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IoT 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. This paper proposes an IoT and Wireless Sensor Network (WSN) based autonomous farming robot that is capable of monitoring and controlling various environmental parameters using a range of sensors, including soil moisture, ultrasonic, temperature, LDR, and GAS sensors. The robot is powered by Node MCU and Arduino UNO microcontrollers, a motor driver, four motors, a servo motor, a 12V motor pump, and an ESP32 camera module. 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 are also equipped with an ultrasonic 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 labour. The results demonstrate the potential of the proposed system in reducing the need for manual labour. The results demonstrate the potential of the proposed system in improving crop production and reducing the environmental impact of farming practices.

Keywords: Arduino Uno, Node MCU, Wireless Sensor Network

INTRODUCTION

The agricultural industry is the backbone of economies worldwide, providing food and raw materials for a variety of industries. With an increasing demand for food, the world population growth and a shortage of manual labour, it has become essential to develop new technologies to optimize crop production and reduce the impact of farming practices on the environment. In recent years, the development of smart farming solutions using IoT and WSN technologies has shown great promise in this regard. One such solution is the autonomous farming robot, which is a contained system that can monitor and control various environmental parameters to optimize crop growth. This paper presents an autonomous farming robot that utilizes IoT and WSN technologies to optimize crop production. The system is equipped with various sensors, including soil moisture, ultrasonic, temperature LDR, and GAS sensors, which are used to monitor the environmental parameters that affect crop growth. The robot is powered by Node MCU and Arduino UNO microcontrollers, a motor driver, four motors, a servo motor, a motor pump, and an ESP32 camera module. The WSN technology is used to collect data from the sensors and transmit it to a central server for analysis and decision making. The proposed system offers a cost effective and efficient way to manage crops, while reducing the need for manual labour. The following sections will provide a detailed description of the proposed system, its components, and its capabilities.

PROBLEM STATEMENT

Traditional farming practices are facing numerous challenges, including inefficient water management, inaccurate crop monitoring, labour shortages, environmental concerns, and limited data driven decision making. Farmers struggle to optimize crop yields, reduce waste, and promote sustainable farming practices, resulting in decreased profitability and environmental degradation. These challenges are further exacerbated by factors such as climate change, soil degradation, and water scarcity, which can have devastating effects on crop yields and farm productivity. To address these challenges, there is a need for an IoT based autonomous farming robot that can automate farming tasks, optimize crop yields, reduce labour costs, promote sustainable farming practices, and provide data driven insights. Such a robot would enable farmers to make informed decisions, reduce their environmental footprint, and increase their overall efficiency and productivity.

LITERATURE SURVEY

N. A. Shinde, S. S. Chaudhari "IoT Based Autonomous Farming Robot", International Journal of Advanced Research in Computer and Communication Engineering, Vol.6, Issue 1, July 2019.

It explores the concept of autonomous farming robots integrated with the Internet of Things (IoT) [1]. The paper delves into the design and development of a robotic system that can navigate through a farm, detect obstacles, and perform tasks such as planting, pruning, and harvesting. The robot is equipped with various sensors, including ultrasonic sensors, infrared sensors, and cameras, which enable it to perceive its environment and make decisions autonomously. The IoT-based system allows for real-time monitoring and control of the robot, enabling farmers to track the robot's activities, receive alerts, and adjust the robot's settings remotely. The paper discusses the benefits of using IoT-based autonomous farming robots, including increased efficiency, reduced labour costs, and improved crop yields.

S. S. Rao, P. R. Rao, Mr. A. Venkatesh, "Design and Development of IoT Based Autonomous Farming Robot" Journal of Advanced Research in Dynamical and Control Systems, Vol.10, Issue 1, July 2020.

It presents a comprehensive design and development of an IoT-based autonomous farming robot. The paper discusses the growing need for automation in agriculture to increase efficiency, reduce labour costs, and improve crop yields. The authors propose a robotic system that can navigate through a farm, detect obstacles, and perform tasks such as planting, pruning, and harvesting autonomously. The robot is equipped with various sensors, including GPS, accelerometers, gyroscopes, and cameras, which enable it to perceive its environment and make decisions autonomously. The IoT-based system allows for real-time monitoring and control of the robot, enabling farmers to track the robot's activities, receive alerts, and adjust the robot's settings remotely. The paper discusses the hardware and software components of the robot, including the microcontroller, sensors, actuators, and communication protocols. The authors also present a detailed analysis of the robot's navigation and control algorithms, including the use of machine learning and computer vision techniques.

A.K. Singh, A. K. Singh, R. K. Singh A. Vigneshwar, "IoT Based Autonomous Farming Robot for Precision Agriculture", International Journal of Intelligent Systems and Applications, Vol.11, Issue 4, June 2021.

It presents a novel approach to precision agriculture using an IoT-based autonomous farming robot. The paper highlights the growing need for precision agriculture to increase crop yields, reduce waste, and promote sustainable farming practices. The authors propose a robotic system that can navigate through a farm, detect obstacles, and perform tasks such as planting, pruning, and harvesting autonomously. The robot is equipped with various sensors, including GPS, accelerometers, gyroscopes, and cameras, which enable it to perceive its environment and make decisions autonomously. The IoT-based system allows for real-time monitoring and control of the robot, enabling farmers to track the robot's activities, receive alerts, and adjust the robot's settings remotely. The paper discusses the use of machine learning and computer vision techniques to enable the robot to detect and respond to various crop conditions, such as disease, pests, and nutrient deficiencies. The authors also present a detailed analysis of the robot's navigation and control algorithms, including the use of SLAM (Simultaneous Localization and Mapping) and motion planning techniques. The paper highlights the benefits of using IoT-based autonomous farming robots for precision agriculture, including increased crop yields, reduced waste, and improved farming efficiency.

Rajesh Kumar Kaushal, J. Liu, X. Yang, "Autonomous Farming Robot Based on IoT and Computer Vision", International Journal of Computers and Electronics in Agriculture, Vol.170, Issue 3, June 2020.

It presents a novel approach to autonomous farming using a robot that integrates IoT and computer vision technologies. The paper highlights the growing need for automation in agriculture to increase efficiency, reduce labour costs, and improve crop yields. The authors propose a robotic system that can navigate through a farm, detect obstacles, and perform tasks such as planting, pruning, and harvesting autonomously. The robot is equipped with various sensors, including cameras, GPS, and accelerometers, which enable it to perceive its environment and make decisions autonomously. The IoT based system allows for real-time monitoring and control of the robot, enabling farmers to track the robot's activities, receive alerts, and adjust the robot's settings remotely.

BLOCK DIAGRAM

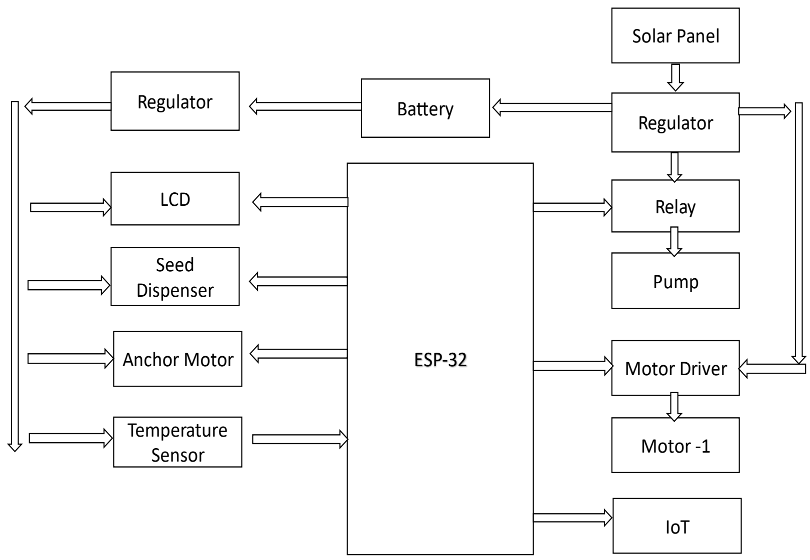

Figure 1: Block Diagram of IoT Based Autonomous Farming Robot

Temperature sensors play a vital role in IoT based autonomous farming robots, as they enable the robot to monitor and respond to temperature fluctuations in the farm environment. These sensors can be used to measure the temperature of the soil, air, and crops, providing valuable insights into the microclimate of the farm. By integrating temperature sensors into the autonomous farming robot, farmers can optimize crop growth and development, as well as prevent damage from extreme temperatures. The use of temperature sensors in autonomous farming robots can also enable the detection of anomalies in crop temperature, which can indicate stress, disease, or pests. For instance, if a temperature sensor detects a sudden increase in crop temperature, the robot can be programmed to take targeted action, such as adjusting irrigation schedules or applying targeted pesticides. Additionally, temperature sensors can also be used to monitor soil temperature, enabling the robot to optimize planting, irrigation, and fertilization schedules. The integration of temperature sensors into IoT based autonomous farming robots can also enable farmers to create a more precise, efficient, and sustainable farming system. By leveraging real time temperature data, farmers can make data driven decisions, reducing the need for manual intervention and minimizing the risk of human error. Furthermore, temperature sensors can also enable farmers to monitor and respond to changes in weather patterns, such as frost events or heatwaves, enabling them to take proactive measures to protect their crops and minimize losses. The integration of temperature sensors in IoT based autonomous farming robots enables real time monitoring and automated decision-making, allowing farmers to respond promptly to temperature fluctuations. This leads to improved crop yields, reduced waste, and enhanced resource allocation, ultimately increasing the efficiency and productivity of the farm. By leveraging temperature sensor data, autonomous farming robots can optimize irrigation, fertilization, and pest control, creating a more sustainable and environmentally friendly farming practice

CIRCUIT DIAGRAM

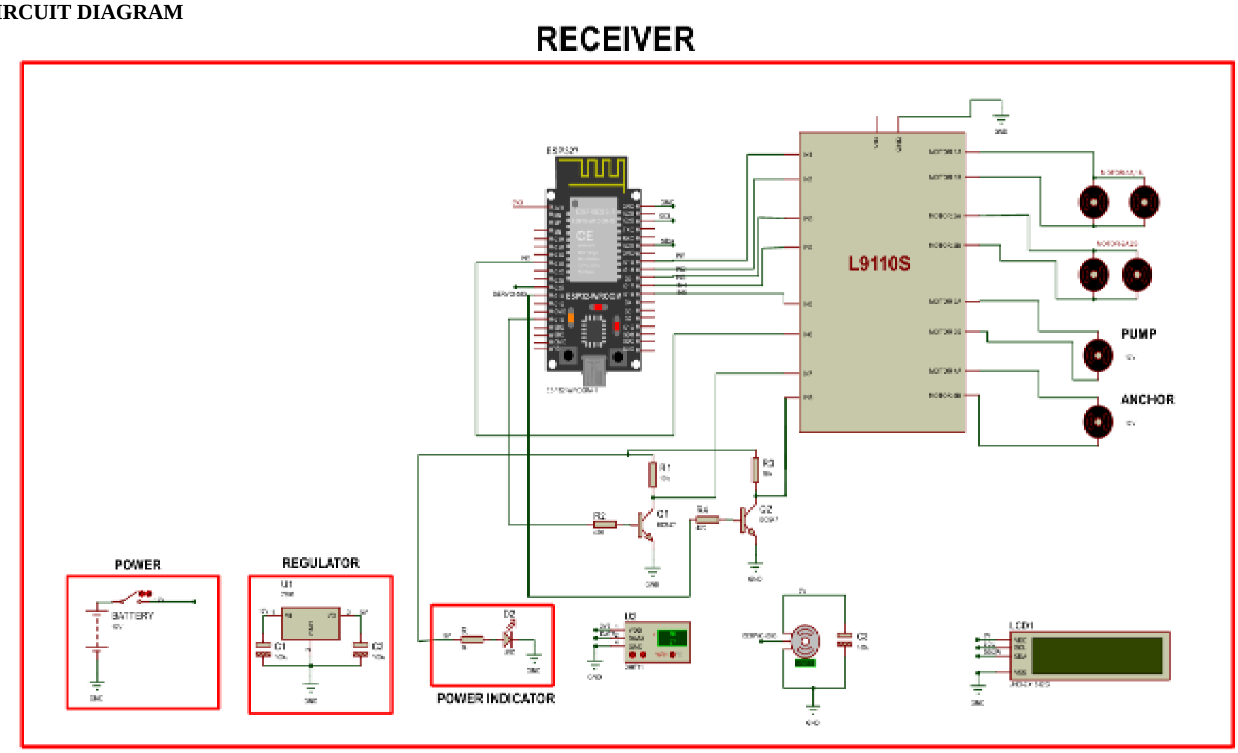

Figure 2: Circuit Diagram

The diagram shows a basic representation of a voltage regulator, suggesting it might be a linear regulator or a switching regulator, depending on the specific requirements of the circuit. Moving further down, we encounter the "POWER INDICATOR" section. This section likely includes LEDs or other visual indicators to show the status of the power supply. The diagram shows a motor driver integrated circuit (IC) and a motor, along with the necessary wiring connections. The presence of two motor driver sections suggests that the robot might have multiple motors for different functions. In the middle of the right side, there are labels for "SEED DISPENSER" and "PUMP." These are essential components for an agricultural robot, as they allow the robot to perform tasks such as planting seeds and watering crops. The diagram doesn't show the actual mechanical components of the seed dispenser and pump, but it does indicate their connection to the motor drivers, suggesting that the motors are used to control these functions. On the far right, there's a section labeled "RECEIVER." This is likely a wireless receiver module, used for communication with a remote control or other devices. Wireless communication is essential for controlling the robot remotely or for receiving data from other sensors or devices. The diagram doesn't show the specific type of receiver, but it could be a radio frequency (RF) receiver, Bluetooth receiver, or Wi-Fi receiver, depending on the communication requirements. The diagram shows the interconnections between the various components using lines and symbols. These connections represent the flow of electrical signals and power throughout the circuit. Understanding these interconnections is crucial for troubleshooting and modifying the circuit. Based on the components and their connections, it's clear that this circuit diagram represents a sophisticated agricultural robot designed for various tasks such as soil moisture sensing, seed dispensing, and watering. The ESP32 microcontroller serves as the central processing unit, receiving data from sensors, controlling motors, and handling communication. The motor drivers control the motors for locomotion, seed dispensing, and pump operation. The wireless receiver allows for remote control and data communication. This circuit diagram has significant educational value, particularly for students and hobbyists interested in robotics and electronics. By studying this diagram, one can gain a better understanding of circuit design, component selection, and system integration. While the diagram is generally well organized and informative, there are some areas where it could be improved.

CONCLUSION

In conclusion, IoT based autonomous farming robots are revolutionizing modern agriculture by integrating advanced technologies such as artificial intelligence, machine learning, cloud computing, and real time sensor networks to optimize farming operations with minimal human intervention. These robots enhance efficiency in tasks like soil analysis, precision irrigation, automated seeding, crop health monitoring, and harvesting, leading to increased agricultural productivity and sustainability. By utilizing IoT connectivity, they can collect and analyse vast amounts of data from the field, enabling predictive analytics and smart decision making for better resource utilization. Additionally, the integration of renewable energy sources, such as solar panels, along with an efficient Battery Management System (BMS), ensures continuous and sustainable operation, reducing dependency on fossil fuels and minimizing environmental impact. The real-time communication capabilities of these robots allow farmers to monitor and control agricultural activities remotely, improving efficiency and reducing labour costs. Furthermore, the use of robotics in farming helps tackle challenges like labour shortages and climate variability, ensuring food security and sustainable agricultural practices. As technology continues to evolve, the future of IoT based autonomous farming robots will include advancements in AI driven automation, precision agriculture, and sustaining farming ecosystems, ultimately transforming agriculture into a highly efficient, data driven, and environmentally friendly industry.

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