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

IoT Based Smart Farming System

Project Guide :- Prof.Mukesh Tiwari

Vikas Gath
Dept. of E&TC
PVPIT Bavdhan Pune,
Pune, India

Lalit Khandalkar
Dept. of E&TC
PVPIT Bavdhan Pune,
Pune, India

Mitali Nande
Dept. of E&TC
PVPIT Bavdhan Pune,
Pune, India

Abstract— Agriculture, being a significant sector of the global economy, is afflicted with various problems such as water scarcity, climate change, and labor shortages. Smart farming, being Internet of Things (IoT) in agriculture, has emerged as a promising technology to enhance productivity, maximize the utilization of resources, and facilitate mechanized labor. This research paper presents a smart farming system developed using IoT modules that monitor and control real-time parameters such as moisture in the soil, temperature, humidity, and light intensity. By automating the irrigation process through data-driven decision-making, the system enhances efficiency and reduces manual labor. Cloud-based analytics and mobile connectivity enable farmers to make data-driven decisions anywhere and at any time

Keywords—IoT (Internet of Things), Smart Farming, Precision Agriculture, Soil Moisture Monitoring, Automated Irrigation System, ESP8266, Sensor-Based Agriculture, Wireless Sensor Networks, Real-Time Monitoring, Cloud-Based Farming Solutions.

I. INTRODUCTION

Over the past decades, the influence of technology on many occupations, including agriculture, has been immense. [1] Conventional farming is generally dependent on manual intervention, occasional observation, and experiential decisions, which are insufficient to address the ever-growing world food requirements. With unpredictable climates, waste in irrigation, and dwindling resources, contemporary agriculture requires a transition to precision farming.

IoT facilitates real-time sensing and control in agriculture, resulting in data-intensive agriculture. Sensors installed within fields gather environmental and soil information and are processed by microcontrollers and transferred to cloud platforms. [2] These data are utilized for automating irrigation, planning farm activities, and remote monitoring of crops. [3] In this paper, we seek to explore the design, implementation, and efficacy of such a system in a real-world context.

II. ASSOCIATED DRUDGERY

Agriculture, although critical to the sustenance of humankind, is perhaps the most tiring and tedious farming practice, particularly where traditional farming is dominant. All farm activities entail relentless human toil, which may lead to exhaustion, inefficiencies, and even poor crop harvests. Outlined below are the most pertinent problems that lead to drudgery among farmers:

A) Manual Irrigation

In most small-scale and medium-sized farms, water is irrigated manually. This involves the farmer:

i. Walking across fields to check soil moisture levels.
ii. Manually operating pumps and valves.
iii. Using time-based irrigation rather than need-based watering.

These methods not only lose water but also consume much physical energy and time. Irrigation at odd hours, such as early morning or late night, becomes tiresome and impractical. Further, over-irrigation or under-irrigation by guesswork results in stress on the crops and lower yield.

B) Frequent Crop Monitoring:

Constant monitoring of plant health is required at every stage—from sowing to harvesting—but doing it manually is a serious issue:

i. Visual Inspection: Crops must be carefully examined by farmers for wilting, color shift, fungal spots, pest attack, and nutrient deficiency. It is time-consuming and stressful.
ii. Large Farm Sizes: With the increasing size of the farm, time and labor required to inspect each section become exponentially larger, typically leading to incomplete assessments.
iii. Weather Restrictions: Observation has to be made irrespective of heat, rain, or humidity, which adds to the physical strain on the farmer.

Besides, visual inspection success depends greatly on experience, which is individual. Mistakes or failures can lead to delays in responding to threats like pests or diseases, reducing productivity and quality of harvest as a whole.

C) Environmental Data Collection:

Environmental parameters like soil temperature, ambient humidity, rainfall, and light intensity significantly influence crop growth, pest activity, and irrigation needs. However, manual collection and interpretation of this data are fraught with limitations:

i. Inaccurate Regional Weather Data**:** Farmers often rely on generalized weather forecasts that may not they can accurately describe local field conditions, especially in remote or heterogeneous terrain.
ii. Manual Measurement Instruments: Thermometers, rain gauges, and hygrometers, if used, demand physical checks and manual documentation, which may cause loss of information or mistakes.

iii. Lack of Real-Time Feedback: Irrigation scheduling, spraying pesticides, and harvesting are all decisions based on historical data, so farm management is not efficient.
iv. Lack of timely and field-level environmental data implies that farmers are forced to guess, reducing their ability to plan or act beforehand. For example, not perceiving an increase in humidity at the micro-level will increase the risk of fungal attacks.

D) Pest and Disease Detection

Disease and pests are two of the most destructive agents of agriculture, capable of annihilating vast fields of crops in matter of days if not discovered and treated in time. The traditional method of detection has several drawbacks:

i. Delayed Visual Identification**:** The disease may already be advanced or widespread when symptoms manifest which would require stronger treatment.
ii. Experience-Based Diagnosis**:** Farmer make use of experience or traditional counsel possible faulty or obsolete.
iii. Excessive Chemical Use**:** Without diagnosis farmers would apply broad-spectrum pesticides and thus spend unnecessary amounts of money , in addition to harming the environment

This method not only increases the environmental cost of agriculture but also result in pesticide resistance in pests and soil erosion . Additionally the cost of chemical input increases exponentially due to the trial-and-error approach

The application of Iot in agriculture minimizes the drudgery of agriculture significantly:

i. Automated Irrigation**:** Irrigation is triggered by soil moisture sensors when needed , with maximum water utilization without human intervention.
ii. Remote Monitoring**:** Wheather conditions and crophealth can be checked by farmers on their phone, reducing site visits.
iii. Accurate Data Logging**:** Monitoring temperature , humidity , and light data in real-time enables accurate decision-making , enabling optimal planting and harvesting times.
iv. Early Alerts**:** Intelligent sensors can detect abnormal changes that signal disease or pest infestation , enabling early intervention.

By combining these technologies , farmers are able to focus on strategy and oversight and not on backbreaking work .The result is greater productivity , less use of resources , and an improved quality of life for the farmer community .

III. sssSystem Design

A) Hardware Components:

i. ESP8266 Microcontroller**:** A low-cost Wi-Fi-enabled microcontroller used for connecting sensors to the internet and processing sensor data.
ii. Soil Moisture Sensor**:** Detects the volumetric water content in soil. It helps determine when the soil needs watering.
iii. DHT11 Sensor: Captures ambient temperature and relative humidity levels essential for understanding crop environment.
iv. Relay Module: Acts as a switch to control high-voltage appliances like water pumps based on sensor outputs.
v. Water Pump: Delivers water to the field; automatically controlled based on soil moisture levels.

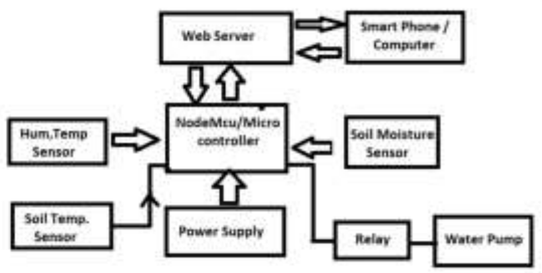

Fig. 1. Block diagram of the process of IoT based smart farming system

B) Software and Cloud Components:

i. Arduino IDE: Open-source environment used to program the ESP8266 microcontroller.
ii. ThingSpeak or Blynk Platform: Used for real-time data visualization and remote monitoring. These platforms provide graphs, alerts, and user interfaces for farmers.
iii. IFTTT Integration: Enables conditional actions such as sending SMS or email alerts when sensor thresholds are reached.
iv. Wi-Fi Module: Built into ESP8266, enables wireless communication with the cloud platform.

C) Working Principle:

i. Sensor Data Acquisition: Soil moisture, temperature, humidity, and light data are continuously captured by sensors.
ii. Local Display & Cloud Upload: The microcontroller displays the data on an LCD screen and uploads it to the cloud.
iii. Automation Trigger: When soil moisture drops below a predefined threshold (e.g., 30%), the relay triggers the water pump.
iv. Remote Control: The farmer can override automatic settings using a mobile app for manual control.
v. Alert System: If temperature or humidity exceeds thresholds, an alert is sent via IFTTT to notify the farmer.

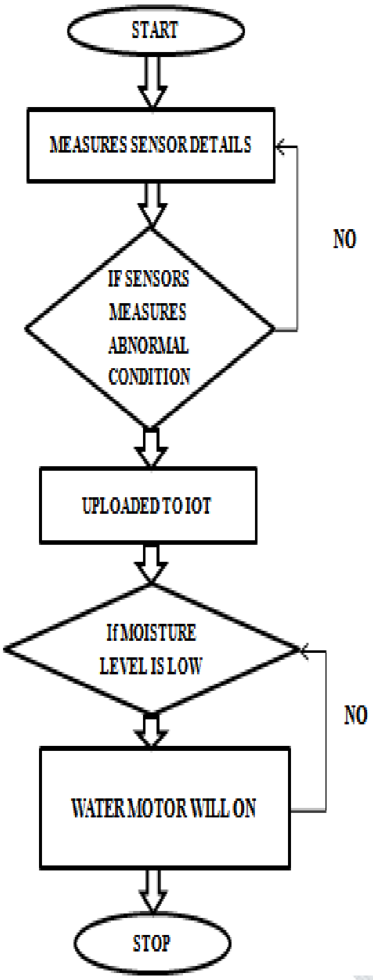

Fig. 2. Flowchart for IoT based smart farming system

The flowchart illustrates the working of an IoT-based smart irrigation system. The process begins with the system measuring environmental parameters through sensors. If any abnormal condition is detected, such as low soil moisture, the data is uploaded to the IoT platform for analysis. The system then checks whether the moisture level is below a predefined threshold. If it is, the water motor is automatically turned on to irrigate the field. This cycle helps in efficient water management and reduces the need for manual intervention in irrigation.

IV. Experimental Results

A) Set up

A prototype was tested on a 2x2 meter vegetable plot over 30 days. The following conditions were maintained:

i. Soil type: Sandy Loam
ii. Crop: Spinach
iii. Daily monitoring schedule: Every 5 minutes data logging

B) Observations:

Parameter	Manual Method Avg.	IoT System Avg.	Improvement
Water Usage (L/day)	100	60	40% saved
Monitoring Time	4 hrs/day	30 min/day	87.5% saved
Crop Yield Increase	Baseline	+15%	Higher productivity
Energy Usage	High	Low	Optimized usage

C) Analysis:

i. The system reduced over-watering by accurately detecting when soil required moisture.
ii. Environmental parameters allowed better decisions for pest control and fertilizer use.
iii. Farmers could monitor their fields remotely, reducing the need for physical presence.

V. Conclusion

The IoT-based smart farming system presented in this paper demonstrates significant improvements in resource usage, operational efficiency, and crop yield. By automating irrigation and monitoring, it reduces labor, saves water, and enables better crop management through real-time insights. The implementation can be scaled and adapted to different crop types and land sizes. Future enhancements could include:

i. Machine learning for predictive analytics
ii. Weather forecasting integration
iii. Solar-powered systems for energy efficiency
iv. A mobile app with GPS-based field tagging

This approach paves the way for precision agriculture, making farming more intelligent and sustainable

References

[1] Patel, K., & Patel, S. (2016). Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges. *International Journal of Engineering Science and Computing.*

[2] Nawandar, N. A., & Satpute, V. R. (2019). IoT based low-cost and intelligent module for smart irrigation system. *Computers and Electronics in Agriculture, 162*, 979–990.

[3] Nandurkar, S. R., Thool, V. R., & Thool, R. C. (2014). Design and development of precision agriculture system using wireless sensor network. *IEEE International Conference on Automation, Control, Energy and Systems.*

[4] Gutiérrez, J., Villa-Medina, J. F., Nieto-Garibay, A., & Porta-Gándara, M. Á. (2014). Automated irrigation system using a wireless sensor network and GPRS module. *IEEE Transactions on Instrumentation and Measurement, 63*(1), 166–176.

[5] Jawad, H. M., Nordin, R., Gharghan, S. K., Jawad, A. M., & Ismail, M. (2017). Energy-efficient wireless sensor networks for precision agriculture: A review. *Sensors, 17*(8), 1781.

[6] Kim, Y., Evans, R. G., & Iversen, W. M. (2008). Remote sensing and control of an irrigation system using a distributed wireless sensor network. *IEEE Transactions on Instrumentation and Measurement, 57*(7), 1379–1387.

[7] Ayaz, M., Ammad-Uddin, M., Sharif, Z., Mansour, A., & Aggoune, E. H. M. (2019). Internet-of-Things (IoT)-based smart agriculture: Toward making the fields talk. *IEEE Access, 7*, 129551–129583.

[8] Rajeswari, R., & Duraiswamy, K. (2015). Smart farming system using sensors for agricultural task automation. *International Journal of Advanced Research in Computer and Communication Engineering, 4*(5), 116–118.

[9] Karthick, P., Rani, B. S., & Venkatesan, R. (2016). Automated irrigation system using a wireless sensor network and fuzzy logic for precision agriculture. *Agricultural Water Management, 170*, 1–14.

[10] Zhang, Y., Wang, G., Wang, A., & Chen, X. (2017). IoT-based intelligent agricultural management system design. *International Journal of Online Engineering, 13*(8), 58–63.

[11] Kumar, P., & Gopal, G. (2016). IoT based smart sensing and alert system for agriculture. *International Journal of Computer Applications, 161*(1), 41–44.

[12] Khiyal, M. S. H., Khan, A., & Shehzadi, E. (2009). SMS based wireless home appliance control system. *International Journal of Computer Science and Engineering*, *3*(6), 20–25.

[13] Ramya, K., Shanmugapriya, D., & Prabakaran, G. (2014). Automatic irrigation system on sensing soil moisture content. *International Journal of Innovative Research in Computer and Communication Engineering, 2*(1), 104–107.

[14] Sathvika, T., & Praveen, K. (2020). IoT based real-time automated irrigation system. *International Journal of Scientific & Engineering Research, 11*(4), 393–397.

[15] Yadav, M. D., & Singh, V. (2021). Implementation of Smart Agriculture Using IoT and Cloud Computing. *International Journal of Computer Applications, 174*(6), 10–15.

[16] Balamurugan, P., & Karthikeyan, S. (2020). Real-time agriculture monitoring and controlling system using Internet of Things. *Materials Today: Proceedings, 33*, 1162–1167.

[17] Preethi, V., & Sivasankari, S. (2017). Smart irrigation system using IoT. *International Journal of Trend in Scientific Research and Development, 1*(6), 71–76.

[18] Bhaskar, P., & Chaitanya, R. (2018). IoT-based smart agriculture monitoring system. *International Journal of Engineering & Technology, 7*(4.5), 121–124.

[19] Singh, S. K., & Tripathi, R. (2018). IoT based smart farming: A review. *International Journal of Science, Engineering and Technology Research, 7*(4), 151–154.

[20] Prathibha, S. R., Hongal, A., & Jyothi, M. P. (2017). IoT based monitoring system in smart agriculture. *2017 IEEE International Conference on Recent Advances in Electronics and Communication Technology (ICRAECT)*, 81–84.