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SMART Irrigation Robot

Prof.Hiranwale.S.B[1], Ghodke Shrushti[2], Sapre Neha[3], Jadhav Shital[4], Godase Smita[5]

[1, 2, 3, 4, 5]*Department of Computer Engineering, HSBPVT'S FOE, Maharashtra, India*

Abstract: Smart irrigation robots are solutions for today's agriculture that solve water management, work efficiency and crop quality problems. This autonomous robotic system combines advanced technology, sensors, artificial intelligence and precision robots to revolutionize the irrigation process. This content highlights the key features and advantages of smart water users. 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 harvest. Using smart algorithms, irrigation strategies can be tailored to specific crop types and growth stages to ensure efficient use. Operating costs. It also promotes sustainability and environmental protection by reducing water waste by providing the required amount of water where and when it is needed.

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

I. INTRODUCTION

Smart irrigation robots are a new solution for inadequate watering of the land, garden or landscape. Robotic processes combine technologies such as sensors, artificial intelligence and automation to optimize x processes. By monitoring the environment such as humidity, weather and the needs of plants, the smart irrigation robot can determine data for spraying crops or plants where and when they need, thus saving water and increasing yields. These robots are designed to reduce labor, save water and ensure the sustainability of agriculture and horticulture. Smart irrigation robot is a multifunctional, autonomous machine that intelligently controls the agricultural irrigation process. Unlike traditional plumbing that relies on schedules or manual maintenance, this robotic system uses the power of advanced sensors, connections and algorithms to deliver controlled water.

The main roles and products of smart water users are:

1) *Measurement technology:* The robot is equipped with many sensors, including soil moisture sensors, water sensors and visual cameras. Sensors constantly monitor the surrounding environment and humidity.
2) *Autonomous Navigation:* The robot's movement is guaranteed by autonomous navigation, which allows it to move anywhere without human intervention. It can adjust its path according to changing environments and problems.
3) *Efficient use of water:* Smart water users can manage water to avoid excess water and water wastage. This not only saves water but also prevents water from damaging crops.
4) *Remote monitoring:* Irrigation robots can be monitored and controlled remotely via mobile applications or web interfaces; Thus, adjustments can be made according to real-time data and weather conditions.

Smart irrigation robots not only improve the quality of water, they also have the concept of precision agriculture. Farmers can manage and monitor the smart remote control through a simple interface, making it easy to make irrigation plans and settings. This not only reduces crop yields, but also reduces the ecological footprint caused by excessive water use. In this guide we only scratch the surface of what smart irrigation robots represent. Symbolizing the combination of advanced technology and environmental responsibility, this project has a bright future with the potential to create a successful, environmentally friendly and agricultural landscape where precision agriculture and sustainable water management will flourish.

II. LITERATURE REVIEW

[1] proposed a method to integrate precision agriculture and smart grid technology. It is aimed to balance the consumption and production of agricultural lands and thus ensure energy supply security.

Collaboration and network support during peak hours[2]. However, to use this model, the energy and water used need to be reduced, making it very expensive and reducing its feasibility.

The work in [3] proposed a centralized smart irrigation system to manage multiple fields. Each farm has a data collection system connected to computers installed on the farm.

Communication occurs over the TCP/IP protocol on the Internet, which limits its use. In [4], a cloud-based smart irrigation control system using wireless sensor networks was proposed. Environmental parameters are collected by sensors and sent to the cloud for analysis. After the sensor data is measured, it is checked by the network partner cloud. The system also requires an internet connection.

The study in [5] also addresses energy and water waste problems in regions with limited water use by using water pipes in the context of IoT. The system collects environmental information and sends it online to farmers for easy decisions, which limits the system's ability to create space.

Operating costs are also high because they include energy and internet costs. The studies conducted in [6] also proposed a monitoring system. It records environmental parameters such as temperature, relative humidity and precipitation, as well as vegetation such as traffic and leaf moisture.

This is done using wireless devices in the area. Statistics are sent to a central location where decisions are made. This control unit communicates with the actuator to start the pump at a certain time. The main difference between this system and the system mentioned in this article is that the control room of the latter has a decentralized structure. Each unit is independent. In [7], it was proposed to use smartphones to change and monitor water flow to solve the need for automatic water management near the roots of vegetables. Humidity, temperature and humidity data are collected and sent to the smartphone where the user can make decisions. The user remotely starts the irrigation system by sending commands to the irrigation controller.

However, it cannot be used in this way as it interferes with the deployment of manpower. This increases operating costs, especially for large smart businesses. It also requires possession of a smartphone and the ability to use it; This poses a challenge for developing countries. Another smart method is proposed in [8], which has a climate changes that will collect humidity data and send it to the central server via Xbee communication. It allows farmers to monitor soil moisture through a user-friendly interface. This ensures good maintenance of the farm. But automatic irrigation is important because it reduces the operating costs of smart farms. This was not included in the decision.

A low-energy, cost-effective platform for irrigation is proposed in [9]. Its name is TinyOS. The operating system consists of three key layers that help improve smart water usage. These layers include management, information and communication. With this process, systems can be created to solve electricity and wastewater problems in water use.

III. 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.

A. Hardware Component's Used
- Microcontroller
- ESP32
- Four DC motor
- Bluetooth module
- Battery 12v
- Water pump
- Sprinkler
- Water tank
- IR Module

1) Microcontroller: A Microcontroller is a key component in SMART irrigation robot as it plays a central role in controlling and automating the irrigation process.
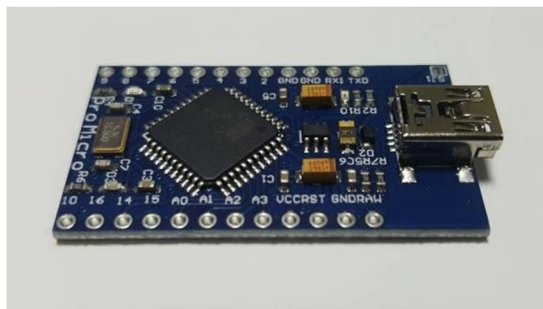
Fig1. Microcontroller

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:

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.

3) 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

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

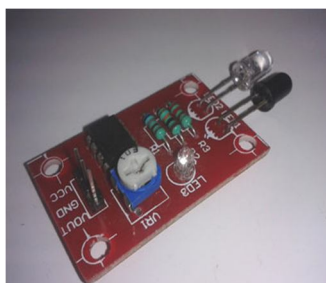Generally, the Bluetooth module can be divided into the following types:
- Data transmission module
- Remote control module

Fig 3. Bluetooth Module

5) IR Module
IR Module is sensor circuit that consists IR LED/photodiode pair, potentiometer, LM358, resistors and LED. IR sensor transmits Infrared light and photodiode receives the infrared light.

B. Software Requirement's

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 its user-friendly PCB design software that allows individuals and small businesses to create PCB layout for their electronic projects.

C. Algorithm Used

1) Line Following
The line follower robot senses a black line by using a sensor 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
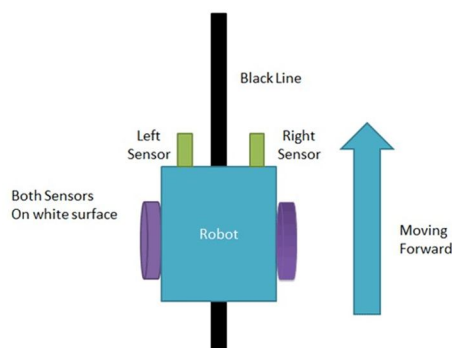- Control Section
- Driver Section

Fig. 5. Block Diagram Of Line Following Robot

Concepts of Line Follower

The concept of working of line follower is related to light. We use here the behaviour of light at the black and white surfaces. When light falls on a white surface it is almost fully reflected and in the case of a black surface light is completely absorbed. This behaviour of light is used in building a line follower robot**.**
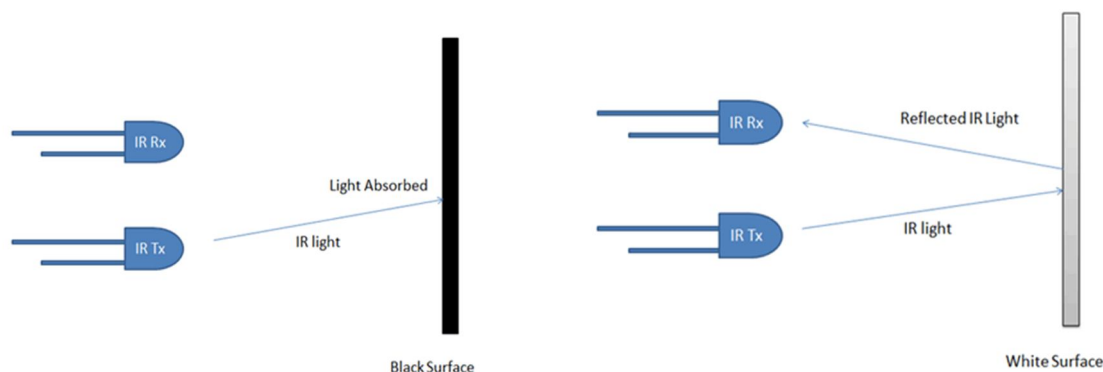
In this Arduino based line follower robot, we have used IR Transmitters and IR receivers also called photodiodes. They are used for sending and receiving light. IR transmits infrared lights. When infrared rays falls on the white surface, it's reflected back and caught by photodiodes which generate some voltage changes. When IR light falls on a black surface, light is absorbed by the black surface and no rays are reflected back, thus photo diode does not receive any light or rays. Here in this Arduino line follower robot when the sensor senses white surface then Arduino gets 1 as input and when senses black line Arduino gets 0 as input.

Circuit Explanation:

The whole Arduino line follower robot can be divided into 3 sections: sensor section, a control section, and driver section.

1) *Sensor section:* This section contains IR diodes, potentiometer, Comparator (Op-Amp) and LED's. The potentiometer is used for setting reference voltage at comparator's one terminal and IR sensors are used to sense the line and provide a change in voltage at the comparator's second terminal. Then the comparator compares both voltages and generates a digital signal at the output. Here in this **line follower circuit,** we have used two comparators for two sensors. LM 358 is used as a comparator. LM358 has inbuilt two low noise Op-amps.

2) *Control Section:* Arduino Pro Mini is used for controlling the whole the process of the line follower robot. The outputs of comparators are connected to digital pin numbers 2 and 3 of Arduino. Arduino read these signals and send commands to driver circuit to driveline follower.

3) *Driver section:* The driver section consists of motor driver and two DC motors. The motor driver is used for driving motors because Arduino does not supply enough voltage and current to the motor. So we add a motor driver circuit to get enough voltage and current for the motor. Arduino sends commands to this motor driver and then it drives motors.

Working of Line Follower Robot using Arduino

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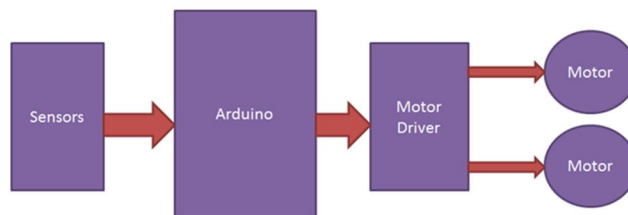

Here in this project, we are using two IR sensor modules namely the left sensor and the right sensor. When both left and right sensor senses white then the robot moves forward.
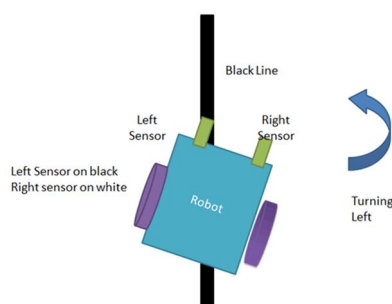
If the left sensor comes on a black line then the robot turn the left side.
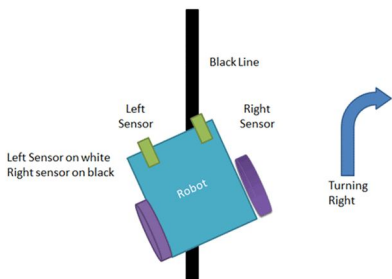
If the right sensor sense black line then robot turn right side until both sensors comes at the white surface. When the white surface comes robot starts moving on forward again.
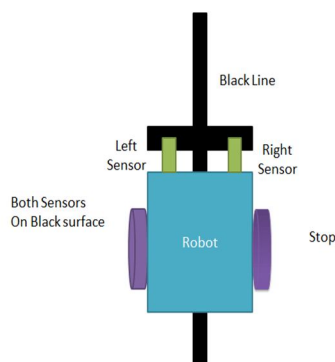
If both sensors come on the black line, the robot stops.

Input		Output				Movement Of Robot
Left Sensor	Right Sensor	Left Motor		Right Motor		
LS	RS	LM1	LM2	RM1	RM2	
0	0	0	0	0	0	STOP
0	1	1	0	0	0	TURN RIGHT
1	0	0	0	1	0	TURN LEFT
1	1	1	0	1	0	FORWARD

There are four conditions in this line following robot that we read by using Arduino. We have used two sensors namely the left sensor and the right sensor.

IV.   CONCLUSIONS

This project presents the design of an IoT based SMART automatic Irrigation robot. The proposed system can reduce the efforts of farmers and provides high yield. It also conserves water for irrigation by locating the sensors. This work have shown the plants can still sustain at low moisture level when the temperature is moderate. Analyzing more than one parameter has made this system an efficient one for managing the field.

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