Journal of **N**onlinear **A**nalysis and **O**ptimization
Vol. 15, Issue. 2 : 2024
ISSN :**1906-9685**

SMART FARMING ROBOT FOR DETECTING ENVIRONMENT CONDITIONS IN A GREENHOUSE

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1. ABSTRACT

The growing global demand for food has driven the development of innovative agricultural practices, including the adoption of smart farming techniques. Smart farming leverages advanced technologies like sensors, drones, and robotics to enhance crop yields, minimize waste, and foster sustainability. A key area where smart farming can have a profound impact is greenhouse farming, where precise environmental control is essential for optimal plant growth. Here's a revised version of the paragraph: "This project centers around the creation of a smart farming robot designed to monitor and assess environmental conditions within a greenhouse. The robot is equipped with various sensors, including temperature, humidity, light, and soil moisture detectors, which collect real-time data from the greenhouse. This data is transmitted to a central server for processing, helping optimize conditions that promote healthy plant growth. In addition, the robot is fitted with a camera to capture images of the plants, enabling it to detect potential issues such as diseases, pests, or nutrient deficiencies. These images are analyzed using machine learning algorithms that can recognize subtle patterns and anomalies, which may not be immediately noticeable to the human eye. For example, if an abnormal temperature fluctuation is detected, the robot can alert the farmer for corrective measures. Similarly, the system can provide recommendations for treatment if disease or pests are identified."

INDTRODUCTION:

With the global population expected to reach 9.7 billion by 2050, the demand for food will put immense pressure on the world's food systems. To meet this demand, farmers and agricultural producers must embrace innovative and sustainable practices that optimize crop yields, minimize waste, and

https://doi.org/10.36893/JNAO.2024.V15I2.126

promote environmental sustainability. One area where technology can have a profound impact is greenhouse farming, where precise control over environmental factors is essential for optimal plant growth. Traditional greenhouse farming depends on manual monitoring and control of temperature, humidity, light, and other factors, which can be time-consuming, labor-intensive, and susceptible to errors. As greenhouse ecosystems become more complex and the need for real-time data analysis increases, farmers face significant challenges in optimizing their operations. In response to these issues, researchers and engineers are exploring the potential of robotics and artificial intelligence (AI) in agriculture. Smart farming robots, featuring advanced sensors, machine learning algorithms, and autonomous navigation capabilities, provide a valuable solution for improving greenhouse farming. These robots can gather real-time data on environmental conditions, detect indications of pests and diseases, and carry out tasks such as watering and pruning automatically. This technology can help farmers enhance crop yields, reduce waste, and foster a more sustainable food production system. This project focuses on the design and development of a smart farming robot specifically tailored for monitoring environmental conditions within a greenhouse.

3. LITERATURE SURVEY

1. Introduction to Smart Farming Robots in Greenhouses

Greenhouse farming provides an ideal controlled environment for crops, but it necessitates constant monitoring and management of variables such as temperature, humidity, light, and soil conditions. To address these challenges, smart farming robots equipped with sensors, IoT technologies, and AI capabilities are being developed to enable real-time data collection, analysis, and automation.

Alfonso et al. (2020) explored the use of autonomous robots for monitoring greenhouse environments through multi-sensor systems. The study highlighted the significance of integrating environmental sensors with mobility platforms to achieve thorough coverage.

Singh et al. (2019) examined the application of IoT-enabled drones and robots in smart agriculture. The study focused on how equipping robots with weather sensors could improve the accuracy of detecting environmental conditions.

2. Sensor Integration for Environmental Monitoring Sensors play a crucial role in smart farming robots by providing accurate measurements of temperature, humidity, carbon dioxide levels, and soil conditions. When combined with advanced wireless communication technologies, these sensors

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enable real-time monitoring of environmental factors. Patil et al. (2021): Focused on the integration of temperature, humidity, and light intensity sensors in greenhouse robots. The study showcased how combining these sensors with autonomous systems can enhance the control of microclimates. Ramesh et al. (2022): Explored the latest developments in soil moisture sensors and their application in robotic systems for efficient monitoring and irrigation within greenhouses.

4. EXISTING SYSTEM

A current system for a smart farming robot designed to detect environmental conditions in a greenhouse involves the use of advanced sensors and automation technologies. These robots are equipped with various sensors such as temperature, humidity, light intensity, and soil moisture detectors. The system continuously monitors the greenhouse environment and collects real-time data, which is then processed to optimize conditions for plant growth. The robot can autonomously navigate the greenhouse, adjusting factors like irrigation and temperature control based on the sensor data. This system aims to improve crop yield, reduce resource waste, and enhance overall greenhouse management efficiency.

System Name: FarmWise

System Overview: FarmWise is an advanced smart farming robot developed to monitor and manage environmental conditions within a greenhouse. The system includes a robot outfitted with a range of sensors, a central server for data processing, and a user-friendly interface for interaction and control.

System Components:

1. Robot: The robot is fitted with the following sensors: - Temperature sensor - Humidity sensor - Light sensor - CO2 sensor - Soil moisture sensor

2. Central Server: The central server handles the collection and analysis of data from the robot's sensors, and it makes decisions based on pre-established criteria.

3. User Interface: The user interface is a web-based application that enables users to monitor the greenhouse environment, receive alerts and notifications, and manage the robot's operations.

DISADVANTAGES:

1. High Initial Cost: The system necessitates a substantial upfront investment, covering the expenses for the robot, sensors, and central server.

2. Complexity: Setting up and maintaining the system requires specialized technical knowledge, which may pose a challenge for some users.

3. Limited Scalability: The system is tailored for small to medium-sized greenhouses and may not be ideal for larger agricultural operations.

5. PROPOSED SYSTEM

Proposed System for a Smart Farming Robot for Monitoring Environmental Conditions in a Greenhouse:

https://doi.org/10.36893/JNAO.2024.V15I2.126

System Name: Smart Greenhouse

System Overview: The Smart Greenhouse is an advanced farming robot designed to monitor and regulate environmental conditions within a greenhouse. The system includes a robot integrated with a range of sensors, a central server for data processing, and a user-friendly interface for system control and monitoring.

System Components:

1. Robot:

- Equipped with the following sensors:
- Temperature sensor
- Humidity sensor
- Light sensor
- CO2 sensor
- Soil moisture sensor
- Autonomous navigation system using GPS and sensors
- Communication module for transmitting data to the central server.

System Functionality:

1. Data Collection: The robot collects data from its sensors and transmits it to the central server.

2. Data Analysis: The central server processes the data using machine learning algorithms and makes decisions based on established rules. Alerts and Notifications: The system sends notifications and alerts to users when any parameter exceeds its predefined threshold.

3. Robot Control: Users can command the robot to perform actions, such as moving to designated locations or modifying the greenhouse environment. Automation: The system automatically adjusts parameters like temperature, humidity, and light levels according to the analyzed data.

Proposed System Advantage:

1. Enhanced Crop Production: The system optimizes environmental conditions within the greenhouse, resulting in better crop yields.

2. Lower Energy Usage: By automating tasks, the system reduces the need for manual intervention, leading to decreased energy consumption.

3. Enhanced Efficiency: With real-time monitoring and automation, the system enables users to promptly address changes and optimize the greenhouse environment.

4. Cost Efficiency: By minimizing manual labor and reducing energy consumption, the system helps achieve significant cost savings.

5. Environmental Sustainability: The system optimizes the greenhouse environment, contributing to a reduction in the environmental footprint of greenhouse farming.

6. BLOCK DIAGRAM :

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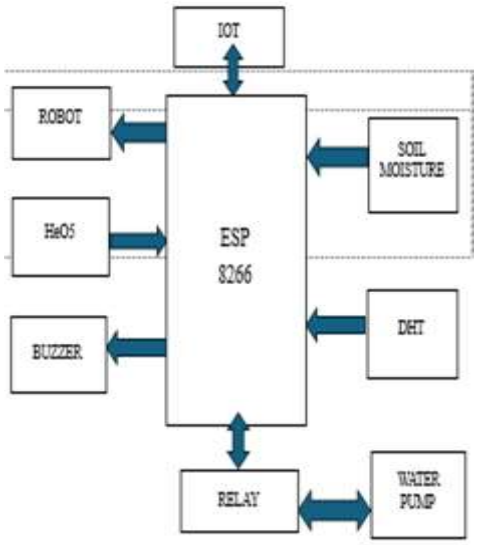
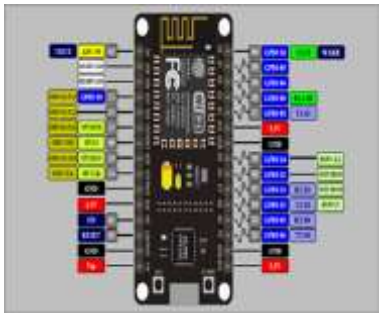


7 .HARDWARE DESCRIPTION :

ESP 8266 :



General-purpose input/output (GPIO) pins are flexible pins on an integrated circuit (IC) that can be configured as either input or output, with their behavior being adjustable during operation. The ESP8266 is an affordable, user-friendly module designed to enable internet connectivity for various projects. It can function both as an Access Point (creating a hotspot) and as a Station (connecting to Wi-Fi), making it easy to fetch and upload data to the internet, ideal for Internet of Things (IoT) applications. The module also allows retrieval of data from the internet via APIs, enhancing your project with access to a broad range of online information. Additionally, the ESP8266 is compatible with the Arduino IDE, making it even more accessible for users. However, this version of the module only provides two GPIO pins (though it can be modified to support up to four), meaning it may need to be paired with another microcontroller, such as an Arduino. For those seeking more advanced standalone capabilities, the ESP-12 or ESP-32 versions may be more suitable. Overall, the ESP8266 is a great option for anyone looking to begin their IoT journey or add internet connectivity to their project.

DHT11 Sensor :

The DHT11 humidity and temperature sensor is available both as a sensor and as a module. The primary difference between the two is the inclusion of a pull-up resistor and a power-on LED in the module version. The DHT11 sensor is designed to measure relative humidity and temperature in the surrounding environment. It utilizes a thermistor for temperature measurement and a capacitive humidity sensor for detecting humidity levels. The DHT11 is a cost-effective digital sensor that provides instant readings of temperature and humidity. This sensor can easily interface

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with microcontrollers like Arduino or Raspberry Pi for real-time data collection. The DHT11 consists of a capacitive humidity sensing element and a thermistor for temperature sensing. The humidity sensor contains two electrodes with a moisture-retaining dielectric substrate between them. As humidity levels change, the capacitance of the sensor changes, which is then measured and converted into a digital signal by the integrated circuit (IC). For temperature measurement, the DHT11 uses a Negative Temperature Coefficient (NTC) thermistor, which decreases in resistance as temperature rises. To ensure that even the smallest temperature change results in a measurable resistance variation, the sensor is often constructed from semiconductor ceramics or polymers, which provide higher resistance for greater sensitivity.

WATER PUMP

A water pump is a device that operates using both mechanical and hydraulic principles to move water through a piping system, generating sufficient force for future use. Water pumps have been in existence in various forms since early civilizations and continue to be widely used in housing, agriculture, municipal, and industrial applications today. The DC 3-6 V submersible water pump is a cost-effective, compact pump motor, as shown in Figure 5. It operates on a power supply ranging from 2.5V to 6V. This pump can handle up to 120 liters per hour while consuming a low current of just 220mA. To use the pump, simply connect a tube pipe to the motor outlet, submerge the pump in water, and provide power to operate it. Water pumps are designed to move large volumes of water from one location to another. Their primary purpose is versatile, and a high-quality pump, when carefully selected, can be ideal for various tasks such as draining water from flooded areas, refilling swimming pools or bathtubs, and circulating pesticides or fertilizers.

RELAY :

A relay is an electromechanical switch that operates automatically using an electrical signal. Unlike a regular switch, which is manually operated to open or close a circuit, a relay uses an electrical signal to control an electromagnet that in turn connects or disconnects another circuit. There are various types of relays, such as electromechanical and solid-state, with electromechanical relays being the most commonly used. These relays typically have two or more contacts, known as

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switching points, to connect high-amperage loads, along with a common contact to link these switching points. The contacts are typically labeled as Normally Open (NO), Normally Closed (NC), and Common (COM). Relays can be used in both AC and DC circuits. In AC relays, because the relay coil is demagnetized at each current zero crossing, there can be continuous breaking of the circuit. To address this issue, AC relays are designed with special mechanisms—such as electronic circuit arrangements or shaded coil mechanisms—that ensure continuous magnetism, preventing circuit interruptions.

Buzzer :

Here's a revised version of the sentence: "A buzzer or beeper is an audio signaling device that can function through mechanical, electromechanical, or piezoelectric (piezo) means. These devices are frequently employed in alarm systems, timers, and to provide audible feedback for user interactions, such as mouse clicks or keystrokes." A buzzer is a small, efficient component that adds sound functionality to projects or systems. With its compact 2-pin design, it can be easily used on breadboards, perf boards, and even on PCBs, making it a popular choice for a wide range of electronic applications. There are two main types of buzzers: a simple buzzer, like the one shown here, which produces a continuous sound when powered, and a readymade buzzer, which typically has a bulkier design and generates a series of beeps due to its internal oscillating circuit. The simple buzzer is more commonly used because it can be customized with additional circuits to suit specific needs in various applications. Here's another revision of the sentence: "This buzzer can be powered by a DC supply ranging from 4V to 9V. While a standard 9V battery is an option, using a regulated +5V or +6V DC supply is recommended for optimal performance. The buzzer is typically linked to a switching circuit, which allows it to be turned on or off at specified times and intervals."

Soil Moisture Sensor :

A soil moisture sensor is a crucial tool in agriculture, horticulture, and environmental monitoring, used to measure the water content in the soil. This sensor is integral to modern precision farming, allowing for efficient irrigation management by providing real-time data on soil moisture levels. By optimizing water usage, soil moisture sensors help minimize water wastage, improve crop yields, and support sustainable farming practices.

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8.SOFTWARE DESCRIPTION

The Arduino Integrated Development Environment (IDE), also called Arduino Software, is a platform used for writing and uploading code to Arduino and Genuino boards. It includes a text editor for writing programs, a message area, a text console, a toolbar with buttons for frequently used functions, and a menu system. Programs created in the IDE are called "sketches" and are saved with the .ino file extension. The editor offers features like cut/paste and search/replace to make coding easier. The message area displays feedback during saving and exporting, as well as any errors. The console shows text output, including detailed error messages and other relevant information. At the bottom right corner of the window, you can find details about the configured board and serial port. The toolbar provides buttons for verifying and uploading programs, creating, opening, and saving sketches, and accessing the serial monitor. Note: In versions of the Arduino IDE prior to 1.0, sketches were saved with a .pde extension. These files can still be opened in version 1.0, but you'll be asked to save them with the .ino extension.

9. APPLICATION

- ✓ Environmental Monitoring: Detects key environmental parameters such as temperature, humidity, CO_2 levels, soil moisture, and light intensity. Ensures optimal conditions for plant growth by providing real-time data for decision-making.
- ✓ Automated Climate Control: Integrates with ventilation, heating, cooling, and shading systems to maintain ideal greenhouse conditions. Dynamically adjusts settings based on detected parameters.
- ✓ Early Detection of Anomalies: Identifies potential problems like sudden temperature drops, high humidity, or CO_2 imbalances that could harm plants. Alerts farmers or triggers automated corrective measures to prevent crop loss.

10.CONCLUSION :

The greenhouse project represents a significant advancement in transforming the agriculture industry, and the proposed system is a key step toward achieving this transformation. This system, comprising a robot equipped with various sensors, a central server, and a user interface, has the potential to optimize greenhouse conditions, reduce energy consumption, and enhance crop yields. By utilizing machine learning algorithms to analyze sensor data, the system can make decisions based on predefined rules and automate tasks, such as adjusting temperature, humidity, and light levels, to create the ideal environment for plant growth. The system's real-time monitoring and automation capabilities enable users to respond quickly to environmental changes, minimizing the need for manual intervention and reducing energy

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use. Moreover, its scalability and flexibility allow it to be applied to greenhouses of various sizes, integrating smoothly with existing systems. The benefits of this system are vast, including improved crop yields, lower energy consumption, increased efficiency, cost savings, and enhanced environmental sustainability. With its innovative features, the smart farming robot designed to monitor environmental conditions in a greenhouse has the potential to revolutionize the agriculture industry. Its development is a critical step toward creating a more sustainable and efficient food production system.

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