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Proceeding Paper

Internet of Things for Smart Farming: Measuring Productivity and Effectiveness †

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Abstract: The Internet of Things (IoT) has been developed using the current internet architecture. The IoT concept aims to increase productivity, accuracy, and financial gains. The purpose of this study is to evaluate how well the agricultural sector is using the Internet of Things (IOT). In this study, descriptive analysis approaches are used with qualitative methods. Reviews of the literature from numerous credible national and international periodicals are used in the data collection process. This study found that it is now possible to remotely monitor agricultural development, soil moisture, and crop risk thanks to the growth of the Internet of Things and the digital transformation of rural areas. The efficiency of agriculture and farming processes can be increased by automating human intervention, especially when using the Internet of Things.

Keywords: Internet of Things; effectiveness; agricultural sector

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1. Introduction

The system of interconnected computers, people with unique IDs, other objects with ability to interact over an internet lacking human touch is called as the Internet of Things (IoT). The Internet of Things (IoT) aims at integrating the physical and digital worlds through communication and data exchange over the internet. Linked sectors, smart towns, smart houses, and smart energy. Therefore, energy linked autos, smart farming, linked architecture and buildings, hospitals, and transport are a few instances of uses for IoT [1]. In the current world, technological breakthroughs have altered nearly every industry, but especially agriculture. Similarly, the relatively risk-averse agriculture industry [2], using sensor and internet of things (IoT) innovations, smart agriculture [3]. It is profitable, improves ecology on the land, protects water supplies, slows down the decomposition of the soil, and ensures a healthy and diverse habitat [4]. Also, all field of agriculture has distinct critical characteristics to be individually assessed in respect to quantity and quality with regard to a certain crop, such as the type of soil, drainage flow, accessibility of nutrients, and insect susceptibility. Farming optimization in the same location requires geographic variations, rotating crops, and a yearly growth development period [5]. In accordance with estimators made by the United Nations, the global population will exceed 9.8 billion people by 2050 and 11.2 billion people after 70 to 80 years [6]. The majority of the effects of population expansion are also expected to have been felt by the estimated rise in world population to over 2 billion [7]. Among the more significant industries in the economy is agriculture, which also contributes significantly to the nation's financial development. In order to meet demand, the Food and Agriculture Organization (FAO) of the United Nations thinks that world food output must reach 70% by 2050 [8].

Smart farming, sometimes referred to as smart agriculture, is a farming technique that employs sustainable techniques to fulfill the rising food demands of the population while avoiding adverse impacts. The whole world has accepted it and is behind it. This strategy's primary concept is to reduce costs across the board for all operations related to the agriculture sector while efficiently utilizing the resources available for sustainable production [9].For the rise in production to occur, cultivation techniques must be improved, and various technologies must be adaptable to deliver vital information about the agricultural fields so that necessary measures may be taken. Smart farming or precision farming is the use of cutting-edge technologies in the fields to achieve an optimum irrigation operation [10,11]. Sowing through crop harvest, storage, and transportation all involve the use of sophisticated machinery and tools in modern agriculture. The system is intelligent and cost-effective due to its accurate tracking capacity and timely analysis utilizing a range of sensors. There are now automated drones, cultivators, tractors, satellites, and robots in besides conventional agricultural technology. Sensors may begin collecting data right away after installation, which is then available for online analysis right away. Accurate data gathering at each place is made possible by electronic sensors, allowing site- and crop-specific farming [12]. The agricultural crop production industry has access to effective solutions to support farmers and researchers thanks to the internet of things. Additionally, it facilitates decision-making by providing numerous data on soil [13], water [14], pesticides [15], fertilizers [16], and manures [17].easily accessible. Precision farming has the potential to further mitigate the consequences of global warming by addressing runoff problems, pollutants, and the use of less pesticides and fertilizers on agricultural products [18,19].

Internet of things may be utilized to control agricultural sensors and connect them to cloud infrastructure, for example, to enable the deployment of precision agriculture [20]. Some of the farming uses for IoT include managing farms, animal monitoring, water control, greenhouse control, drones, and automated farm machinery. All of these contribute to agrarian automation. They also requires an aid to the farming food industry's durability. To meet these demands, agricultural output forecast, crop protection, and land assessment are crucial for global food production [21].

2. Materials and Method

The architecture of our suggested IoT-based smart farming monitoring system (SFMS) for crop farming is covered in this section. The Internet of Things, cloud computing power, and the advancement of mobile and communication technologies may lead to the creation of low-cost smart agricultural applications and solutions. The design of our suggested SFMS system comprises sensors that collect data regarding air humidity, light intensity and temperature. Through a gateway, sending the unprocessed data to a cloud platform so they may be analyzed. After that, the farmer receives notification via email, Short Messaging Service (SMS), or mobile app to take any necessary precautions. The three levels generic architecture of the Internet of Things are the Layers of perception, network, and application, as illustrated in Figure 1 [22]. At the perception layer, often referred to as the "sensing layer", Events in the actual world are acquired via a variety of sensors, etc. The network layer uses gateways, routing and switching functions, Wi-Fi and Bluetooth, and other technologies to route data across the Internet. The application layer communicates with the user directly. Using the services that they have identified, each of these tiers carries out certain duties and activities [23].

Traditional farming uses very little, if any, technology and is solely dependent on the expertise of the farmers. Information on environmental factors and their influence on crop growth, health, and productivity is lacking, as is data analysis and prediction systems. Our goal is to close the technology gap and use contemporary technical solutions for improved crop production and cultivation, as well as for the mitigation of crop-related issues. IoT-based farming has the potential to overcome the drawbacks of traditional farming. IoT-based solutions have the potential to improve crop quantity and quality, increase productivity, and manage diseases.

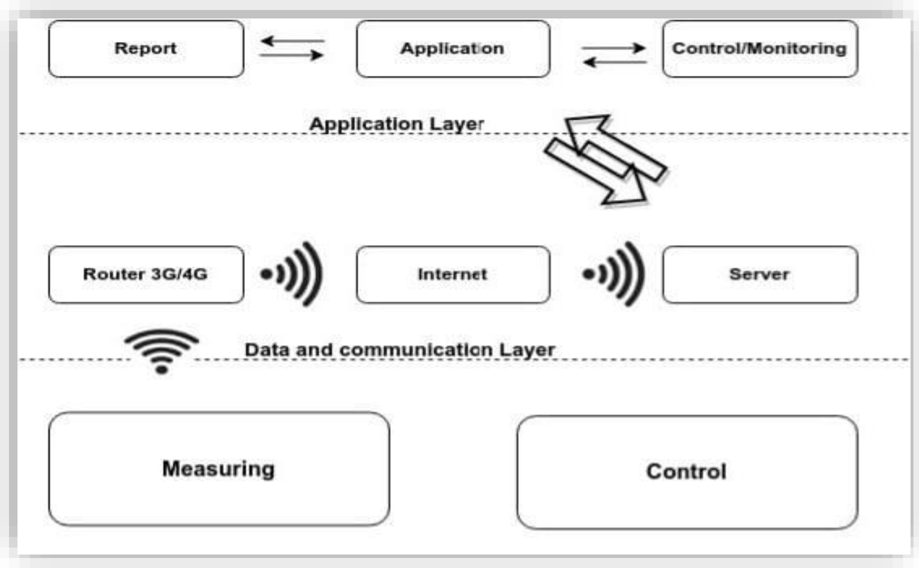

Figure 1. Three layer of Internet of things.

3. Results

Adopting innovative techniques based on sensor and IoT technology increased crop output more than using traditional agricultural practices. The improvement of produce quality and output is greatly helped by the regulated use of novel, cutting-edge sensor-based technologies. One of the first smart farming techniques, cultivation of plants in a regulated setting became popular the nineteenth century. In nations that experienced extreme weather, these practices intensified over the 20th century. Indoor agriculture produces crops that are less impacted by the environment. As a consequence, crops that were previously produced under ideal conditions are now cultivated anytime, anyplace, thanks to the usage of sensors and communication tools. Crop production under regulated conditions depends on a number of variables, including shed constructions and wind-effects-controlling materials, aeration systems, the precision of monitoring parameters, decision-support systems, etc. The exact monitoring of environmental factors is one of the biggest obstacles in greenhouses; as a result, it takes a number of measuring units to forecast the many parameters needed to regulating and maintaining the regional weather. Sensors are utilized in a greenhouse powered by IoT to detect and keep track of interior characteristics including humidity, temperature, light, and pressure. In addition to shielding plants from hail, winds, UV radiation, bug and pest assaults, the smart greenhouse has assisted farmers in automating field labor without manual inspection. Utilizing lighting, temperature, and air humidity sensors, hibiscus plants are cultivated with the necessary wavelength at night. Research found that the need for water was reduced by 70–79%, and the IoT makes it feasible for farmers to communicate directly with consumers to increase farming's efficiency and profitability. For researchers and designers, creating viable precision farming systems for smallholder farmers still poses testing and design challenges. The use of GPS and position information to direct machinery to specified locations within the farm, increasing agricultural production in comparison to human-driven equipment, is another advantage of data analytics in smart agriculture. Time, gasoline, and operating costs will all be saved as a result of this.

Using IoT	Agriculture Application	advantages for agriculture
WSNs: Sensor nodes capable of radio communication	sensors collaborating to monitor various physical characteristics	data from sensors can be easily managed and collected
Internet-based computing known as "cloud computing" or "on-demand computing"	access to a pool of computer resources and data on demand for PCs and other devices	Maps of agricultural fields and cloud storage are two examples of data produced using cloud computing services that are simple to maintain and gather.
Massive Data Analysis: The study and analysis of enormous data sets	a variety of data types are accessible	Learn about market trends, customer preferences, and other crucial information.
A computer system called an embedded system comprises of both hardware and software	The system performs certain tasks, such as efficiently coordinating various processes and keeping tabs on and controlling them.	Production costs might be drastically reduced, increasing profitability and sustainability.
IoT systems rely on communication protocols to allow connectivity	Several different types of data sharing are made possible by these protocols for data transfer via the network.	Simple management of enormous volumes of data gathered from sensors and cloud computing, cloud storage, etc..

Figure 2. IoT use in agricultural improvement.

Table 1 below displays digital values associated with the graphical outputs of all sensors. Ubidots internet server is used to aid execute monitoring and numerous captures of experimental data. As previously stated, sensor data is saved on a cloud server and updated every five seconds. The table below displays only 11 random experimental values. To demonstrate the operation of the suggested system in various environmental settings, these values are included as an example.

Table 1. Sensor-Based Assessment and Tracking Benefits of Intelligent Agriculture.

Sr. No	Temperature (F)	Humidity (%)	Heart Index	Flame Detection	Soil (%)	Pres (Hg)
1	75.10	52	23.83	Peace	85	35.81
2	75.10	53	23.81	Peace	85	32
3	75.10	53	23.83	Peace	85	35.81
4	75.10	52	23.83	Peace	85	34.6
5	75.10	53	23.83	Peace	85	39.8
6	75.10	53	24.06	Peace	85	31
7	75.10	62	24.50	Peace	76	35.81
8	75.10	78	24.87	Fire-367	72	33
9	75.10	92	24.93	Fire-382	72	35.81
10	75.10	94	26.02	Fire-377	82	35.40
11	76	94	26.02	Fire-372	76	35.81

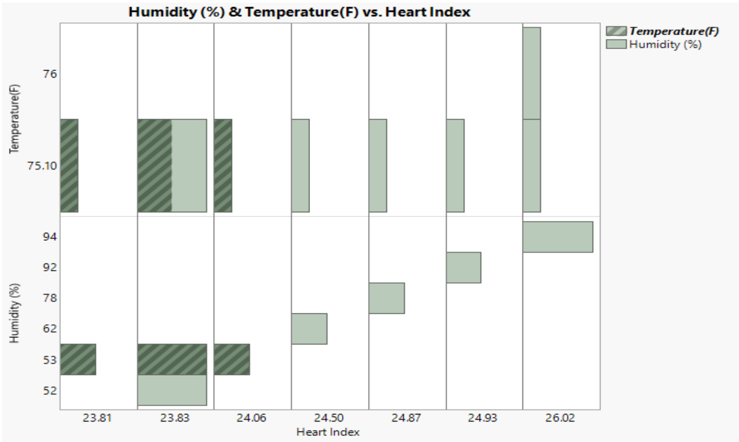

Figure 3. Temperature and humidity by Heart Index.

Industrial agricultural farming techniques degrade soil quality more quickly than nature can rebuild it. Arable land has decreased due to the alarming pace of erosion and agricultural use of fresh water, adding to the strain on existing water troughs. With vertical farming (VF), it is possible maintaining the plants in a highly controlled environment, considerably lessening the use of resources while simultaneously boosting output at various periods; based on the quantity of stacks, just a percentage of the ground surface is required. When compared to conventional farming, additionally VF is quite good at raising yields and decreasing usage of water. The goal of IoT-based phenotyping is to assess the crop and associated traits and provide resources for crop breeding and digital agriculture. The links between genotypes, phenotypes, and their growth conditions are determined by the trait analysis methods and modeling tools.

4. Discussion

The IoT has lately had a significant impact on the agriculture business, with a wide variety of sensors being used for various smart agricultural aims. IoT applications are linking a growing number of networked devices, including various sensors, drivers, and intelligent objects, to mobile devices over the internet on an annual basis. As consequence of the extensive use of wireless remote data collecting, IoT services include information exchange and smart controlling and making decisions solutions. These skills may support the smart agriculture sector by facilitating productive output. Developing modernized farming while researching the IoT area of interest in the agricultural sector is the conventional approach to agriculture. IoT growth has greatly benefited all industries during the past 10 years [**Error! Reference source not found.**]. IoT has a tendency to be a vital technology in integrating different approaches to offer clever remedies for all the recognized issues. It facilitates easy communication between people and things. IoT has helped to solve issues in many other industries, but it is especially important in the agriculture sector [**Error! Reference source not found.**]. By installing connected sensors across the farm, which provide immediate data, farmers can make decisions and execute action to boost crop yields. All information of cultivation and wireless sensor networks (WSNs) with GPS capabilities are constantly updating topographic information. Recent advancements in computerized visuals and Data processing has expanded WSN's capabilities and made it possible to evaluate crop quality and health precisely.

5. Conclusions

The development of IoT technology in recent years has largely helped the farming sector, especially because of its connecting infrastructure. Included in this are the networking of remote data collecting, smart objects and the use of vehicles and sensors accessible through mobile devices and the internet, sophisticated analysis and decision-making performed in the cloud, and the automation of agricultural processes. Farmers will get insight into how to conduct precise and useful agriculture to resolve field concerns through the use of remote sensors, such as those for temperature, humidity, soil moisture, water level sensors, and pH value. By developing efficient tactics, this development can enable agricultural management systems to manage farm data in an organized manner and expand the agribusiness.

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