JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

A ROBOTIC DEVICE FOR SMART IRRIGATION AND SURVEILLANCE

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Abstract: Agriculture is a vital food source for a growing human population. Robots are smart machines and can be appliedin various fields such as manufacturing, diligence, production lines, agriculture, and health. Nevertheless, they are at their best when undertaking tasks that humans may find physically challenging due to limitations of resources like time and money, skills, or disabilities or sometimes the necessity of working in extreme conditions. This therefore allows for fast acquisition of water content values as well as humidity and temperature levels in the soil such that farmers can make informed decisions on water application (irrigation). Such integration results in efficient and informed decision-making processes towards agricultural as well as environmental spheres respectively. Leveraging cutting-edge technology, this ground-breaking solution is aimed at enhancing the accuracy, usefulness, and sustainability of soil management practices. The system also integrates a smart irrigation system where the farmer can initiate irrigation by just clicking theirsmartphone once the moisture content goes below a given level. This combination with modern communicationdevices demonstrates how easy it is to operate and use the system. Furthermore, to improve the surveillance ability of agricultural operations an ESP32-CAM module allows for live monitoring on mobile screens.

I. INTRODUCTION

Worldwide, agriculture is the lifeblood of various countries, and its main challenge is now to sustain an ever-growing world population with enough food. This means that aspeople continue to grow in number, so does the necessity for food, hence pushing this industry toward technology adoption and modernization. Therefore, all over the world, the need for agricultural automation has become necessary and this prompts nations to make technological advances geared towards changing consumer tastes [1],[2],[3]. Agriculture not only supports economies but also enhances progress in society; it therefore must continually improve itself through efficiency and productivity enhancement. The changing consumer preferences require embracing innovative technologies in food production [4]. Agricultural optimizations become a crucial undertaking given the heavy reliance on agriculture by many nations [5]. Smart irrigationtechnology is a new scientific discipline based on data-driven approaches which is aimed at improving agricultural productivity while minimizing environmental degradation.In the contemporary global agriculture landscape, numerous sensors generate massive datasets providing insights into the operational environment as well as farming activities [6],[7].Our team has created a robotic device, which is powered by the Internet of Things (IoT) for water conservation and effective water management. This is a technologically advanced robot rover that moves through fields independently, and farmers can control it using their smartphones while at home or in other areas far away from their farms. This innovation represents the highest technological standard when considering agriculture. Thesmart irrigation implementation is central to this up-to-date system. If there's a low soil moisture level as noted by a farmer, they can remotely activate the irrigation system by pressing on their smartphone screen only once. This smooth interconnection simplifies activities related to water saving and maintains optimum soil moisture leading to good crop growth and yield increase in the agriculture sector. In conclusion, incorporating cutting-edge technology into agricultural practices marks a revolution in farming suchthat entities coping with the challenge of feeding the growing global population can protect nature at the same time.

II. PROBLEM STATEMENT

The agriculture sector faces serious problems in meeting the escalated food demand amidst labour shortages, limited resources and environmental concerns. Traditional farming methods often fail to efficiently optimize soil managementas well as irrigation practices without compromising sustainability. The existing technologies provide some solutions for monitoring soil parameters or controlling irrigation, but they do not integrate them and are often not user- friendly. Therefore, what is required is a comprehensive approach that incorporates robotics and sensor technology to overcome these challenges. Such asolution should have a wide range of functions includingsoil monitoring, irrigation control and instantaneous feedback; all of which should be easy to access and use. Ourresearch is aimed at developing such a system which we hope will revolutionize agricultural management practices and increase yields while reducing degradation of the environment.

III. OBJECTIVE

Design and implement an integrated system with robots and sensors for soil monitoring, water management and real-time monitoring in agriculture.
Evaluate the effectiveness and efficiency of the system to ensure it is effective and accessible, especially for farmers in r emote or limited areas.

IV. LITERATURE SURVEY

We explored many cases to gain information for the project in our research work. These documents are important resources that support our work by providing valuable information and guidance. The references to our research articles are given with each article's summary.

Machine Learning in Agriculture: A Review [1] Machine learning combines with agriculture to improve crops,livestock, water resources, and soil management, thus improving agricultural decision-making and production.

Comprehensive Review of Agricultural Automation Using Artificial Intelligence [2] Agricultural monitoring is important to meet food growing needs using artificial intelligence, deep learning, the Internet of Things, and automation to provide new solutions to improve crop selection, fertilizer use, water management, and agriculture. holistic agriculture.

Current Development and Future Prospects of Agricultural Technology: The Door to Sustainable Agriculture [3] advanced technologies like IoT must be used in agriculture to meet increasing food demand and provide sustainable, improved crops.

Irrigation with smart power. [4] Technology, techniques, andapps can reduce water costs in smart systems for water.

Smart Water Systems Can Help in Reducing Water Costs through the Use of Technology, Methods and Applications.
[5] In agriculture, Wireless Sensor Networks (WSNs) have apotentiality that calls for specific problem resolution as well as looking into the next steps on how agriculture can be improved.

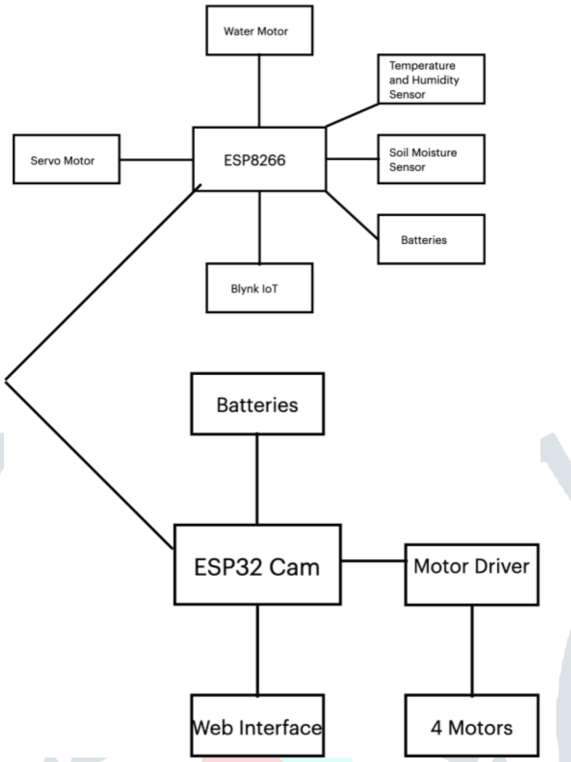
"Big Data" in Agriculture: Decisions Driven by Data Science Techniques in Precision Agriculture [6] Machine learning particularly data science technologies can makeagriculture more informed via better decision making but barriers must be overcome so that we use big data analytics effectively in precision farming.

The Future of Agriculture is Digital [7] This means focusingon technological advancements such as IoT developments where various application scenarios can improve smart agricultural knowledge taking into account future directions for business and commercial aspects of farm technology andbusiness.

V. EXISTING SYSTEM

The existing systems in smart irrigation and surveillance have laid a solid foundation for agricultural technology,offering significant improvements over traditional methods. However, the limitations of these systems, including their lack of integration, scalability issues, high costs, and generally reactive nature, highlight the need for more advanced, holistic solutions. The proposed robotic device aims to address these limitations by offering an integrated, scalable, and proactive system that combines smart irrigation with comprehensive surveillance, leveraging the latest in IoT, AI, and renewable energy technologies to meetthe complex demands of modern agriculture.

VI. PROPOSED SYSTEM



System architecture

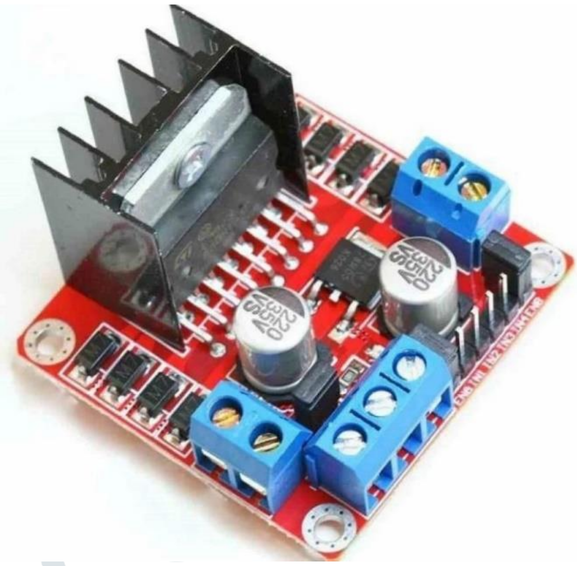
The system consists of a remote-controlled car, which is equipped with soil moisture sensors, an ESP8266microcontroller, a motor driver and a water pump motor for irrigation. The mobile platform for soil moisture sensing is provided by this remote-controlled car such that it can walk around the farm while gathering data. The ESP32 microcontroller functions as the CPU (Central Processing Unit) that runs all calculations regarding car motion and ESP8266 is responsible for gathering soil moisture, temperature, and humidity and controlling the water pump. The soil moisture sensor's information is wirelessly sent to the Blynk cloud server through the ESP 8266 microcontroller. Therefore, using the mobile Blynk application, farmers can observe their soil moisture levels inreal-time from anywhere they are on Earth. This data can be accessed by farmers who could then decide on whether to irrigate or not to irrigate. The system has a user-friendly interface that allows farmers to interact with it easily. The Blynk mobile application givesusers an overview of how their systems is functioning. It also enables them to control and monitor their soil moisture levels at any time or place as well as start sprinkling whenever necessary. Furthermore, the app supports alerts and notifications based on specific events like low soil moisture levels that demand immediate irrigation. The proposed system architecture employs rechargeable batteriesas the power source for the remote-controlled car and its associated electronic components. These batteries are rechargeable cells that can store electrical energy and are made for recharging by an external power source. The process of charging them involves connecting to an external power source through a circuit designed specifically for charging. Such a charging circuit ensures that the batteries will be safely and efficiently charged, thereby preventing overcharge or damage.

VII. HARDWARE / SOFTWARE REQUIREMENTS

1. ESP32 Cam Module

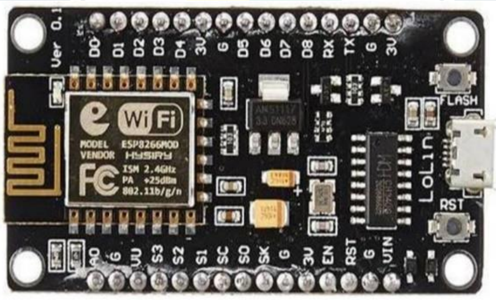
ESP32 CAM module can be identified as a smallboard that interfaces the ESP32 microcontroller with a camera, thus enabling WiFi connectivity aswell as picture and video recording functions.

2. Motor Drive



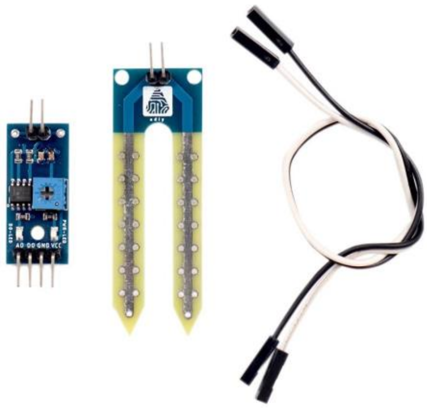
Motor driver L298N: A dual H-bridge motor drivermodule, which can offer two-way control of two DC motors with high current carrying capacity.

3. NodeMCU ESP8266



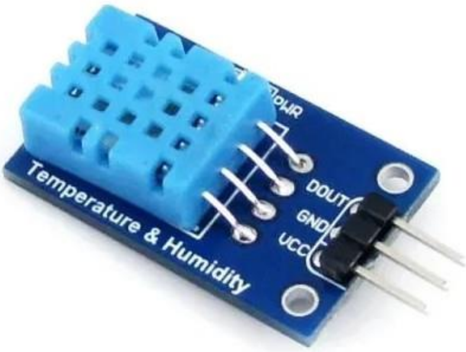
A low-priced WiFi microcontroller module appreciated for its simplicity and compatibility withwireless IoT projects.

4. Soil Moisture Sensor



The soil moisture sensor is one of the sensors thatare often employed in agriculture or automatic irrigation to measure the amount of water held in the soil.

5. Temperature and Humidity Sensor



The DHT11 sensor is a temperature and humidity sensor that has a digital interface and provides precise measurements for monitoring environmental conditions.

6. Water Pump Motor

An electric motor that can move water, which istypically employed in the plumbing business, aquariums, or hydroponic systems.

7. DC Motors

It is a motor that works with direct current (DC)and is usually used in plenty of applications likerobots, drones, and work machines.

8. Rechargeable batteries

An IoT device needs a small battery for power.These devices typically use small rechargeable batteries.

VIII. DISCUSSION AND SUMMARY

Several points for future research are outlined to advancethe current state of the art:

The primary aim of the robotic device is to automate irrigation processes and provide surveillance solutions, addressing the challenges of water conservation and crop monitoring. The increasing demand for food requires efficient use of resources, where technology can play a pivotal role in optimizing water usage and monitoring crop health to prevent disease and pest infestation. Addressing cases where two diseases are present on the same fruit or different disorders exhibit similar symptoms is a challengingresearch area. Investigating accurate methods for identifyingand differentiating multiple diseases in the same fruit, including disease stages, is crucial.

Implementing such devices has shown a significant reduction in water consumption, optimized crop growth and early detection of plant health problems. In addition, surveillance capabilities increase security against animal theft and intrusion, providing a comprehensive solution to the challenges of modern agriculture. Some systems rely on manual data sets where each disease may have differentstages with different symptoms. There is a significant gap indetecting various stages of diseases and providing accurate solutions for these diseases.

Future research and development efforts are key to improving these systems to make them more cost-effective, user-friendly, and adaptable to different agricultural environments.

By leveraging technologies such as IoT, AI and machine learning, these devices can autonomously control irrigation schedules based on real-time environmental data, ensuring optimal plant growth while conserving water.

Surveillance functions not only contribute to the safety ofthe agricultural area but also monitor plant health and enableearly detection of disease or pest infestation and interventions. It is essential to develop a decision support system or application that is easily accessible to farmers. Such a system could allow farmers to capture images of plants using sensor devices and send them to a decision support system. The system would then detect plant diseases in their early-stage sand provide treatment recommendations.

IX. ADVANTAGES

Remote monitoring and control: Farmers can monitor and control the irrigation system remotely, making it easy to manage large or multiple fields remotely.

Adaptability to climate change: By optimizing water useand monitoring environmental conditions, these farming systems help adapt to changing climates and extreme weather events.

Enhanced farm security: The surveillance function not only monitors crop health but also increases farm security bydetecting unauthorized access and protecting assets and investments.

X. FUTURE SCOPE

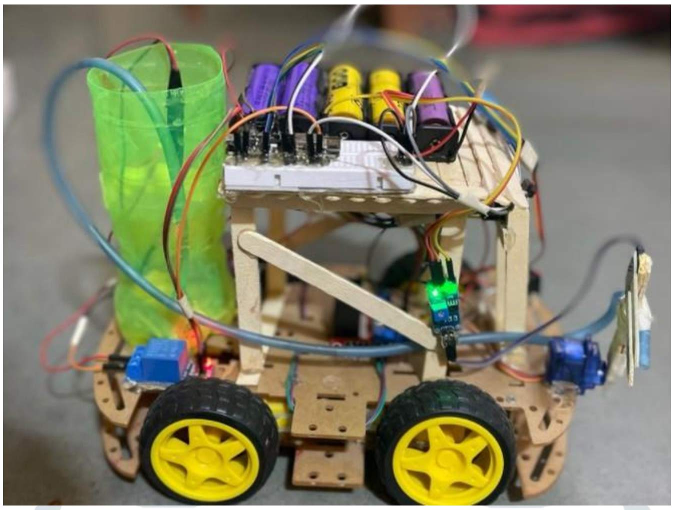
The future scope of this research presents several promising avenues for further exploration and development.

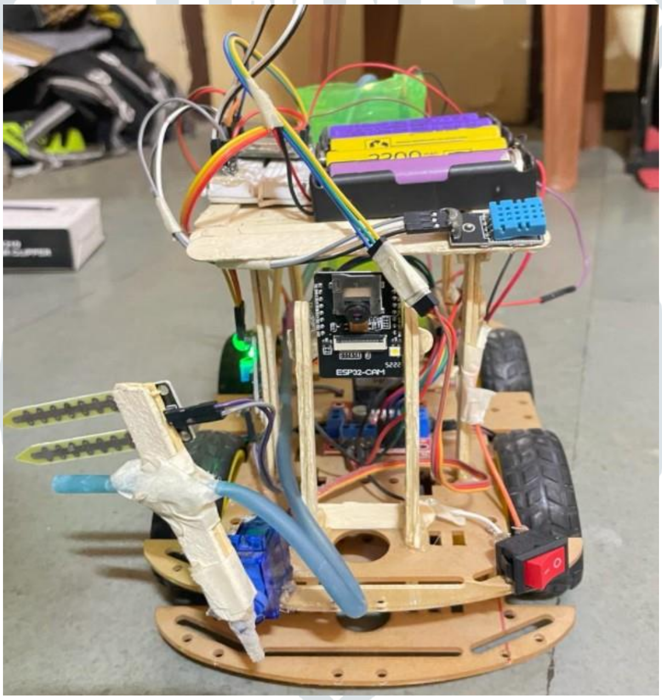
First, there is the potential to create a comprehensive dataset that compiles the values collected by the sensors, including soil moisture, temperature and humidity, alongwith corresponding time stamps. This data set can serve as avaluable resource for conducting detailed analyses and gaining deeper insights into agricultural conditions over time.

In addition, the use of machine learning techniques such as predictive modelling offers an exciting opportunity to usethe dataset to predict soil moisture and other variables with greater accuracy. By training machine learning algorithmson collected data, we can develop predictive models that anticipate changes in soil conditions and enable proactive decision-making and resource management.

In addition, integrating the system with a LoRa (Long Range) communication system is another way to increasethe efficiency of smart irrigation. By using LoRa technology, which enables long-distance communication with low energy consumption, we can improve data transmission and communication between the agricultural monitoring system and the irrigation infrastructure. This integration can optimize water use, reduce resource wastage and further improve the sustainability of agricultural practices.

XI. SNAPSHOTS





X. CONCLUSION

In conclusion, the integration of intelligent robots equipped with sophisticated sensors represents a significant advance in agricultural management practices. By deftly performing tasks that humans may find difficult, these robots simplify operations and increase productivity in a variety of fields including manufacturing, production lines, breeding and healthcare. The incorporation of sensors enables accurate evaluation of key soil parametersand enables data-driven decision-making processes in agriculture and the environment. Powered by state-of-the- art technology, this innovative solution not only optimizesland management practices but also includes smartirrigation features for efficient water use. In addition, the real-time monitoring capabilities provided by the ESP32- CAM improve surveillance and facilitate early intervention, thereby supporting the sustainability ofagricultural practices. Overall, this paradigm shift in agricultural management underscores the transformative potential of advanced technology in increasing efficiency, productivity, and sustainability, and positions it as a cornerstone for modern agricultural practices.

XII. REFERENCES

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