Design and Implementation of IOT AGRIBOT

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Abstract — This robotic vehicle is an agricultural machine of multipurpose system gives an advanced method to sowing, ploughing, watering, pH sensing, water level monitoring, seeding with minimum manpower. Moreover, the vehicle can be controlled by IoT (Internet of Things) using an Android smart-phone and Cloud Computing. The whole process calculation, processing, monitoring are designed with motors & sensors interfaced with microcontrollers and plotted humidity, temperature, flood state using Think Speak. Some agricultural robots are designed to work alongside human labor, enhancing the capabilities of farmers rather than replacing them entirely. This collaboration can improve overall productivity and make farming a more attractive and sustainable profession. Agricultural robots often come in modular designs, allowing for flexibility in adapting to different tasks and farm sizes. They can be customized to perform specific functions such as planting, spraying, or harvesting based on the needs of the farmer. Agricultural robots leverage technologies such as GPS (Global Positioning System), machine vision, and sensors to precisely control and monitor various farming processes. This enables farmers to optimize resource utilization, including water, fertilizers, and pesticides. Agri-bots are equipped with a range of sensors collecting data about the crop condition, soil health, and environmental parameters. This data is crucial for making informed decisions about crop management.

Keywords: IoT, Think Speak, Cloud Computing, Robotic Vehicle

I. INTRODUCTION

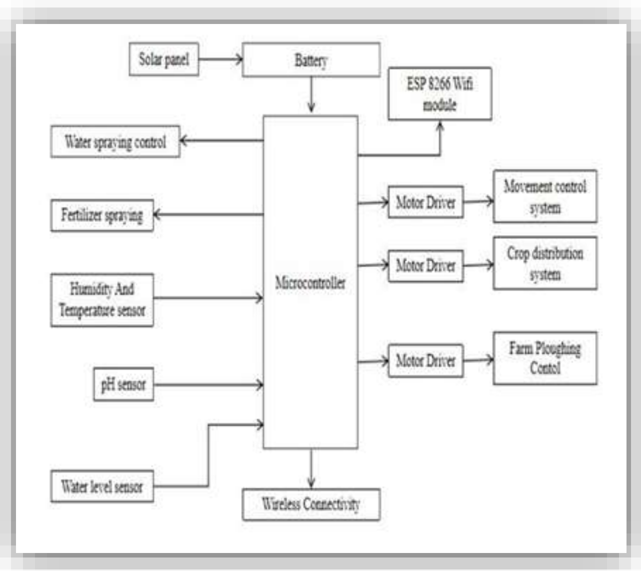
The agricultural sector serves as the backbone of the Indian economy, supporting approximately 17 percent of the world's population with only 2.3 percent of the world's terrestrial area and 4.2 percent of its water resources. Despite its critical importance, agricultural productivity growth has been sluggish, with harvesting intensity increasing by only 26 percent since 1950-51. The net sown area stands at 142 million hectares, highlighting the immense pressure on India's agricultural resources. Efficient agricultural operations, including sowing, weeding, and fertilizing, are crucial for maximizing yields and optimizing resource utilization [1]. The traditional methods of seed sowing and soil fertilization suffer from various drawbacks, including inefficiency, high labor requirements, and inconsistent results. To address these challenges, there is a pressing need for innovative solutions that enhance agricultural productivity while minimizing resource inputs One promising approach is the development of multifunctional Agribot capable of performing various agricultural tasks autonomously. These robots leverage basic components such as DC motors, stepper motors, relays, and microcontrollers to execute tasks such as plowing, seed sowing, and soil covering. The mechanical design of these Agribot is relatively simple yet highly effective, enabling seamless integration into existing agricultural practices [2]. However, the pace of agricultural growth has varied across regions, with areas that experienced the greatest impact from the Green Revolution now facing stagnation [6]. To sustainably enhance agricultural productivity and address emerging challenges, such as climate change and resource scarcity, continued innovation is essential. New technologies must focus on pushing yield boundaries, improving input efficiency, and promoting more sustainable farming practices.

II. PROPOSED SYSTEM

In the pursuit of sustainable agriculture, the development of a weed suppression robot is a noteworthy advancement. This robot, equipped with autonomous navigation and advanced sensing technology, targets and manages weeds in a precise and efficient manner.

The incorporation of mechanical tools or selective herbicide application ensures minimal impact on main crops. The development process involves conceptualization, prototyping, and rigorous field testing to refine the robot's functionality. Energy efficiency is prioritized, utilizing advanced battery technology or solar power. Through continuous data analytics, insights gained from real-world performance contribute to ongoing improvements, promising a future where weed management is not only effective but also environmentally conscious. The weed suppression robot represents a transformative solution for optimizing crop yields and promoting sustainable farming practices.

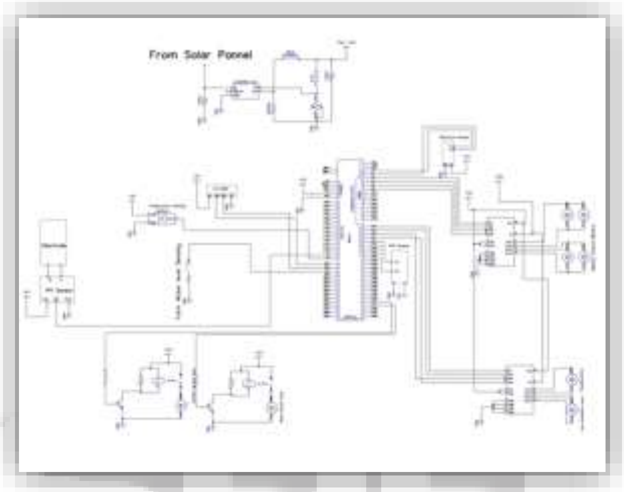
III. BLOCK DIAGRAM



The major working components and connections of Agri-Bot is illustrated below. AT mega act as the main controller motor drivers used here for movement control, crop distribution and farm ploughing. WIFI-module used here for the data transition from cloud to microcontroller. Wireless connectivity for the data exchange between phone and micro-controller. Water spraying, fertilizer, Spraying, Humidity with temperature sensing, fire sensing and water level monitoring can be done by using this method. The major working components and connections of Agri-Bot is illustrated below. ATmega328 act as the main controller, motor drivers are used here for movement control, crop distribution and farm ploughing. WIFI-module used here for the data transition from cloud to microcontroller. Wireless connectivity for the data exchange between phone and micro-controller. The very first block is the solar panel which is connected to the battery, for charging the battery. As for the battery we're using a 12V battery and is connected to the micro-controller. In the block there are given two directions for the arrows. If we're giving signals to the micro-controller then that arrow is given towards the micro-controller, if the micro-controller is giving the signal for the necessary functions then that arrow is going from the micro-controller. The water spraying mechanism is used in the demo project for showing how the watering works, for that a submersible pump is used. The same working is done in the case of fertilizer spraying.

Humidity and temperature sensors are connected to the micro-controller for sensing the temperature and humidity of the field and the datas are giving to the micro-controller which is then uploaded to the cloud storage. pH sensor is used to check the soil condition, whether is the soil is good or bad for seeding. If the soil is too wet then we'll get the signal saying that the soil is good, if the soil is too dry, then we'll the signal saying that the soil is bad [7]. This has to be done before ploughing and seeding. Water level sensor is connected to the board for the constantly checking the field's water level in order for checking the occurrence of flood in the field. ESP-8266 is connected with the micro-controller for accessing the cloud storage in which the data's can be stored and monitored. Three motor driver blocks are shown with three different workings. One is used for the movement of the bot through the field, other ones are used for seeding and ploughing purposes. For movement a 12V 150 rpm motor is used, which is controlled by the motor driver. For ploughing, since it's got an up and down motion a motor driver is used. Everything is controlled through an android app. At the bottom side of the block diagram we can see a block mentioned as wireless connectivity, which is used to connect the bot wirelessly with the smart phone by using a Bluetooth module [8].

IV. CIRCUIT DIAGRAM



The agriculture robot circuit integrates a solar panel to harness renewable energy for power. The circuit is done according to the block diagram. All the components required for this particular system are used here. ATmega328 is he micro-controller borad which acts as the main brain of this system. Here solar panel is connected directly with the battery to charge the battery. On the left side of the circuit we can see an ultra-sonic sensor, HC SR04. It has 4 pins, Vcc , trigger, echo and ground. Ultra-sonic sensor is mainly used for sensing the obstacles in front of the bot, like if the bot is functioning in auto mode then this ultra-sonic sensor would sense if there is any obstacle within 10m distance and if the sensor detects an obstacles then the bot will stops automatically. So the ultra-sonic sensor will send an ultra-sonic sound waves which will struck the obstacle and reflects the wave back to the sensor and the sensor will pick this incoming signal and measure it's distance [3].

A temperature sensor, DHT-11 temperature and humidity sensor, is used for checking the field's temperature and humidity conditions. Since they are picking up analog signals as input the sensor module is connected to the A0, analog pin of the micro-controller. Additionally, a humidity and temperature sensor provide crucial environmental data, aiding in crop monitoring and management. Water level sensor is connected with the digital pin of the micro-controller. Normally the pin is set to high using a pull-up function through program. When the sensor detects water level of the field then the lid of the sensor is pulled up giving the signal for the occurrence of flood. The farm water level sensor detects the water level in irrigation systems, ensuring efficient water usage [4]. A pH sensor is connected with the micro-controller as shown in the circuit diagram Motor drives control the movement of the robot, allowing it to navigate through the fields. An ultrasonic sensor enables obstacle detection, preventing collisions with objects in its path. Together, these components form a comprehensive system for automated agricultural tasks, promoting sustainability and productivity in farming practices.

For movement we're using a 12V 150 rpm motor which is controlled by the micro-controller through a motor driver. Here, we've used l298N Motor driver. The motor driver is provided with four inputs and correspond outputs, two enable pins, ground pin , Vc and Vcc. Two inputs and outputs are required for front side of the bot and similarly for the back side of the bot. The two enable pins are normally set to high to enable the all inputs in ready state. For moving forward, we're giving the command for forward through the app, so then the output 1 and output 3 will receive the voltage to drive the motor forward and output 2 and 4 will be grounded. Similarly, for moving backward, the output 2 and 4 will receive the voltage to turn the motor in the opposite direction. For moving right, the right side motors will turns forward and left side motors will turn backwards. Similar goes for left movement, left side motors will move forward while the right side will turn backward. Another motor driver is used for the ploughing, since it requires up and down motion. For seeding since only one direction of motion is required, the seeding motor is coupled to a relay. Watering and fertilizing are done with a submersible pump that is linked to a relay. The motor runs by triggering the relay. Normally the pump is open, no voltage is give at that time, so the relay will help in flowing the current to the pump. Therefore, the Arduino will transmit signals to the relay, which will cause the pump to start, when we issue a command through the app[8].

V. WORKING

The Agri-Bot is a field robot that is turned on and maintains a safe environment for plants in the most efficient way. It can be controlled manually or automatically via Bluetooth and an Android app named smart agro robot. Its five primary functions are ploughing, watering, and distributing crops. The ATmega 328 micro-controller, an 8 bit, 28 pin integrated circuit, serves as the project's main brain. The circuit diagram shows how all of the necessary hardware is connected to the micro-controller.

First, a pH sensor is used to measure the soil's pH. Because the sensor measures analog variables, it is connected to the microcontroller's analog pin. The farmer will then receive the information and take the necessary action. Whether the soil is good or bad is shown by the pH values, which are continuously monitored and displayed in the Android app's UI. Here, motor drivers are utilized not only for ploughing and crop distribution, and also for the robot's movement. The farmer gives a wireless signal to start the motor. To provide sufficient power to the motors for spraying fertilizer, water and three relay circuits are utilized. Here, a solar panel is used to supply the battery with sufficient voltage before it is linked to the microcontroller. Since the controller cannot receive solar power directly, a DC-DC Buck convertor (LM2596) is utilized. A potentiometer is used to adjust the voltage at which batteries charge.

Here, an ultrasonic sensor with four legs the HC-SR04 is utilized. Vcc, Gnd, TRIG, and ECHO. The micro-controller's digital pin is linked to the trigger and echo pins, and the vcc is supplied with a 5-volt supply. Since temperature in agricultural fields affects harvesting efficiency, we have added a temperature sensor that is connected to the controller's analog pin. For wireless connectivity, an HC-05 Bluetooth module is installed, which allows the farmer to conveniently operate the robot via an Android app. Additionally, the ESP 8266 wifi module is utilized in this instance for cloud storage, where the robot's operating program is provided and saved[5].

Regarding the robot's movement, the controller sends signals to four motors. Moving forward and backward is done simply by following the signal. The movements to the left and right are distinct. The left motor will rotate in reverse when moving left, and the right motor will rotate in forward motion. In a similar manner, when moving to the right, the left motor rotates in a forward direction while the right motor rotates in reverse. Ploughing and seeding are done with separate motors; however, since only one direction of motion is needed for seeding, the seeding motor is coupled to a relay. Watering and fertilizing are done with a submersible pump that is linked to a relay. Therefore, the Arduino will transmit signals to the relay, which will cause the pump to start, when we issue a command through the app.

A. Hardware Implementation

Hardware development involves the design, prototyping, testing .by using the android app called smart agro robot the movement and working of robot can be done. Power management systems, including batteries or solar panels, provide the necessary energy for sustained operation in the field. Moreover, communication modules facilitate data exchange and remote-control capabilities, enabling real-time monitoring and management of the agribot's activities. Through continuous innovation and iteration, hardware developers strive to enhance the robustness, efficiency, and autonomy of agribots to meet the evolving need of modern agriculture.

B. *Software Implementation*

The software implementation of an agri-bot is a complex endeavour aimed at enabling autonomous operation, efficient task execution, and data-driven decision-making in agricultural environments. At the core of agri-bot software are algorithms for navigation and path planning, allowing the robot to move autonomously through fields while avoiding obstacles and optimizing routes. The software implementation of an agribot is a complex endeavour aimed at enabling autonomous operation, efficient task execution, and data-driven decision-making in agricultural environments [6].

At the core of agribot software are algorithms for navigation and path planning, allowing the robot to move autonomously through fields while avoiding obstacles and optimizing routes. Machine learning and computer vision techniques are often employed for crop detection, weed identification, and yield estimation, empowering the agribot to make informed decisions about planting, harvesting, and crop management. Additionally, software systems enable the integration of sensor data for real- time monitoring of environmental conditions such as soil moisture, temperature, and pH, facilitating precision agriculture practices. Data management and analytics modules are essential for storing, processing, and analysing large volumes of agricultural data collected by the agri-bot, enabling farmers to derive insights and optimize decision-making processes[9].

Moreover, user interfaces and remote-control functionalities provide farmers with intuitive ways to interact with and supervise the agri-bot's operations, ensuring flexibility and ease of use in diverse agricultural settings. Overall, the software implementation of an agribot is crucial for maximizing efficiency, productivity, and sustainability in modern farming practices. By using the Thing-Speak MATLAB Visualization can be possible by Real-time monitoring of Agri bot. Graphical Representation of Humidity, temperature and flood state can be obtained . This real time analysis give a clear idea above the climate and water state [7].

VI. Scope of the Project

- Precision Farming: Agricultural robots can be designed for precision farming tasks, such as precise planting, seeding, and fertilizing. This improves efficiency and reduces resource usage.
- Autonomous Navigation: The project can involve the development of autonomous navigation systems for robots, enabling them to navigate through fields without human intervention. This can include obstacle detection and avoidance.
- Weed Control: Agricultural robots can be equipped with vision systems to identify and remove weeds, reducing the need for herbicides and promoting sustainable farming practices.
- Crop Monitoring and Management: Implementing sensors and cameras on robots allows for real-time monitoring of crop health, growth, and yield estimation. This information aids in better crop management decisions.
- Harvesting Automation: Designing robots capable of harvesting crops autonomously can address labour shortages and improve harvesting efficiency, especially for labour-intensive crops.
- Data Analytics: The project can include the development of data analytics tools to process the large amount of data collected by agricultural robots. This data can provide valuable insights for farm management.
- Remote Sensing: Integrating remote sensing technologies, such as drones or satellites, with agricultural robots can enhance the overall monitoring and management of large agricultural areas.
- Energy Efficiency: Implementing energy-efficient designs and power sources for agricultural robots ensures longer operational times and reduces environmental impact.
- Human-Machine Collaboration: Some agricultural robots may involve human-machine collaboration, to perform tasks efficiently.

VII. Conclusion

In conclusion, this ongoing project on agriculture robots has marked significant strides towards revolutionizing farming practices. The successful implementation of precision planting, crop monitoring, and automated harvesting underscores the potential of robotic technologies in optimizing agricultural processes. Despite challenges faced, the project has demonstrated tangible benefits, enhancing efficiency, reducing labor demands, and ultimately contributing to improved crop yields. As we reflect on this endeavor, lessons learned pave the way for future advancements. The scalability and applicability of these robotic solutions hint at a promising future for sustainable and precision farming. This project serves as a testament to the transformative power of technology in shaping the landscape of modern agriculture.

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