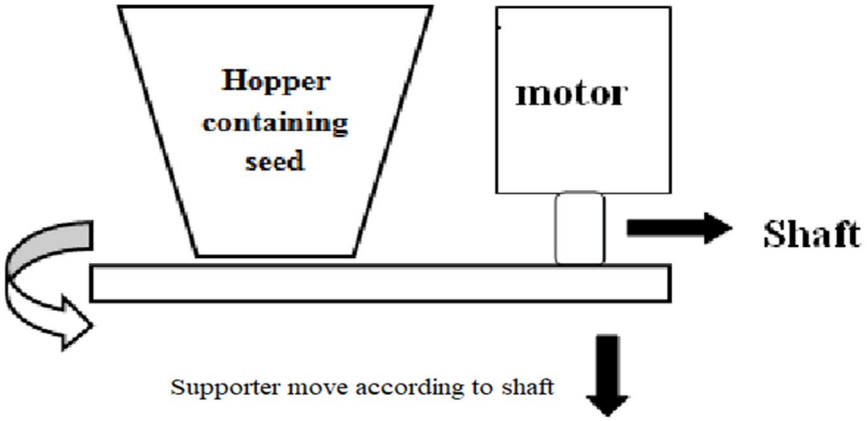


Fig 4 – working Of Hopper

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3) Mode 3: Leveler

Leveler is placed at front of the robot. This will help to make an uneven surface to a flat shape. This will work simply by making Front actuators come down. When robot starts moving forward, the even surface has up's and down's leveler will make all the area to flat surface. This is very compatible for leveling gardens, small areas, closing gaps, etc.

4) Mode 4: Sprinkler



Fig 5 - Micro submersible pump

This is lightweight, small size, high efficiency, low consumption and low noise water pump.It has been used widely; in household include cooking, cleaning, bathing, space heating and water flowers, etc.

5) Mode 5: Leaf Disease

The tomato samples having six disorders are considered to evaluate its accuracy and to recognize the leaf disease as Healthy or Unhealthy. As a part of image processing, the samples of tomato are resized to 256 × 256 pixels to maintain equal in their size throughout the experiment. The HE and K-means clustering are employed to maximize the quality and segment the leaf samples. Based on the K-means clustering response, the leaf is diseased or not can be predicted at the early stage of operation. The boundaries of the leaf samples can be extracted using contour tracing.

The DWT, PCA and GLCM are used to extract the informative regions/features of the samples. In the next stage as a part of machine learning approaches the SVM, KNN and CNN are used to classify the features and the performance of the model is recorded.

VI. CONCLUSION

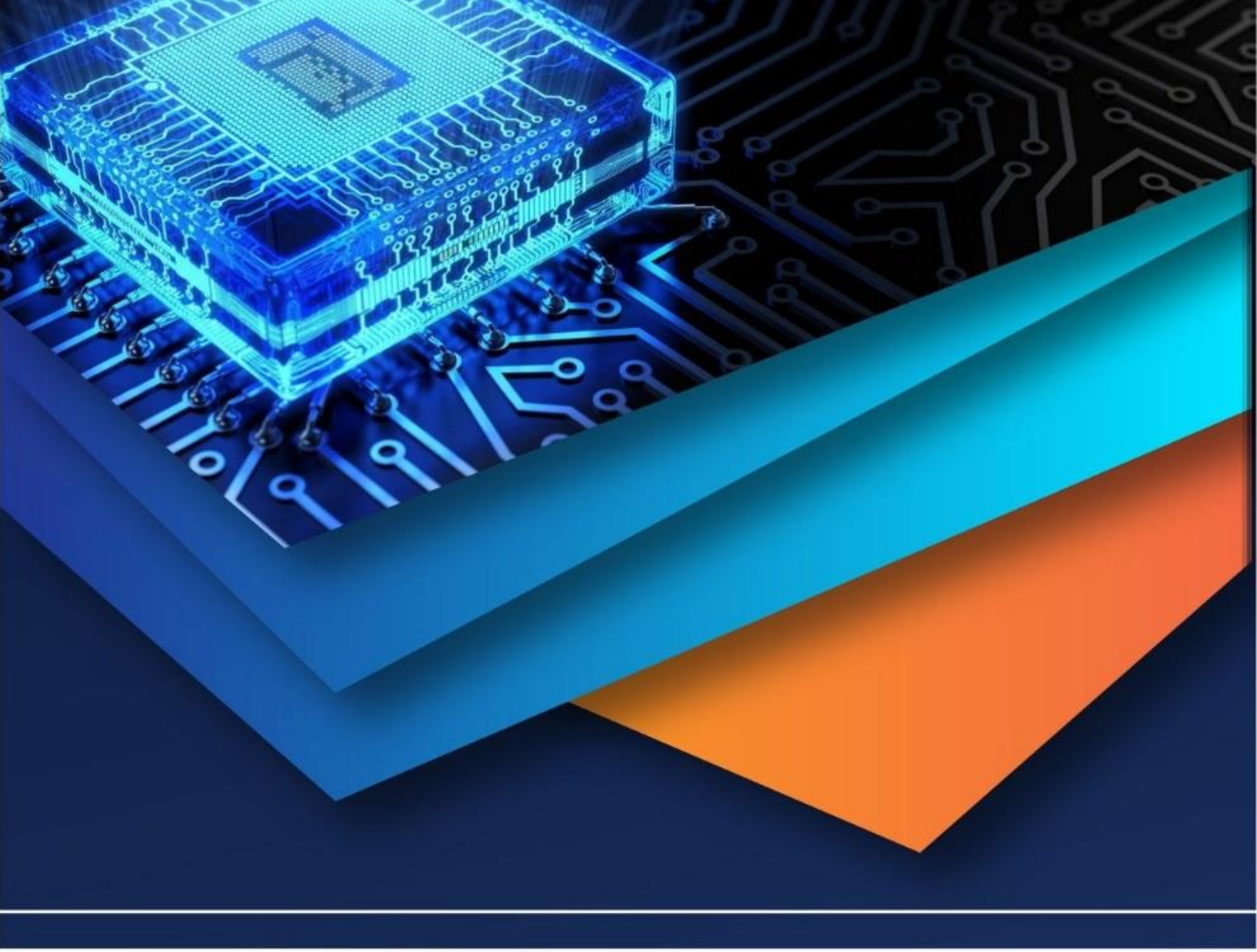
Multipurpose autonomous agricultural robot" has successfully implemented and tested for various functions like ploughing, seeding, leveling and water spraying. It was developed by integrating agricultural robot with C programming. Application of inexpensive navigation sensors to the robot farming system makes the system economically adaptable with the environment. With the development of robot farming system, food production can be increased considerably and economically.

With fully-automated farms in the future, robots can perform all the tasks like mowing, fertilizing, monitoring of pests and diseases, harvesting, tilling, etc. This also enables the farmers to just supervise the robots without the need to operate them. The project can be enhanced to any other kinds of crop. Hence, it can be applicable to the real time agricultural field.

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