IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

AGROSPHERE: A COMPREHENSIVE APPROACH TO SMART GREENHOUSE MANAGEMENT WITH IOT INTEGRATION AND CLOUD ANALYTICS

[1]Durgesh Tripathi, [2]Mayurakshi Khanang, [3]Devanshu Singh ,[4]Fauzan Habib ,[5]Mohd Sohail

[1]Assistant Professor, [2,3,4,5] UG Scholar

Department of Computer Science and Engineering

Axis Institute of Technology and Management, Kanpur, Uttar Pradesh

Abstract: In India, traditional farming methods pose various challenges as the world rapidly changes. This paper introduces a new solution: a smart greenhouse system designed just for the farmers. By using advanced technologies like the Internet of Things (IoT), cloud computing, and mobile apps, this system aims to make farming easier and more productive while using resources wisely.

This system relies on a network of sensors placed throughout the greenhouse. These sensors keep track of important things like soil moisture, temperature, light, and even rainfall. The data from these sensors is sent to a cloud system where it is analyzed. This helps farmers make smart decisions about things like when to water plants, how to adjust ventilation, and even how to control the lighting.

Another important part of this system is a GSM module. This allows farmers to check on and control their greenhouse from anywhere using their phones. But it's not just about making things easier - this system also helps farmers take better care of the environment. By combining technology and farming knowledge, it promises to make farming in India more efficient, productive, and sustainable.

In short, this paper introduces a smart greenhouse system designed specifically for Indian farmers. It uses technology like IoT, cloud computing, and mobile apps to make farming easier, reduce the need for labor, and promote environmentally friendly practices. It's a big step forward for farming in India.

Index Terms - Smart Greenhouse Systems, IoT, Cloud Computing Mobile Application Development, GSM Module, Indian Agriculture

I. INTRODUCTION

Indian agriculture which once was admired all over the world due to its ethnic and historical importance, today is in a critical point, determining the fact that innovations and sustainability are more needed than ever. On the one side, the industry is rooted in its traditions yet there are issues with the availability of labor, inefficiency of resource utilization, and unpredictability of climatic factors. This complex system is an opportunity for technology to be an instrument through which the traditional methods of crop farming are changed and food availability is stepped up to meet the ambitious goal of improving the lives of our country's growing population.

The very first in the technologically innovative corridor is "smart greenhouse systems," which is in fact a total shift in agronomy. This integrated technological solution is about the combination of the Internet of Things (IoT), cloud computing, as well mobile applications which are used to monitor, control, and improve the growing environment for the crops. It is because of the extensive geographical scale as well as the distributed climate situation of India, the integration of smart greenhouses into the agricultural sector opens the doors to deal with the existing issues related to the common farming methods.

This research paper discusses the cognitive representation, mechanism, and ramifications of smart greenhouse systems in the Indian agricultural sector. Practical insights are given in the form of theoretical frameworks, and real-world studies, and the main aim of the concept is to reveal in what way this system increases crop yield, promotes sustainability, and strengthens the resilience of crops. Through the examination of the benefits and the disadvantages of smart greenhouse technologies, this article intends to deepen policymakers, researchers, and practitioners who are trying to revamp and recover the agricultural sector in India.

II. BACKGROUND

The traditional farming methods deeply ingrained in India's heritage face unprecedented challenges today. With rapid urbanization, climate change, and population growth, the agricultural sector struggles with issues like labor scarcity, shrinking arable land, and unpredictable weather patterns. To tackle these challenges while ensuring sustainable practices and food security, innovative approaches are urgently needed.

Enter smart greenhouse systems—a promising solution revolutionizing crop cultivation practices and overcoming the limitations of traditional farming methods. By harnessing technologies like the Internet of Things (IoT), cloud computing, and mobile applications, these systems offer a comprehensive approach to farming. They enable real-time monitoring and control of environmental conditions within greenhouses, allowing precise management of factors like temperature, humidity, and light intensity. With data analytics and automation, farmers can make informed decisions to optimize resource usage and maximize yields.

In India's diverse agricultural landscape, characterized by varying climates and geography, smart greenhouse systems hold immense potential. They promise to enhance productivity, resilience, and sustainability in crop cultivation, offering a transformative path forward for the agricultural sector.

FIG 1 : GREENHOUSE SYSTEM

III. LITERATURE REVIEW

In the last few years, the idea of smart greenhouse technology as a means of revolutionizing Indian agriculture has gained a lot of traction. Researchers investigated how such integrated systems, which combined breakthrough technologies such as the IoT and cloud computing, addressed the inherent problems in traditional farming. Smart greenhouse systems have been found to assist in fast-tracking crop cultivation techniques, ensuring optimum resource utilization, and boosting productivity.

Research by Patel et al. (2020) emphasizes the importance of IoT technology in enabling real-time monitoring and control of environmental conditions within greenhouses. This allows farmers to make informed decisions regarding irrigation, ventilation, and lighting, leading to more efficient crop management.

Studies by Gupta and Singh (2021) have demonstrated how cloud computing can facilitate data storage, analysis, and decision-making, enabling farmers to optimize greenhouse operations and maximize yields.

Khan and Sharma (2022) highlight the role of smart greenhouse technologies in reducing water usage, minimizing chemical inputs, and enhancing crop resilience to climate change.

Overall, the literature suggests that smart greenhouse systems hold promise for modernizing and revitalizing India's agricultural sector. By integrating advanced technologies and sustainable practices, these systems offer a pathway toward increased productivity, improved food security, and enhanced environmental stewardship.

IV. METHODOLOGY

4.1Research Design

Taking a mixed-method approach for the study of smart greenhouses in Indian agriculture. Using such an approach, we will have a deeper view of the subject. It is this method that allows for combining both qualitative and qualitative approaches thus creating a well-informed complex investigation on the smart greenhouses adoption and their effects on agricultural settings. The quantitative component of our study would entail holding in-depth, semi-structured interviews with varied individuals such as farmers, agriculture experts, and technology developers among others as part of the qualitative component. These interviews will be directed at their experience and view on intelligent greenhouse systems that incorporate the biggest challenges identified. Through the collection of personal narratives and perceptions, we are hoping to show fine-tuned adoption and implementation processes.

Along with qualitative research, the surveys will be distributed across a cross-section of farmers in different parts of India for collecting quantitative data. These surveys will address technological dimensions like the present farming methodologies, the level of knowledge on intelligent greenhouse solutions, and the likelihood of application of the same. Counting the feedback will help us to determine the patterns, the trends, and the correspondences that give us the much-needed information about the widespread of smart greenhouse adoption.

We conclude that the adoption of a mixed methodology will produce a robust and comprehensive analysis of smart greenhouses' functioning in the Indian context of agriculture. Such investigations would be informative for policymakers, researchers, and field practitioners who strive to revamp and reap the benefits of the sector.

4.2 Data Collection Methods

To ensure that our research support on smart greenhouse systems in Indian agriculture is both comprehensive and diversified in terms of the data gathering methods used, we purposely use a set of varied data collection approaches to collect the data from multiple angles and perspectives.

4.2.1 Semi-Structure Interviews

We run in-depth, semi-structured interviews with the main players such as the farmers, agricultural experts, and the available technology providers. These interviews help map their encounters, understandings, and problems with smart greenhouse applications with all kinds of information, depth, and detail. By involving participants in free-form conversations, we aim not only to identify new information that may be missing from the literature form but also to fill the information gaps by findings that may get passed over through the use of statistics only.

4.2.2 Surveys:

The survey is performed on a random collection of farmers using the structured approach from at least four regions of India. These surveys that are used to collect quantitative data on varied items like traditional farming practices, present knowledge about smart greenhouse technologies, and readiness to take the critical step would also be administered. Through collecting standardized responses which were made by a large number of respondents, we can see the trends, the patterns, and as well as the correlations that give us a lot of informative data on the smart greenhouse adoption scenario.

4.2.3 Observations:

We also observe greenhouse activities for ourselves and we communicate with farmers in context to gain real-world experience of the practical solutions of smart greenhouse systems implementation. Through direct contact with greenhouse plant operations and seeing farmers work with technology, we acquire the information necessary to see the problems existing in the data gathered in other ways of study.

4.2.4 Document Analysis:

By evaluating documents, reports, and studies on smart greenhouse systems in homegrown agriculture and our primary research we add more information to come up with a full picture. This includes reviewing government policies, the manufacturing industry report, and academic publications to develop a full understanding of the general context and current level of using smart greenhouses acceptance in India.

Through the application of these data collection techniques, we can conduct an in-depth and comprehensive investigation of smart greenhouse settings for Indian farming, allowing our research to be enriched by many varying views and information.

4.3 Data Analysis Techniques

In the research on smart greenhouse systems in Indian agriculture, we harness various data analysis methods to unearth deep interrelations among the obtained data. These techniques are one by one for a thorough analysis and inference of both qualitative as well as quantitative data.

4.3.1 Thematic Analysis (Qualitative):

For qualitative data that have been obtained from interviews, we apply thematic analysis to find repeated themes, patterns, and trends. This can be achieved by following a systematic process of coding and classifying the data to make out the core meaning and further analyzing it. Through identifying a continuous line of thought across participant responses, we will gain in-depth knowledge of the experiences, views, and challenges that are linked to smart greenhouse adoption.

4.3.2 Statistical Analysis (Quantitative):

Data obtained via surveys are subjected to statistical analyses to spot changes, correlations, and associations. This includes descriptive statistics to summarize important points and inferential statistics to test hypotheses and make conclusions about the relationships between variables. By statistical analysis, we can quantify relationships and patterns in the data and evidence to back our research findings and abstraction of the situation.

4.3.3 Content Analysis (Document Analysis):

Smart greenhouse systems and Indian agriculture-related documents, reports, and literature are analyzed with the help of content analysis methodology. This is achieved by technically scanning the texts and categorizing them according to their main themes, trends, and insights. Examining not only contemporary texts but also a wide spectrum of documents allows us to verify primary information and provide extra depth and context to our research.

Triangulation:

Triangulation is considered a strategy for achieving a balance in the validity and reliability of our results. Doing this requires comparing and contrasting findings obtained via different techniques (e.g., interviews, surveys, and observations) to corroborate the information and discern the same or divergent patterns. Triangulation helps the overall credibility of our research to be strengthened by ensuring the coherence and consistency of data.

4.4 Validity and Reliability

Attaining the veracity and reliability of our research results is very important for us to preserve the integrity and credibility of our study on the model of smart greenhouses for Indian agriculture.

4.4.1 Validity:

Strategies to heighten the authenticity of our research include the following. Firstly, we make sure that our data collection methods are related to the research goals. This will enable us to gather applicable and effective data. Furthermore, we adopted the triangulation method, using various data collection tools to verify and confirm the results. Besides this we do member checking; seeking feedback from participants helps us to make sure that our interpretations are according to the experiences and opinions of participants.

4.4.2 Reliability:

Reliability is guaranteed through consistent and repeated research procedures applied in our lab. We keep tangible records of how we collect and analyze data so that our endeavors are well-documented, transparent, and reproducible. Apart from that, we conduct inter-coder reliability checks for the data analysis of qualitative data and two or more people re-code the data independently to confirm the genuineness of our findings. We strictly comply with the research methods and study protocols to ascertain the accuracy of our results.

V. IMPLEMENTATION

5.1 Hardware Components

Arduino Uno microcontroller
Soil moisture sensor
Temperature sensor
Humidity sensor
Servo motors
GSM module
LCD display
Rain sensor
Water pump

5.2 Software Components

Arduino IDE
Cloud computing platform
PCB design software (e.g., Eagle)
Circuit simulation software (e.g., LTSpice)

5.3 Implementation

5.3.1 Integrated Sensor Fusion System

Developed an own software sensor fusion system that collects data from using of soil moisture sensors, temperature, humidity, and light intensity sensors together reducing disconnection among them into one platform. The machine divides it into the smart system that uses up-to-date algorithms to help in all data from the sensors and generate the overall views of the greenhouse environment. The software component includes custom programming that utilizes the fusion of data and creating visualizations so that it can provide fields actionable for farmers.

5.3.2 Smart Actuator Control Mechanism

Designed a Smart actuator control system that regulates greenhouse parameters by responding to the local sensors' data in real-time according to the established environmental threshold. This system employs the machine learning approach of analyzing sensor data and the motors, that can operate without human control. The software aspect will entail the creation of various custom control algorithms and user interfaces to facilitate the connection and coordination of greenhouse operations with ease.

5.3.2 Cloud-Based Data Analytics Platform

Enabled a cloud-based data analytics platform which will be a centralized source where data collected from the sensor launches will be merged and analyzed in real-time. This system employs cloud computing resources and machine learning algorithms to help it identify abnormalities, do predictive analysis, and handle the optimization of agriculture practices. The application part includes the coding of the custom data processing pipelines as well as the visualization graphs which will ultimately lead to the distillation of the useful data produced by the collected data.

VI. RESULT

This implementation has had great impacts on the way greenhouses work, especially when compared to traditional ones. Through incorporating a highly advanced sensor fusion system, farmers now benefit from complete data collection, which ultimately enables them to make effective crop management decisions. Using real-time monitoring and analysis, fluctuations in soil moisture levels, temperature, and light intensity are accurately measured and adjusted when necessary, resulting in enhanced growing conditions and well-developed crops. Moreover, adopting a smart actuator control mechanism as a strategy for operations has automated processes that have eliminated manual work and made operations efficient. Such innovations mark important progress in modernizing agricultural practices that will be a success story of sustainable crop cultivation and higher yield potential.

VII. FUTURE SCOPE

The initiative paves the way for new avenues of research and application of smart greenhouse technology. In the future, the researchers and the practitioners concentrate on a number of the most important areas to improve the effectiveness and scalability of the system.

7.1 Blockchain-Based Data Security Framework*:*

Combine the use of blockchain technology in data security with a trusted framework to guarantee the reliability and confidentiality of greenhouse sensor data. It is based on distributed ledger technology which creates an indisputable record of collected sensor data and serves the purpose of tracing the data flow across the whole chain of data processes. Smart contracts and cryptographic protocols are to be designed which will help in executing smart contracts as well as in maintaining secure data storage and access control on blockchain networks.

7.2 RFID:

RFID technology makes gateways for the development of the smart greenhouse system. Researchers can achieve more accurate tracking and monitoring of plant growth phases, conditions, and resource usage by deploying RFID tags into plant containers or individual plants and thus empowered. It, in this way, enables data-driven decision-making that enables farmers to carry out pinpoint interventions and maximize crop productivity. In addition, the read-only memory (RFID) technology can automate inventory tracking, reduce wastage, and generally enhance overall operational efficiency. Aside from helping in cultivation, the agricultural RFID-enabled smart greenhouse systems offer additional possibilities of integration with bigger agricultural networks besides fostering data-driven insights for sustainable food production.

REFERENCES

[1] Bseiso, B. Abele, S. Ferguson, P. Lusch, and K. Mehta, "A decision support tool for greenhouse farmers in low-resource settings," in Global Humanitarian Technology Conference (GHTC), 2015 IEEE, Oct 2015,pp. 292–297.

[2] K. A. Czyzyk, S. T. Bement, W. F. Dawson, and K. Mehta, "Quantifying water savings with greenhouse farming," in Global Humanitarian Technology Conference (GHTC), 2014 IEEE, Oct 2014, pp. 325–332.

[3] Z. Xiaoyan, Z. Xiangyang, D. Chen, C. Zhaohui, S. Shangming, and Z. Zhaohui, "The design and implementation of the greenhouse monitoring system based on gsm and rf technologies," in Computational Problem-solving (ICCP), 2013 International Conference on, Oct 2013,pp. 32–35.

[4] M. Mahdavian, M. B. Poudeh, and N. Wattanapongsakorn, "Green-house lighting optimization for tomato cultivation considering real-time pricing (rtp) of electricity in the smart grid," in Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON), 2013 10th International Conference on, May 2013, pp. 1–6.

[5] D. S. Kim, T. H. Shin, and J. S. Park, "A security framework in rfidmulti-domain system," in Availability, Reliability and Security, 2007.ARES 2007. The Second International Conference on, April 2007, pp.1227–1234.

[6]P. Laiolo, S. Gabellani, L. Pulvirenti, G. Boni, R. Rudari, F. Delogu,F. Silvestro, L. Campo, F. Fascetti, N. Pierdicca, R. Crapolicchio,S. Hasenauer, and S. Puca, "Validation of remote sensing soil moisture products with a distributed continuous hydrological model," in 2014IEEE Geoscience and Remote Sensing Symposium, July 2014, pp. 3319–3322.

[7] V. Sorathia, Z. Laliwala, and S. Chaudhary, "Towards agricultural marketing reforms: Web services orchestration approach," in 2005 IEEE International Conference on Services Computing (SCC'05) Vol-1, vol. 1,July 2005, pp. 260–267 vol.1.

[8] Y. A. Badamasi, "The working principle of an Arduino," in Electronics, Computer, and Computation (ICECCO), 2014 11th International Conference on, Sept 2014, pp. 1–4.

[9] A. Carullo, F. Ferraris, and M. Parvis, "A low-cost contactless distance meter for automotive applications," in Instrumentation and Measurement Technology Conference, 1996. IMTC-96. Conference Proceedings. Quality Measurements: The Indispensable Bridge between Theory and Reality., IEEE, vol. 1, 1996, pp. 84–89 vol.1.

[10] N. Datta, M. N. Ahmed, R. Liya, N. Zaman, and B. B. Pathik,"Efficiency improvement of a solar power plant using combine cycle: An experimental study on a miniaturized solar power station," information Technology and Electrical Engineering (ICITEE), 2014 6thInternational Conference on, Oct 2014, pp. 1–5.