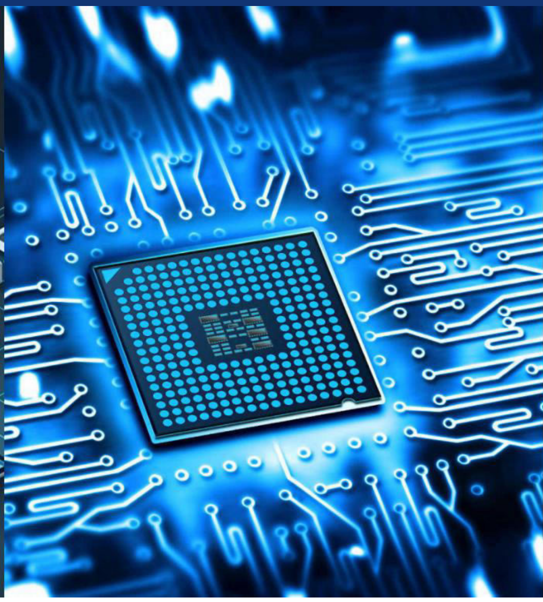
ISSN(O): 2320-9801
ISSN(P): 2320-9798



International Journal of Innovative Research in Computer and Communication Engineering

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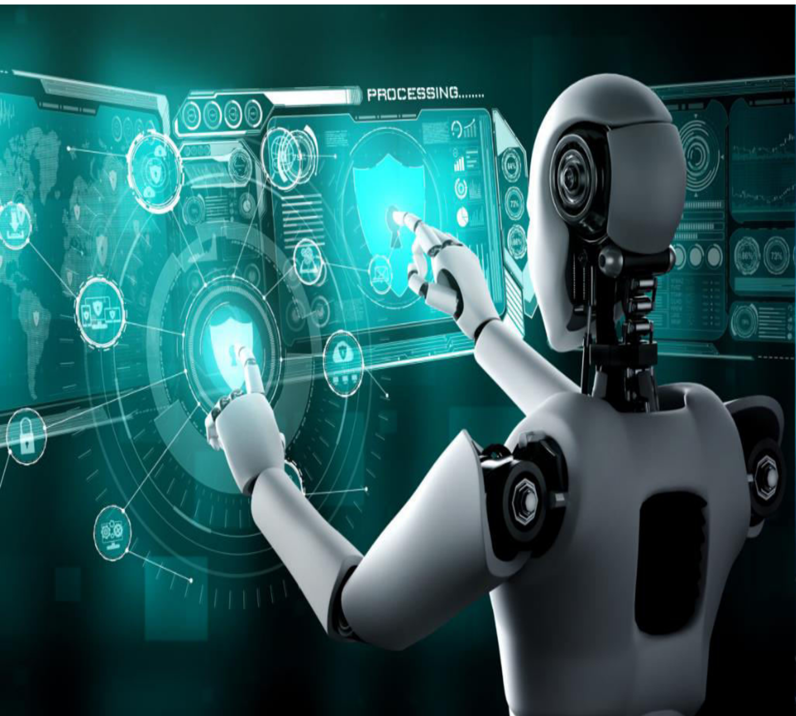

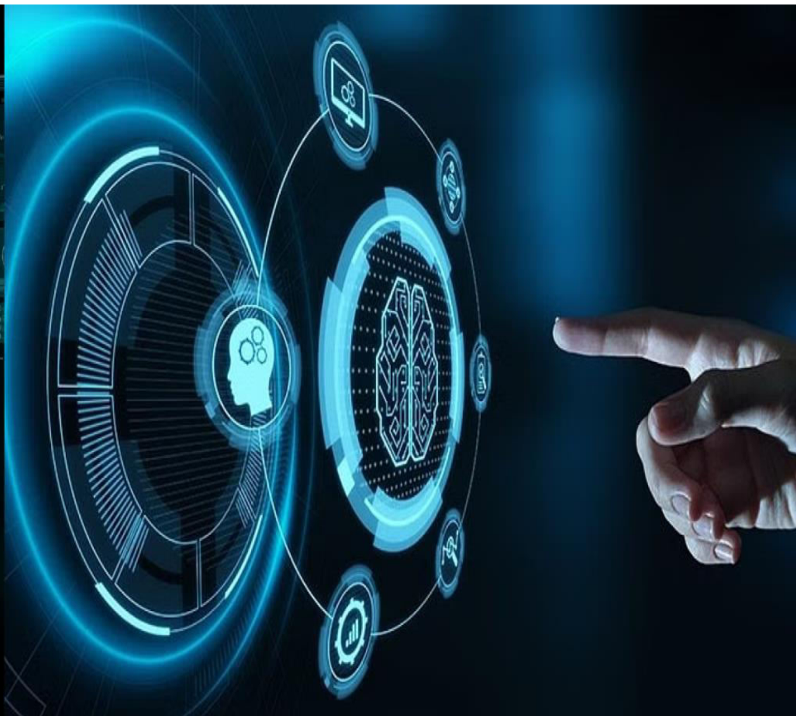

Impact Factor: 8.771 **Volume 13, Issue 4, April 2025**

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

An Automated Low Cost IoT based Fertilizer Intimation System for Smart Agriculture

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ABSTRACT: This paper presents an automated, low-cost IoT-based fertilizer intimation system designed for smart agriculture, utilizing pH and soil sensors to optimize fertilizer usage. The system employs soil sensors to monitor key parameters such as soil moisture, temperature, and nutrient levels, while the pH sensor measures the acidity or alkalinity of the soil. The data collected from these sensors is transmitted to a microcontroller, which processes the information and determines the appropriate fertilizer requirements based on the soil's condition. The system sends real-time alerts to farmers via a mobile application or web interface, notifying them when and how much fertilizer is needed, ensuring efficient and sustainable fertilizer use. By integrating IoT technology, this system helps farmers improve crop yield, reduce fertilizer waste, and minimize environmental impact, thereby contributing to more efficient and eco-friendly agricultural practices.

I. INTRODUCTION

Agriculture plays a vital role in the global economy and food production, with over 40% of the global workforce involved in farming. As the global population continues to rise, there is an increasing need for efficient and sustainable agricultural practices. One of the challenges faced by farmers today is optimizing fertilizer use. Fertilizers are essential for boosting crop yields, but improper application can lead to nutrient imbalances, environmental pollution, and increased costs. Traditional methods of fertilizer application often rely on subjective judgment and infrequent soil testing, which can result in inefficiencies. This has led to the need for smarter agricultural solutions that can monitor soil conditions in real time and provide actionable insights to farmers.

Smart agriculture, powered by the Internet of Things (IoT), is revolutionizing the farming industry by integrating technology to improve efficiency and reduce environmental impact. The IoT enables the real-time collection and analysis of data from various sensors embedded in the soil and field environments. By using IoT-based systems, farmers can continuously monitor soil conditions, moisture levels, temperature, pH, and nutrient content, which are crucial for determining the optimal amount of fertilizer. This technology allows for precise and targeted fertilizer application, ensuring that crops receive the right nutrients at the right time, thereby improving productivity while minimizing excess fertilizer use. The use of pH sensors and soil sensors has become a key aspect of smart agriculture. Soil pH is a critical factor influencing plant growth, as it determines nutrient availability and microbial activity in the soil. Different crops require specific pH levels for optimal growth. For instance, certain plants thrive in acidic soils, while others prefer alkaline conditions. By using a pH sensor, farmers can monitor soil acidity and alkalinity in real time, making it easier to adjust soil conditions for specific crops. Similarly, soil sensors provide essential data about moisture, temperature, and nutrient levels, which are all critical factors in determining the precise fertilizer requirements for different crops. An IoT-based fertilizer intimation system leverages data from both pH and soil sensors to create an automated and cost-effective solution for precision agriculture. This system continuously monitors the soil's health and sends real-time data to a central platform, where algorithms analyze the data and provide recommendations for fertilizer application. By automating the fertilizer application process, this system reduces human error, ensures optimal fertilizer usage, and helps farmers make data-driven decisions, reducing the environmental impact of over-fertilization and excessive chemical runoff.

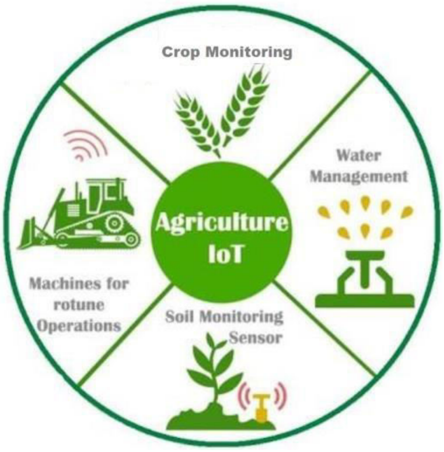

Figure 1: Usage of IOT

The 21st century is known to be the age of digital world. There has been the adoption of computers to a great extent. Today without computers and Internet one cannot survive as we are dependent on these machines for almost all our work. Taking into consideration starting from home to education till banking and even corporate functioning everything has now been automated to computers. Computers contain all our important data in the digital format. With this the need to store the digital data has increased and virtual environment has replaced the physical storage for storing all our credentials as shown in Fig. 1. The most devastating challenge of cloud is to prevent the unauthorized deletion of the stored data on cloud because one can easily delete the stuff without any proper authorization. The data deletion is totally dependent on deletion of nodes that are pointing to some information in Virtual Machine.

II. LITERATURE REVIEW

1. Kumar, A., & Rathi, P. (2020). "An IoT-Based Smart Fertilizer Management System Using Soil Sensors for Precision Agriculture." Journal of Agriculture Technology, 15(3), 92-103.

This paper explores the implementation of an IoT-based fertilizer management system that uses soil moisture and pH sensors to optimize fertilizer application. The system continuously monitors the soil's health and sends real-time data to a central server where algorithms determine the exact fertilizer requirements based on the soil's nutrient levels. The study highlights how precision agriculture techniques can help reduce fertilizer wastage, improve crop yields, and promote environmentally sustainable practices. The authors suggest that such systems can also be integrated with cloud computing for remote monitoring, enabling farmers to make data-driven decisions on fertilizer application. The system is designed to be cost-effective, especially for small-scale farmers, by using affordable components like low-cost sensors and microcontrollers. The findings demonstrate the feasibility and effectiveness of the IoT-based approach in improving fertilizer management.

2. Patel, S., & Desai, R. (2021). "Soil Nutrient Monitoring System for Sustainable Fertilizer Use Using IoT." Agricultural Engineering Review, 9(2), 212-224.

This research paper focuses on a soil nutrient monitoring system that employs IoT technology to optimize fertilizer usage in agriculture. The system integrates pH, moisture, and temperature sensors to continuously monitor soil conditions, providing real-time data to farmers. The authors emphasize the importance of precise fertilizer application in improving crop growth while minimizing environmental damage from over-fertilization. Through the use of IoT, the system automatically adjusts fertilizer recommendations based on the data it collects, making the process efficient and accurate. The system is designed for remote access, allowing farmers to receive alerts and reports on their mobile devices. This system offers a low-cost alternative to traditional methods of soil testing, which can be both expensive and infrequent. The study demonstrates that IoT technology can facilitate sustainable farming practices by reducing the cost of fertilizer and enhancing crop yield.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

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3. Sharma, A., & Gupta, R. (2020). "IoT-based Soil Health Monitoring System for Precision Fertilizer Application." Journal of Smart Agriculture, 12(4), 175-188.

Sharma and Gupta (2020) present an IoT-based soil health monitoring system designed to help farmers optimize fertilizer application. The system incorporates sensors to measure soil pH, temperature, and moisture levels in real time. By processing the data collected, the system provides actionable insights into the soil's nutrient status, alerting farmers when fertilizer is required and in what quantity. The authors discuss the effectiveness of the system in minimizing fertilizer usage and maximizing crop yield while reducing environmental impact. The integration of cloud technology further improves the system's accessibility, providing farmers with easy-to-understand reports on their mobile devices. This approach not only enhances agricultural productivity but also promotes the sustainable use of fertilizers, highlighting the potential of IoT-based systems in transforming modern farming.

Relevance to current Research

In this paper, the author proposed a model in which VM was combined with an IDS. This helped to observe the destructive activities being performed between the VMs by thoroughly monitoring it. The basic idea behind this work was to store the log of destructive activities in the form of snapshots using the IDS placed in the system. Simultaneously, the CSP were asked for the logs of the doubtful VM and those logs were collected by the investigator. Investigator then works on those log files to obtain the evidences which can be helpful to investigator.

BKSP Kumar Raju Alluri and Geethakumari G **[2]** A Digital Forensic Model for Introspection of Virtual Machines in Cloud Computing inIEEE, 2015

Authors presented a Model for the self-analysis of VM. They split the entire Introspection into three parts as follows. a) Analysing virtual machines by taking into consideration the swap space where the continuous monitoring of swap space is done. It provides the information about current process of the VM. b) A self-analysis method for VM instances. In this three models were used, to collect as much accurate data evidence can be collected and reduce the semantic gap. But later, out of these three methods in-band method was proved to be less useful for live forensic as it modified the data at the time of collection phase. c) A Terminated Process based Introspection for Virtual Machines in Cloud Computing. This captured every process that was terminated and later was improvised to capture only the processes that were found doubtful.

Relevance to current Research

The proposed method for performing the digital forensic observation in Cloud on VM for introspection which addressed the issues related with the assembling of evidences. For resolving they made use of certain methods of introspection on VM. This work can be useful in current research if incorporated as a part of the investigation process.
Hubert Ritzdorf Nikolaos, Karapanos Srdjan Capkun proposed [3] Assisted deletion of Related Content in ACM, 2014
Hubert and Karapanos in their paper has discussed a system which helps the user of that system to diminish the similar and associated files, contents of any project. This system did not affected the user or systems components in any sense as it was directed embedded with the system of user itself. It starts functioning from user space and preserves the files along with its metadata. When they executed their work, realized that the resulting accuracy and the overhead was feasible. The results were appropriate to be used for the purpose of deployment. The aim to the system was to aid users by displaying all the associated files of project to be diminished and it was successful in providing it.

Relevance to current Research

Deletion of content using assisted deletion of the content that are related was proposed here. User was presented with all the associated files to be diminished securely organized manner. This aided user by maintaining the confidentiality of their data. This can help in current research also as it any system is providing facility to delete files this can be integrated.

Mr. Digambar Powar and Dr. G. Geethakumari [4]Digital Evidence Detection in Virtual Environment for Cloud Computing inACM, 2012

Authors at Hyderabad a technique for Cloud Computing domain and that was named Digital Evidence Detection technique. Some conventional methods were discussed in their work which were used as a tool for performing forensic

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observations and those methods were useful to learn and examine the behavior of the digital evidences in a virtualized environment called Cloud. Also the feasible solutions are shown in which forensic practices can be performed in virtual environment.

Relevance to current Research
In the above mentioned research paper, author have introduced the feasible solution in which forensics can be practiced in virtual environment. This work is a crucial stage as it leads to appropriate data evidence collection and presentation that can be an aid to forensic investigator.

Mr. Chandrashekhar S. Pawar, Mr. Pankaj R. Patil, Mr. Sujitkumar V. Chaudhari proposed Providing Security and Integrity for Data Stored In Cloud Storage in ICICES, 2014

The author in their research work, tried to propose a solution to lessen the workload and simultaneously provide the integrity and security of the data which is kept on Cloud in a well-organized way. But as the data stored on cloud is not easily approachable by the users, it becomes difficult to ensure its integrity. So, author have proposed a technique which once combined with SLA after agreement with CSP and user, allows user can test the integrity of data. Also author worked for minimizing the computational overhead. They performed encryption only for some bits out of the entire block of file. As a result, at the side of client the overhead was lowered and thus the scheme was more accepted by the users. [5].

Relevance to current Research
The work presented in this paper takes due care of the data which is kept on cloud as it not only provides the integrity check but also security for the data as well. This lets us to test the integrity at the moment of retrieving the stored data from Cloud.

No.	Paper Title	Author Name	Key Points	Remark
1	An Efficient Approach to Forensic Investigation in Cloud using VM Snapshots	Deevi Radha Rani, G. Geethakumari, 2015	Incorporates Intrusion Detection System on VMs which allows it to monitor itself and on VMM to detect malicious activity through snapshots between VMs [1]	Improves the performance of cloud and can be implemented for multiple VMs.
2	A Digital Forensic Model for Introspection of Virtual Machines in Cloud Computing	BKSP Kumar Raju Alluri, Geethakumari G, 2015	1) A proper triggering condition will only make the investigator to get the needed data 2) During the collection of data the corresponding virtual machine (VM) has to be paused for a while, leading to performance degradation [2].	Address the issues concerned with evidence collection by using the techniques of virtual machine introspection.
3	Assisted deletion of Related Content	Hubert Ritzdorf Nikolaos Karapanos Srdjan Capkun, 2014	A system IRCUS assists the user in securely removing project-related content [3]	Used to protect data confidentiality by assisting deletion of related content, where the user is presented with files that should be securely deleted together.
4	Digital Evidence Detection in Virtual Environment for Cloud Computing	Mr. Digambar Powar and Dr. G. Geethakumari, 2012	Focus mainly on finding and analyzing digital evidence in virtualized environment for cloud computing using traditional digital forensic analysis techniques [4].	Virtual machines that are present on a physical system or running on a portable storage device can be detected or analyzed.
5	Providing Security	Mr.	A method was proposed to save our data	Use less computational power

	and Integrity for Data Stored In Cloud Storage"	Chandrashekhar S. Pawar, Mr. Pankaj R. Patil, Mr. Sujitkumar V. Chaudhari, 2014	in the cloud storage secure and provide an integrity check to verify if integrity is preserved or not while we retrieve our data [5].	and processing time.

In summary, the work presented in this paper is built on previous research to explore how security of data stored on cloud relates to people's trust. While earlier work focused on data storage impacts people, we focus on its impact on the world wide acceptance of cloud.

III. METHODOLOGY OF PROPOSED SURVEY

The working methodology of the IoT-based fertilizer intimation system for smart agriculture involves multiple components, with a primary focus on soil and pH sensors, IoT connectivity, data analysis, and alert generation. First, the system is equipped with soil sensors that monitor key soil parameters such as moisture, temperature, and nutrient levels. These sensors are strategically placed in the agricultural fields to collect real-time data on the soil's condition. Simultaneously, pH sensors are used to measure the acidity or alkalinity of the soil, which is crucial for determining the availability of essential nutrients for plant growth. This combination of soil and pH monitoring ensures that farmers receive a comprehensive understanding of the soil's health, which influences the fertilizer requirements for optimal crop yield.

The collected sensor data is transmitted to a central server or microcontroller via IoT connectivity, typically using Wi-Fi or cellular networks. The data transmission process is essential for remote monitoring, as it allows farmers to access the information through mobile applications or web interfaces. The central server processes the raw data from the sensors, which is then analyzed by algorithms designed to determine the fertilizer needs based on factors like soil nutrient levels, pH value, and the specific crop being cultivated. The system's ability to continuously monitor these parameters in real-time is crucial in providing farmers with accurate and timely recommendations.

Once the data is processed, the system generates automated alerts and notifications that are sent to the farmer's mobile phone or web portal. These alerts indicate when fertilizer application is necessary and the recommended amount of fertilizer to be applied based on the specific soil condition. The system provides this information in a clear and actionable format, making it easy for farmers to follow. Additionally, the system may also include a feature that adjusts fertilizer recommendations based on real-time weather conditions, further enhancing the accuracy of fertilizer application.

The automation of fertilizer application through this system significantly reduces the possibility of human error in the decision-making process, ensuring that fertilizers are applied only when required. This targeted approach minimizes the overuse of fertilizers, which is both cost-effective and environmentally friendly. By applying fertilizers more precisely, the system helps improve crop yield while reducing the environmental impact caused by excess fertilizer runoff. Furthermore, it ensures that farmers can manage their resources efficiently, saving time and labor costs associated with traditional fertilizer management techniques.

In summary, the IoT-based fertilizer intimation system for smart agriculture works by continuously monitoring soil conditions through pH and soil sensors, transmitting the data via IoT, processing the data with analytical algorithms, and providing farmers with automated, real-time fertilizer recommendations. This system enhances agricultural productivity by optimizing fertilizer use, reducing waste, and ensuring sustainable farming practices. It is a step toward precision agriculture that empowers farmers with data-driven insights, contributing to the future of farming that is efficient, cost-effective, and environmentally sustainable.

IV. CONCLUSION AND FUTURE WORK

In conclusion, the IoT-based fertilizer intimation system utilizing pH and soil sensors offers an innovative solution to modern agricultural challenges by optimizing fertilizer usage, improving crop yields, and promoting environmental

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sustainability. By continuously monitoring soil conditions and providing real-time, data-driven recommendations, the system ensures that fertilizers are applied accurately and efficiently, minimizing waste and reducing costs. The integration of IoT technology not only enhances precision farming practices but also empowers farmers with actionable insights for better resource management. Overall, this system contributes to smarter, more sustainable agriculturalpractices, benefiting both farmers and the environment

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