Smart Monitoring of Plants and Automatic Irrigation

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ABSTRACT: Agriculture consumes a significant portion of global freshwater resources and remains a key driver of economic development. Effective resource management is therefore critical to ensuring sustainable agricultural practices. This project presents an innovative automated system for monitoring plant health and managing irrigation. The system leverages advanced sensors to track soil moisture, environmental conditions, and signs of plant stress. A soil moisture sensor triggers a water pump when moisture levels fall below a set threshold, optimizing water usage. To enhance crop protection, PIR sensors detect the presence of pests and predators, while a color sensor monitors leaf health by identifying color variations that may indicate disease. A rain sensor is integrated to automatically close a protective shed during heavy rainfall, preventing potential plant damage. Additionally, the system sends SMS alerts to inform farmers of irrigation events and potential threats, enabling timely interventions. This comprehensive solution promotes efficient water use, early detection of plant health issues, and improved crop security, thereby contributing to higher agricultural productivity and sustainability.

KEYWORDS: IRRIGATION, PLANT, RAIN, SMS, HEALTH.

I.INTRODUCTION

Agriculture plays a vital role in global water consumption and economic growth, necessitating effective resource management to address the challenges faced by farmers. This project introduces an innovative automated system designed to monitor plant health and manage irrigation efficiently, leveraging advanced sensor technology and automation. In this system integrates sensors such as PIR and soil moisture sensors to detect pests, monitor environmental conditions, and ensure optimal hydration. The soil moisture sensor triggers a water pump when moisture levels fall below a predetermined threshold, optimizing water usage and ensuring consistent plant growth. It also enhances the system with a color sensor to monitor leaf health by detecting color variations indicative of diseases. Motion sensors identify potential threats like predators, while a rain sensor activates a protective shed during heavy rainfall, safeguarding crops. The system also sends SMS alerts to farmers regarding irrigation activities and pest detections, enabling informed decision-making. This comprehensive approach combines health monitoring, automated irrigation, and environmental protection to promote sustainable farming practices and improve agricultural productivity.

Literature Review

Nagpal and Manojkumar (2016) present a hardware implementation of an intruder recognition system for farms using a wireless sensor network. The system detects unauthorized access and alerts farm owners through real-time monitoring. It highlights the integration of wireless communication for enhanced farm security. [1]

Yasin, Zeebaree, and Zebari (2019) present an Arduino-based automatic irrigation system that integrates monitoring and SMS control features. The system automates irrigation by detecting soil moisture levels and enables remote management via SMS alerts. It highlights advancements in precision agriculture through IoT technologies. [2]

Seelye, Mark, et al. "Low cost colour sensors for monitoring plant growth in a laboratory." *2011 IEEE international instrumentation and measurement technology conference*. IEEE, 2011.[3]

II.OBJECTIVE

To develop an automated system for plant health monitoring and efficient irrigation through sensors to optimize water usage, detect plant diseases, identify pets and predators, and protect crops from environmental damage, thereby enhancing agricultural sustainability and productivity.

III.BLOCK DIAGRAM

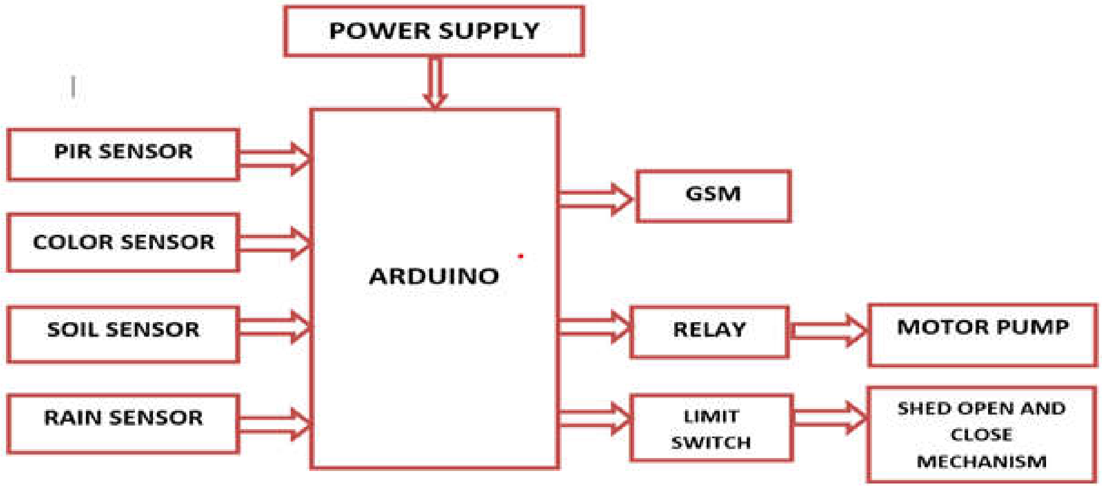

Fig.1 proposed block diagram

PIR Sensor**:** Detects motion by measuring infrared radiation emitted by objects in its field of view.

Soil Moisture Sensor: Measures the moisture content in the soil to determine if watering required.

Rain Sensor: Detects rain by sensing water droplets on its surface. while a rain sensor activates a protective shed during heavy rainfall, safeguarding crops.

Color Sensor: Detects the color of a leaf by measuring the light reflected using RGB channels.

The Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It was named as UNO to label the first release of Arduino Software. It was also the first USB board released by Arduino. It is considered as the powerful board used in various projects. Arduino.cc developed the Arduino UNO board. The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms. The figure below depicts the modern chip version of Arduino and labelled the parts.

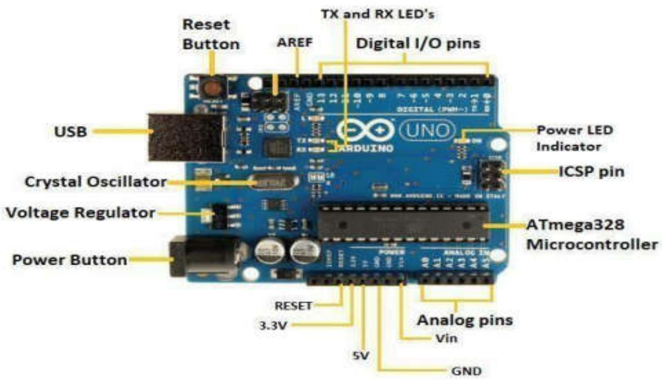

Fig 2 Arduino UNO chip

A Passive Infrared sensor (PIR sensor) is an electronic device that measures infrared (IR) light radiating from objects in its field of view. PIR sensors are often used in the construction of PIR-based motion detectors. Apparent motion is detected when an infrared source with one temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall.

Fig 3. PIR Sensor

Soil moisture sensors measure the volumetric water content in soil indirectly by using properties like electrical resistance, dielectric constant, or neutron interaction, as proxies for moisture content. These measurements require calibration as they vary with factors such as soil type, temperature, and electrical conductivity. Remote sensing methods, like reflected microwave radiation, are also used to assess soil moisture in agriculture and hydrology. Another type of sensor measures soil water potential (e.g., tensiometers, gypsum blocks). In this project, two copper electrodes are used to detect moisture: one is powered, and the other connects to a controller. If the soil is wet, the second electrode receives potential through the soil, signaling moisture; otherwise, it indicates dryness.

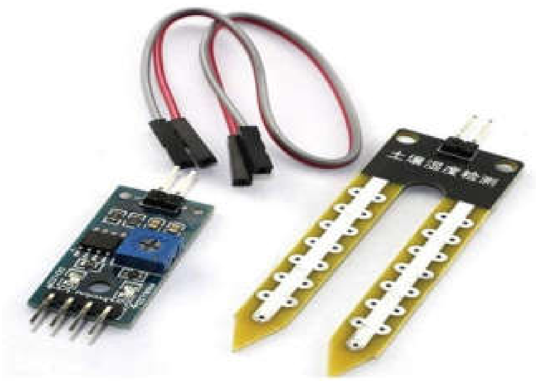

Fig 4 Soil Moisture sensor

GSM (Global System for Mobile Communications) is a cellular network where mobile phones connect by locating nearby cells. Operating mainly in 900 MHz and 1800 MHz bands (850 MHz and 1900 MHz in some Americas), it uses time-division multiplexing to provide multiple speech channels per frequency. GSM-900 supports 124 channels with 45 MHz duplex spacing, while extended GSM (E-GSM) adds 50 more channels. The channel data rate is 270.833 kbit/s with a frame duration of 4.615 ms.

Fig 5 GSM Module

A color sensor is an electronic device that detects and identifies different colors based on the light they reflect. It typically works by shining light often red, green, and blue onto a surface and measuring how much of each color is reflected back. This reflected light is captured by photodetectors, and the sensor then calculates the RGB values to determine the exact color. Color sensors are widely used in industries for quality control, sorting, and automation.

Fig 6 Color sensor

A rain sensor detects rainfall and automatically activates a system to cover plants. It works by using two conductors separated by an insulator, where water droplets reduce resistance and change the voltage. The sensor includes a nickel-coated PCB with etched conductive strips that sense moisture levels. When it detects rain, a BC547 NPN transistor amplifies the signal and sends it to a microcontroller. The microcontroller then sends a GSM alert to the user and activates a servo motor to cover the plant. The sensor has four pins VCC, GND, DO, and AO and provides both analog and digital outputs based on moisture level.

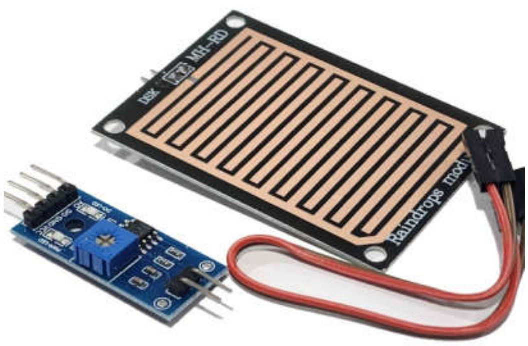

Fig 7 Rain sensor

IV.HARDWARE MODULE

This Hardware module consists of two transformers, PIR sensor, Soil moisture sensor, GSM module, Arduino Uno, DC pump, voltage regulator, relay, rain sensor, DC motor.

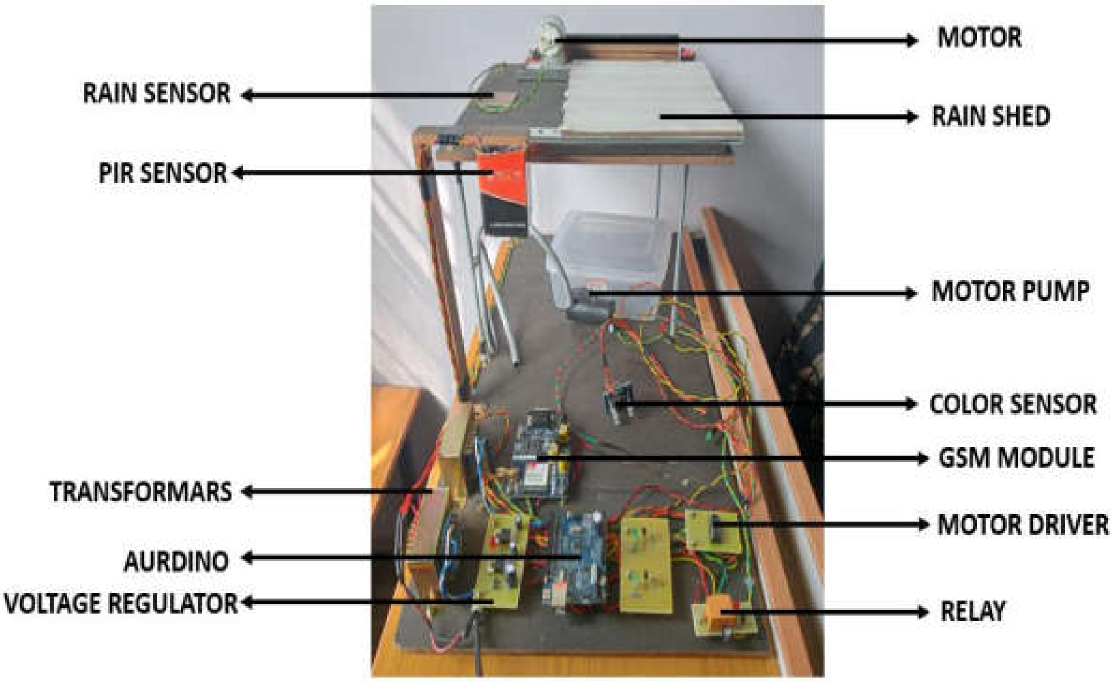

Fig. 8. Hardware Module

The system for health monitoring of plants and automatic irrigation, performed its tasks, including accurate soil moisture detection, pets' detection via PIR sensors, and autonomous irrigation control. Irrigation will be activated when the soil moisture level is low and automallically pump the water, PIR sensor is used to detect the moments of the pets and trigger the notification through GSM to the authorized person. System operates autonomously with minimal human intervention. the system enhances its capabilities by introducing color sensors to monitor plant health through leaf color variations, enabling early detection of diseases. while a rain sensor automates the closing of a protective shed during heavy rainfall, safeguarding crops from damage.

V.TESTING AND RESULTS

Detection of pests or predators

The PIR sensor will accurately detect movement near the plants and differentiate between human/animal movements and the target pests. When pests or predators are detected, the system will trigger a notification or an alert.

Automatic irrigation

The sensor will provide accurate moisture levels corresponding to the actual conditions. The system will trigger the water pump when moisture falls below the preset threshold (e.g., 30% moisture).The system will activate irrigation only when required and avoid over-watering.

Plant color finding

In this Case when the leaf is dry the color sensor will detect and it give SMS to the authorized person, so that the person can protect the plant by pesticides.

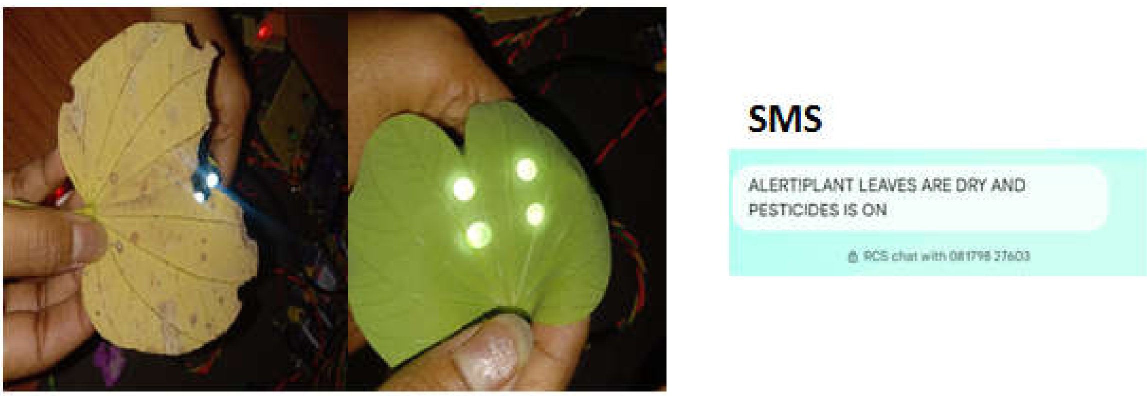

Fig 9 plant color finding

Automatic shed closing

When there is heavy rain, the rain sensor will detect and it automatically closes the shed to protect the plants from damage.

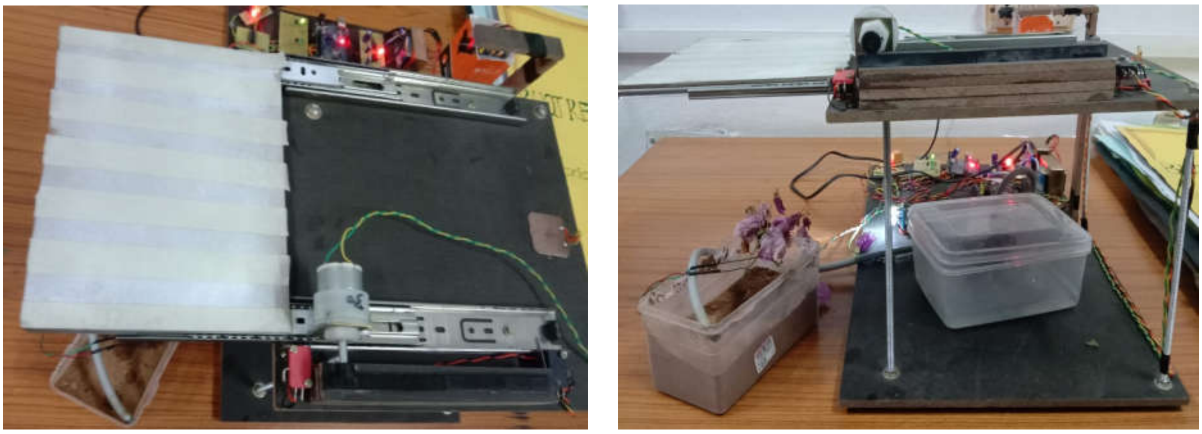

Fig 10 Automatic shed closing

VI.CONCLUSION

This paper highlights the potential of automation and smart agriculture in tackling key challenges such as water management, pest control, and plant health monitoring. By using advanced sensors like PIR sensors for pest detection and soil moisture sensors for real-time irrigation the system greatly improves farming efficiency and reduces the need for manual labor. Automated water pumps ensure that crops receive the right amount of water, minimizing waste and maintaining proper hydration even during dry periods. Additionally, the system uses color sensors to monitor plant health through leaf color, allowing early detection of diseases. A rain sensor further enhances protection by automatically closing a shed during heavy rainfall, safeguarding crops from weather damage. Overall, this smart farming approach boosts crop yield, cuts down on costs and effort, and supports sustainable agriculture and environmental conservation.

VII.FUTURE SCOPE

The future scope of this paper includes expanding its capabilities to incorporate more advanced technologies such as IoT and AI for predictive analytics. By integrating wireless communication modules like GSM or LoRa, farmers could remotely monitor and control the system using smartphones or web applications. Machine learning models could be employed to analyze historical data and predict pest infestations, soil fertility, or water needs, enabling preemptive actions. The addition of solar panels can make the system energy-efficient and independent of external power sources, especially for remote areas. Scaling the system to monitor additional parameters such as temperature, humidity, and nutrient levels could provide a comprehensive solution for precision agriculture. Ultimately, this project has the potential to transform conventional farming into a data-driven, resource-efficient, and eco-friendly practice.

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