SMART Irrigation Robot

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ABSTRACT

Intelligent irrigation robots are solutions for modern agriculture that address the challenges of water resource management, labor efficiency, and crop yield optimization. This autonomous robotic system combines advanced technology, sensors, artificial intelligence and precision robotics to revolutionize the irrigation process.
This summary provides an overview of the main features and benefits of smart irrigation robots.
The robot uses a network of soil moisture sensors and weather data to make real-time, data-driven decisions about when and how much to irrigate crops.
Using artificial intelligence algorithms, irrigation strategies can be adapted to specific crop types and growth stages to ensure efficient use of resources.
Intelligent irrigation robots operate autonomously, reducing the need for manual labor, saving time and effort. Operating costs. In addition, it minimizes water wastage and promotes sustainability and environmental protection by providing the exact amount of water only when and where it is needed.

Keywords: *- Internet of Things (IOT), smart irrigation, Water level sensors, Temperature, Sensor, embedded system, smart agriculture*

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1. INTRODUCTION

The Smart Irrigation Robot is an innovative solution for efficient and automatic watering of agricultural fields, gardens or landscape. This robotics system combines various technologies including sensors, AI and automation to optimize the x process. By monitoring environmental conditions such as soil moisture levels, weather forecasts and plant needs, a smart irrigation robot can make data-driven decisions to water crops or plants when and where they are needed, conserving water resources and improving crop yields.

These robots are designed to reduce human labor, conserve water and increase the overall sustainability of agricultural and horticultural practices.

A smart irrigation robot is a multifunctional autonomous machine that has the ability to intelligently manage irrigation processes in agricultural fields. Unlike traditional irrigation systems that rely on fixed schedules or manual monitoring, this robotic system harnesses the power of advanced sensors, connectivity and algorithms and provides efficient water management.

Key features and components of the Smart Irrigation Robot include:
1. Sensing technology: The robot is equipped with an array of sensors, including soil moisture sensors, water sensors and image recognition cameras. These sensors continuously monitor environmental conditions and soil moisture.
2. Autonomous Navigation: Mobility of the robot is ensured by an autonomous navigation system, which enables it to move in all areas without human intervention. It can adapt its route based on changing field conditions and obstacles.

3. Precision Water Application: The smart irrigation robot can precisely control water usage, avoiding over-irrigation and water wastage. This not only saves water but also prevents waterlogged soil, which damages crops.
4. Remote monitoring and control: Framers can monitor and control the robot remotely through a mobile app or web interface, allowing them to make adjustments based on real-time data and weather forecasts.

The smart irrigation robot doesn't just stop at water optimization, it embodies the concept of precision agriculture. Farmers can remotely manage and monitor this intelligent system through an intuitive interface, fine-tuning irrigation schedules and settings with ease. This reduces not only crop yields but also the ecological footprint associated with excess water use.
In this introduction, we have only scratched the surface of what the SMART Irrigation Robot represents. It symbolizes the convergence of advanced technology and environmental responsibility, offering a glimpse of a future where precision agriculture and sustainable water management practices flourish, promising a more prosperous, environmentally friendly and efficient agricultural landscape.

2. LITERATURE REVIEW

An approach to the integration of precision agriculture and smart grid technologies is presented in [1]. The aim is to balance consumption and production in agricultural land, which increases the sustainability of energy supply.

Coordination with and support network in the peak [2]. However, there is a need to minimize the amount of energy and water used in implementing this approach, which makes it quite expensive, reducing its feasibility.

The work in [3] proposes a central intelligent irrigation system that controls several farms. Each farm has a data collection node that is connected to a computer installed on the farm. Communication takes place via the TCP/IP protocol over the Internet and this limits its usability.

In [4], a cloud-based control system for smart irrigation using wireless sensor networks is presented. Environmental parameters are collected by sensors and sent to the cloud for evaluation. The network of actors is controlled remotely from the cloud after evaluating the sensor data. This system also requires an internet connection.

The work in [5] also addresses the problem of energy and water wastage in water-limited areas using an irrigation system that is based on the concept of the Internet of Things. The system collects environmental information and sends it to the farmer to make an easy decision using the internet, which limits its feasibility in developing regions. Operating costs are also quite high as they include labor and internet costs.

The research done in [6] also proposes a monitoring and control system. It collects environmental parameters such as temperature, relative humidity and precipitation, as well as plant condition such as truck size and leaf moisture. This is done using wireless devices that are spread over the ground. Statistical data is sent to the central unit where the decision-making strategy is located. This control unit communicates with actuators that activate the water pumps for a certain period of time. The main difference between this system and the system proposed in this paper is that the control units in the latter are decentralized. Each implementation unit is self-contained.

In [7], the use of remote switching and monitoring of the irrigation system using smartphones is presented to solve the need for automatic water control near the roots of vegetables. Soil moisture, temperature and humidity data are collected and sent to a smartphone where the user can make a decision. The irrigation system is switched on remotely by the user sending a command to the irrigation controller. However, this is not an automated approach as it involves the deployment of human manpower. This greatly increases operating costs especially for large smart farms. It also required owning a smartphone and the skills to use it, which posed some challenges for the developing world.

Another smart system is proposed in [8], it has customized humidity sensors to collect humidity information and send it to a central server via Xbee communication. It allows farmers to monitor soil moisture with a user-friendly interface. This ensures effective monitoring of the farm. However, automating irrigation is important because it reduces the operating costs of a smart farm. This was not incorporated into the proposed solution.

A low-energy, cost-effective platform for use in irrigation is presented in [9]. It's called TinyOS. The OS has three basic layers that facilitate the development of smart irrigation applications. These layers include control, sensing and communication. This OS can be used to develop systems that can solve the problems associated with wasting energy and water in irrigation.

3. PROPOSED SYSTEM

A smart irrigation robot is for an efficient agricultural management system that enables farmers to tackle the challenges they face. IoT has many applications, addressing key issues such as soil moisture detection, water conservation management, crop growth monitoring, etc. This project enables better and smarter irrigation through temperature, humidity and other sensors networked to communicate with the user. . For farmers and growers, the Internet of Things has provided highly productive ways to cultivate land with the rich use of cheap, easy-to-install sensors and the insightful data they offer.

A smart irrigation robot consists of a water sprinkler and an integrated network of sensors. To enable communication, the sprinkler is controlled by a microcontroller via a servo motor. The microcontroller sets the angle between which the servo motor should rotate, enabling the sprinkler to irrigate only within those angles.

3.1. Hardware Component's Used:

i. Microcontroller
ii. ESP32
iii. Four DC motor
iv. Bluetooth module
v. Battery 12v
vi. Water pump
vii. Ultrasonic sensor
viii. Sprinkler
ix. Water tank
x. Waterproof Robot Body

1. 2Microcontroller:

A Microcontroller is a key component in SMART irrigation robot as it plays a central role in controlling and automating the irrigation process.

Fig1. Microcontroller

Here's how a microcontroller is used in such system:

- **Sensor Integration:**

  The microcontroller is connected to various sensors such as soil moisture sensors, temperature sensors, humidity sensors, and sometimes even weather sensors.

  These sensors collect data about the environment, soil conditions, and weather.

- **Data Processing:**

  The microcontroller processes the data from the sensors to make decision about when and how much to water the plants. It can analyze the soil moisture levels, weather forecasts, and other relevant data to determine the optimal irrigation schedule.

- **Wireless Communication:**

  In some cases, microcontroller in SMART irrigation system are equipped with wireless communication modules like Wi-Fi or Bluetooth. This allows remote monitoring and control of the irrigation system through a smartphone app or a web interface.

- **Automation and Optimization:**

  The microcontroller can run algorithms that automate the irrigation process and optimize it for water conservation and plant health. It can adjust watering schedules and duration dynamically to adapt to changing environmental conditions.

- **User Interface:**

  Some SMART irrigation systems have a user interface, often a touchscreen or a mobile app, where users can input settings and preferences. The microcontroller processes user inputs and adjusts the irrigation parameters accordingly.

A microcontroller in a SMART irrigation robot serves as the brain of the system, collecting and processing data from various sensors and controlling the irrigation process to ensure efficient and effective watering while conserving resources.

2. **ESP32:**

ESP32 performs as a complete standalone system or a as a slave device to a host MCU, reducing communication stack overhead on the main application processor.

ESP32 can interface with other system to provide Wi-Fi and Bluetooth functionality through SPI/SDIO or 12C/ UaRT interface.

Fig 2. ESP32

Here's how it is implemented:

1. **Hardware Components:**

- **ESP32 board:**

  This will be the brain of irrigation system.

- **Soil moisture sensors:**

  To measure the moisture level of the soil.

- **Water Sprinkler:**

  To deliver water to the plant.

2. **Connect Sensors and Actuators:**

- Connect the soil moisture sensors to ESP32's analog pins to measure soil moisture.
- Connect the water sprinkler to the ESP32's digital pins to control water flow

3. **Bluetooth module:**

Bluetooth module is a basic circuit set of chip which integrated Bluetooth functions and which can be used in wireless networking transmission.

Generally, the Bluetooth module can be divide into the following types:

- Data transmission module
- Remote control module

Fig 3. Bluetooth Module

4. **Ultrasonic Sensor:**

An Ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pules that relay back information about an object's proximity.

Fig 4. Ultrasonic Sensors

3.2 Software Requirement's:

i. Arduino IDE (Programming c language)
ii. Express PCB (Schematic Layout)

1. **Arduino IDE:**
   The Arduino Integrated Development Environment (IDE) is an open-source software platform used for writing, compiling, and uploading code to Arduino boards. It provides a user-friendly interface for programming Arduino microcontrollers and includes a code editor, compiler, and various libraries to make it easier to develop projects. Arduino IDE is commonly used by hobbyists, students, and professionals for creating a wide range of electronics projects.
2. **Express PCB:**
   Express PCB is a CAD software that is used to create layout for printed circuit boards (PCB). The CAD is divided into the more helpful category.
   Express PCB is known for it's user-friendly PCB design software that allows individuals and small businesses to create PCB layout for their electronic projects.

3.3 Algorithm Used:

i. **Line Following**

The line follower robot senses a black line by using a sensors and then sends the signal to Arduino. Then Arduino drives the motor according to sensor's output.

The whole **Arduino Line Follower robot** can be divided into three sections:

- **Sensor Section**
- **Control Section**
- **Driver Section**

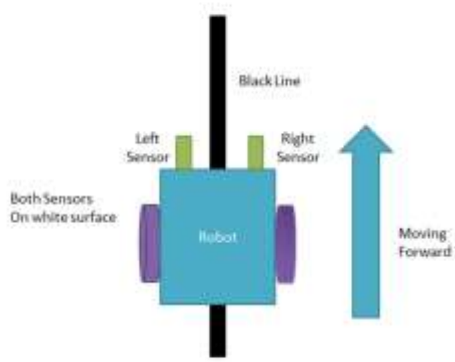

Fig. 5. Block Diagram Of Line Following Robot

3.CONCLUSIONS:

This project presents the design of an IoT-based SMART automatic irrigation robot. The proposed system can reduce farmers' efforts and produce high yields. It also detects sensors and saves water for irrigation. This research shows that plants can maintain low humidity when the temperature is moderate. The analysis of several parameters makes this system an effective system for field management.

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