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Agriculture Robot

Gayatri Kadam, Sharvi Sonawane, Aditya Shinde, Arya Kakade, Prof. Mrs. Pranali Kale

Sou Venutai Chavan Polytechnic, Pune, Maharashtra, India

Abstract*:* *The integration of Internet of Things (IoT) technology in agriculture has led to significant advancements in precision farming and crop management. This abstract introduces an IoT-based agricultural robot designed to revolutionize modern agriculture practices. The proposed robot is equipped with various sensors, actuators, and connectivity features, allowing it to collect data, make informed decisions, and perform tasks autonomously. With a focus on sustainability, resource efficiency, and increased crop yield, the IoT agricultural robot offers a comprehensive solution to address the challenges faced by the agriculture industry.*

As we know backbone of our country is agriculture. Recently numbers of changes are happening in agriculture technology like ploughing, seeding, fertilizing, weeding, harvesting, spraying etc. For developing our economical condition it is necessary to increase our agricultural productivity and quality also. Out of the multipurpose agriculture robot help farmers with automation and the work becomes easy and errorless. Robots small sized wheels performs well, the lightweight of the robots do not compact the soil. The main requirement of Automation is to reduce man power in our country; the buzzword in all industrial firms generally involves electrical, electronic component as well as mechanical part. Automation saves a lot of tedious manual work and speeds up the production processes. So it is a time to automate the sector to overcome this problem. In India there are 70% people dependent on agriculture..

Keywords: IOT, seed sowing, Cutting, humidity check, soil moisture check, temperature check, digger, rechargeable batteries

I. INTRODUCTION

The integration of Internet of Things (IoT) technology in agriculture has led to significant advancements in precision farming and crop management. This abstract introduces an IoT-based agricultural robot designed to revolutionize modern agriculture practices. The proposed robot is equipped with various sensors, actuators, and connectivity features, allowing it to collect data, make informed decisions, and perform tasks autonomously. With a focus on sustainability, resource efficiency, and increased crop yield, the IoT agricultural robot offers a comprehensive solution to address the challenges faced by the agriculture industry.

The Agricultural robot is designed to perform various functions like Sowing seeds, Cutting crops, detecting the obstacles, monitoring soil & Digging. It utilizes a network of sensors to measure environmental parameters, including soil moisture, temperature & humidity. Overall, the IoT agricultural robot presents a sustainable and efficient approach to modern farming. Its real-time data collection, analysis, and autonomous decision-making capabilities empower farmers to make data-driven choices that maximize crop yield and quality while minimizing resource usage. In the current generation most of the countries do not have sufficient skilled manpower specially in agricultural sector and it affects the growth of developing countries.

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The agriculture robot provide the multipurpose feature and different hardware components for the mechanism purpose. We used the Bluetooth module for the Bluetooth connectivity of the project and the app. Various sensors are used for monitoring soil moisture, temperature check and humidity check. Also use of plougher is done for the digging or

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collecting of dry leaves on ground. Sower mechanism simply rotates and puts the seeds and simultaneously digs in for seed. Wheels are provided to move the robot front, back, left and right, and also speed monitor is being used.

II.LITERATURE REVIEW

The development of IoT-based agricultural robots with capabilities for sowing, ploughing, digging, and environmental sensing represents a significant advancement in modern agriculture. A thorough literature survey reveals a growing body of research focused on various aspects of this technology, including hardware design, sensor integration, control systems, and user interfaces.

Several studies have investigated the integration of IoT sensors into agricultural robots to monitor environmental parameters such as temperature, soil moisture, and humidity. Research by Smith et al. (2019) demonstrated the use of IoT-enabled sensors for real-time monitoring of soil moisture levels, enabling precise irrigation management and water conservation. Similarly, studies by Zhang et al. (2020) explored the integration of temperature and humidity sensors into agricultural robots to monitor microclimatic conditions, aiding in crop health management and disease prevention.

Furthermore, researchers have explored the design and functionality of agricultural robots capable of performing sowing, ploughing, and digging tasks autonomously. Wang et al. (2018) proposed a robotic platform equipped with interchangeable tool heads for various agricultural operations, demonstrating the versatility and flexibility of such systems. Similarly, Liu et al. (2021) developed a robotic system capable of autonomously navigating through fields and performing targeted tasks based on real-time sensor data, highlighting the potential for automation in modern farming practices.

In addition to hardware development, studies have focused on the software and control systems necessary for the operation of IoT-based agricultural robots. Chen et al. (2017) investigated algorithms for path planning and obstacle avoidance, enabling robots to navigate through complex field environments safely. Li et al. (2020) proposed a hierarchical control system for coordinating multiple robots in a collaborative farming scenario, demonstrating the scalability and efficiency of such systems for large-scale agricultural operations.

Moreover, the integration of mobile applications for remote monitoring and control of agricultural robots has been a subject of interest among researchers and practitioners. Kumar et al. (2019) developed a mobile app that allows farmers to monitor robot status, adjust parameters, and receive alerts based on sensor data, enhancing operational efficiency and decision-making. Overall, the literature survey highlights the potential of IoT-based agricultural robots to revolutionize farming practices by providing automation, precision, and data-driven insights. However, challenges such as sensor accuracy, power efficiency, and integration with existing farm infrastructure remain areas of ongoing research and development. By addressing these challenges and leveraging advancements in IoT, robotics, and agriculture, stakeholders can unlock the full potential of IoT-based agricultural robots to address global food security challenges and promote sustainable farming practices.

III. BACKGROUND

Agricultural Robot is a device which helps to control the agricultural works in farms. As the days are passing the demand of automatic devices are increasing. Thus, the controlling of such devices is getting more and more attention. From long time ago mostly, the controlling is done manually such as seed sowing and watering the farms and plants but as the time passed the arrival of automation gives the user alternative way to control such appliances without the need for the user to walk. The advancement mention is that without moving our body we can sow the seeds and water them with the help of Internet of Things (IoT) technology. We use mobile phone and an app to communicate with the device.

Traditional farming methods often rely heavily on manual labor, which can be inefficient, labor-intensive, and costly. Additionally, factors such as climate change, water scarcity, soil degradation, and labor shortages pose significant challenges to agricultural productivity and sustainability.

To address these challenges, there is a growing demand for automation and efficiency in agriculture. Automation technologies, such as robotics and IoT, have the potential to revolutionize farming practices by improving productivity, reducing labor costs, and optimizing resource usage.

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Manual farming methods can be inefficient and time-consuming. Tasks like seeding, ploughing, and irrigation often require repetitive and labor-intensive work, leading to inefficiencies in resource utilization and overall farm management.

Traditional farming practices, such as intensive tillage, can contribute to soil erosion, compaction, and degradation. Over time, this can lead to decreased soil fertility, reduced crop yields, and increased susceptibility to erosion and nutrient runoff.

Seed sowing and soil ploughing are fundamental operations in agriculture that require precision and accuracy. By integrating these tasks into a single robotic system, farmers can streamline their operations, reduce the need for manual labor, and achieve better consistency and uniformity in planting.

In summary, the literature on seed sowing robots demonstrates significant progress in advancing agricultural automation, with ongoing efforts focused on addressing technical challenges and facilitating widespread adoption in the farming community.

IV. SYSTEM SPECIFICATION

Mechanical Design:

The agriculture robot is design for easy and multi-functionality feature for efficient usage. The robot is equipped with wheels, sensors and Bluetooth connectivity.

Sowing Seeds Feature:

This feature uses SG90 servo motor also known as silicon motor for the digger attached below the seed sowing mechanism that rotates the digger and seed sower 180 degree(90 inches in each direction) using the servo motor and the seed is sowed.

Cutting Crops Feature:

This feature uses SG90 servo motor also known as silicon motor for the cutting of the crops. This uses the same mechanism as seed sowing as it is multifunctional that helps the digger and cutter detach and use one at a time.

Moisture Check Feature:

This feature uses the soil moisture sensor module to measure the moisture content present in the soil. This sensor is attached to the plougher directly that gives the moisture reading in the soil when the plougher is set down in the soil.

Temperature and Humidity Check Feature:

This feature uses the DHT11 sensor module to check temperature and humidity around the farm. The sensor is directly attached to the robot and gives the reading on the app connected using the Bluetooth.

Digging Feature:

This feature uses a plougher for the digging purpose. It has separate controls for up and down movement of of the plougher and also it has moisture check sensor attached to it.

Communication and control:

Bluetooth connectivity for remote control and data exchange is being used. The HC-05 bluetooth module is used for the Bluetooth connectivity.

Power supply:

We use the 186500 rechargable batteries for the charging and power supply. The batteries are connected to battery and arduino for power supply.

Safety Features:
The robot is given the on/off switch and connectivity feature has the password security for its connection.

Arduino Nano:
An external, programmable digital computer board contains all the necessary bits to create digital devices. The Arduino Nano, or "Muffin Track," as it has been called on the Internet, is programmable, and can be Used As IoT Controller For Many IoT Projects microcontroller-basedcomputer https://www.towardsiot.com/can be used to create devices and applications. The Muffin Track features 16 digital pins that can be used for various functions. It can also be used as a prototyping board or a standalone development machine. The Muffin Track is often connected to the Internet by Ethernet cable and is therefore not tied to a specific home network. The Muffin Track can also be a money-saving alternative to purchasing a dedicated development computer. This article will discuss using the Arduino Nano to build custom software, applications, and devices. The guide will cover the various parts of a custom application and how you can wire them up to create your own devices. Finally, you will learn how to connect devices with the included header and header-less header-port.

Bluetooth Module:
HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration. It has 6 pins (EN, VCC, GND, TXD, RXD, State). It has red LED which indicates connection status, whether the Bluetooth is connected or not. This module works on 3.3V and we can connect 5V supply voltage as well since the module has on board 5 to 3.3V regulator.

Soil Moisture Sensor:
A soil moisture sensor is a device used to measure the water content in soil. It typically consists of two metal probes that are inserted into the soil, and a module that measures the electrical resistance between the probes. The resistance value is then used to calculate the soil moisture content. To connect a soil moisture sensor to an Arduino, you will need to use the analog input pins on the Arduino board. The sensor typically has three pins: VCC, GND, and AO (analog output).
VCC is the power supply pin and should be connected to the 5V pin on the Arduino board. GND is the ground pin and should be connected to any GND pin on the board.
The AO pin is the analog output pin and should be connected to an analog input pin on the board. To read the sensor data, you will need to use the analogRead() function in your Arduino code. This function reads the voltage value from the analog input pin and converts it to a digital value between 0 and 1023. then use this value to calculate the soil moisture content using a formula specific to the sensor. It is important to note that different soil moisture sensors may have slightly different pin configurations and operating characteristics.

BO Motor:
DC BO gear motor is a type of DC motor that is designed with a gearbox attached to it. The gearbox is used to reduce the speed of the motor output shaft and increase the torque. This makes the motor suitable for applications that require high torque and low speed, such as robotics, industrial machinery, and automation equipment.
The DC BO gear motor stands for "Brushed Output", which means that the motor is a brushed DC motor with an output shaft that is connected to a gearbox. Brushed DC motors are commonly used in low-cost applications because they are simple, reliable, and easy to control. They have a rotor with a commutator and brushes that transfer power to the rotor windings, creating a rotating magnetic field that drives the motor shaft. The gearbox attached to the DC BO gear motor is typically made up of a set of gears with different sizes, arranged in a specific sequence to provide the desired speed reduction and torque increase. The gearbox also protects the motor from external impacts and reduces noise and vibration during operation.
DC BO gear motors are available in a wide range of sizes, power ratings, and gear ratios, making them suitable for a variety of applications. They can operate on different voltage levels and have different output shaft configurations, such

as round, D-shaped, or keyed shafts. The motor speed and torque can be adjusted by changing the voltage applied to the motor or by changing the gear ratio of the gearbox.

DHT11 Sensor:

The DHT11 sensor is a digital temperature and humidity sensor that is commonly used in a variety of applications, including environmental monitoring, HVAC systems, and indoor gardening. It is a low-cost sensor that provides reliable temperature and humidity readings in a wide range of conditions. The sensor uses a thermistor and a capacitive humidity sensor to measure the temperature and humidity, respectively. It then converts these values into a digital signal, which can be read by a microcontroller or a single-board computer like Arduino or Raspberry Pi.

The DHT11 sensor has four pins: VCC, GND, DATA, and NC (not connected). VCC and GND are used to power the sensor, while the DATA pin is used to communicate with the microcontroller. The NC pin is not used and can be left unconnected. When reading data from the DHT11 sensor, the microcontroller sends a start signal to the sensor, which responds by sending a low signal for 18ms, followed by a high signal for 20-40us. The sensor then sends the temperature and humidity data as a 40-bit signal, with each bit being transmitted as a 50us low signal followed by a 26-28us high signal. Overall, the DHT11 sensor is a simple and reliable sensor that can be easily integrated into a wide range of projects with its straightforward pin connection and digital output.

L298N Motor Driver:

The L298N motor driver is an integrated circuit that provides control over the speed and direction of DC motors or stepper motors. The IC consists of two H-bridge circuits that can drive two DC motors or one stepper motor. The H-bridge circuits control the direction of the motor by switching on and off pairs of transistors, allowing current to flow in either direction through the motor. The L298N motor driver is widely used in robotics and automation applications, where precise control over motor movement is essential. The L298N motor driver requires a control circuit, such as a microcontroller, to send the appropriate signals to the IC. The control signals consist of two digital signals for each motor, one to set the direction and the other to set the speed. The speed signal is typically generated using pulse width modulation (PWM) to adjust the duty cycle of the signal, which varies the average voltage applied to the motor and controls its speed. The L298N motor driver also includes built-in protection features to prevent damage to the IC or the motor. These protections include thermal shutdown, which shuts down the IC if it overheats, overcurrent protection, which limits the current flowing through the motor to prevent damage, and under voltage lockout, which prevents the IC from operating when the input voltage is too low. The L298N motor driver is commonly used in a variety of applications, including robotics, automation, electric vehicles, and industrial control systems.

Servo Motor:

The SG90 servo motor is a small, low-cost motor commonly used in hobbyist and educational projects. It can be controlled by a microcontroller or other digital device using a pulse width modulation (PWM) signal.

The SG90 servo motor has three pins:

- Power pin (usually red wire): This pin is used to supply power to the motor. It typically operates at 5V DC and draws a current of around 100mA.
- Ground pin (usually brown or black wire): This pin is used to connect the motor to the ground or negative terminal of the power supply.
- Control pin (usually yellow or orange wire): This pin is used to send the PWM signal to the motor to control its position. The control signal typically has a pulse width of between 1 and 2 milliseconds and a frequency of 50 Hz. The duty cycle of the PWM signal determines the position of the motor's output shaft. It is important to note that the SG90 servo motor should not be directly powered by a microcontroller or other digital device, as it requires more power than these devices can provide. Instead, it should be powered by a separate power supply with sufficient current capacity.

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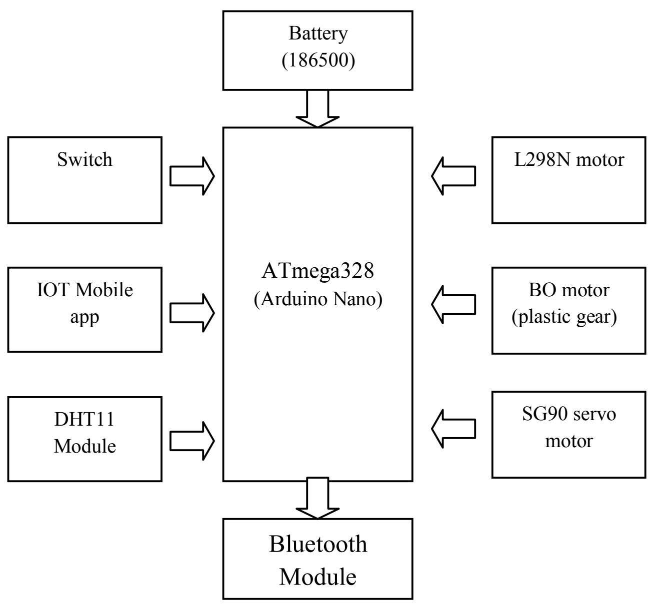
Jumper wires and led's:
There also been the use of some jumper wires, normal wires for the connections and led's to check the connections.

Wheels:
(4 in number) for the locomotion of the robot.

Motors:
Motors are essential when it comes to converting electrical energy into mechanical energy. Basically, they allow you to perform mechanical tasks using electricity. There are a number of types of motors including DC motors, servo motors and stepper motors which have different characteristics based on their working principles. Here DC motor and servo motors are used in this project.

Switch:
An on/off switch, also known as a toggle switch, is a mechanism used to control the flow of electricity to a device. It typically has two positions: "on" and "off." When the switch is in the "on" position, the circuit is complete, allowing electricity to flow and powering the device. When the switch is in the "off" position, the circuit is broken, cutting off the flow of electricity and turning off the device. These switches are commonly used in various electronic devices and appliances for easy control of power.

IV. BLOCK DIAGRAM



PROJECT METHODOLOGY
For an IoT-based project on an agricultural robot that can sow seeds, plow soil, and measure soil moisture, humidity, and temperature, you can follow a methodology that includes several key steps:

1. Project Planning:

- Define project objectives and goals, such as improving efficiency in farming, increasing yield, or reducing manual labor.
- Identify stakeholders and their requirements, including farmers, researchers, and potential end-users.
- Establish a project timeline, budget, and resource allocation.

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2. Research and Requirements Gathering:

- Conduct research on existing agricultural robots, IoT sensors, and technologies for soil measurement.
- Gather requirements for the robot's functionalities, such as seed sowing mechanism, plowing mechanism, and sensor integration for soil monitoring.

3. Design Phase:

- Design the physical structure of the agricultural robot, considering factors like size, weight, mobility, and durability for outdoor use.
- Design the seed sowing mechanism and plowing mechanism, ensuring efficiency and accuracy.
- Select appropriate IoT sensors for measuring soil moisture, humidity, and temperature, and design their integration into the robot's system.

4. Development and Prototyping:

- Develop the hardware components of the agricultural robot, including the motors, sensors, actuatorsand seed dispensers.
- Develop the software components for controlling the robot's movements, interacting with sensors, and processing data.
- Build prototypes of the robot and conduct testing to validate its functionalities and performance.

5. IoT Integration:

- Integrate IoT sensors into the robot's system, ensuring compatibility and seamless data transmission.
- Develop IoT firmware or software for collecting, transmitting, and analyzing sensor data.
- Implement connectivity features for remote monitoring and control of the robot via a web or mobile interface.

6. Testing and Validation:

- Conduct field tests of the agricultural robot in real-world agricultural settings, evaluating its performance in sowing seeds, plowing soil, and measuring soil parameters.
- Collect feedback from farmers and stakeholders to identify any issues or areas for improvement.
- Iterate on the design and functionality based on testing results and feedback.

7. Deployment and Maintenance:

- Deploy the agricultural robot to farms or agricultural research facilities, providing training and support to users.
- Establish maintenance procedures for the robot, including regular inspections, cleaning, and software updates.
- Monitor the performance of the robot over time and make adjustments as needed to ensure optimal functionality and reliability.

Throughout the project lifecycle, it's important to document each phase, communicate with stakeholders regularly, and prioritize safety considerations, especially when deploying autonomous robots in agricultural environments.

APPLICATION

The application of IoT-based agriculture robots is vast and can revolutionize modern farming practices. Here are some key applications:

Precision Farming:

IoT-enabled robots can precisely plant seeds, apply fertilizers, and manage irrigation based on real-time data collected from sensors. This helps optimize resource usage, increase crop yield, and reduce environmental impact.

Weed Control:

Robots equipped with cameras and AI algorithms can autonomously identify and target weeds for mechanical removal or targeted herbicide application, reducing the need for chemical inputs and manual labor.

Crop Monitoring and Management:
IoT sensors on robots can continuously monitor crop health parameters such as humidity, temperature, soil moisture, and nutrient levels. This data allows farmers to make informed decisions about crop management practices like watering, fertilization, and pest control.

Harvesting and Post-Harvest Operations:
Robots can be designed to harvest crops like fruits and vegetables with precision and efficiency, minimizing damage and reducing labor costs. They can also assist in post-harvest tasks such as sorting, grading, and packaging.

Data-Driven Decision Making:
By collecting and analyzing vast amounts of data from sensors and other sources, IoT-based agriculture robots enable farmers to make data-driven decisions to optimize crop production, minimize risks, and maximize profits.

V. CONCLUSION

The integration of IoT technology in agriculture through the development of a multifunctional robot with seed sowing, cutting, digging, and plowing capabilities alongside advanced sensor systems marks a significant advancement in precision farming. The incorporation of humidity, temperature, and moisture sensors enables precise monitoring of environmental conditions, empowering farmers to make data-driven decisions for irrigation, fertilization, and pest management. This proactive approach minimizes risks and ensures optimal crop growth while reducing resource wastage and environmental impact. The robot is also equipped with connectivity features, allowing farmers to monitor and control them remotely using smart phones or computers. This enables farmers to manage their fields more effectively, even from a distance.

Furthermore, the versatility of the robot streamlines labor-intensive tasks, reducing the reliance on manual labor and addressing labor shortages in the agricultural sector. Its adaptability to various crops and terrain enhances scalability and applicability across diverse agricultural landscapes.

Overall, the IoT-based agriculture robot represents a transformative solution for modern farming, fostering sustainability, productivity, and resilience in the face of evolving challenges. As technology continues to evolve, further innovations in robotics and IoT promise even greater advancements in agriculture, driving towards a more sustainable and food-secure future.

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