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An IoT Solution for Smart Farming

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ABSTRACT

Agriculture is crucial to the agricultural country's development. In India, farming employs over 70% of the population and accounts for one-third of the country's GDP. Agriculture has always been a huge obstacle to the country's progress. Smart agriculture, which involves upgrading present agricultural processes, is the only solution to this challenge. In today's world, technology has advanced significantly, and various instruments and techniques are accessible in the agricultural industry. There is a need to shift towards new technology known as the Internet of Things in order to enhance efficiency, productivity, global market, and reduce human intervention, time, and cost. Connected gadgets have proven valuable in all aspects of our lives, from health and fitness to home automation, automotive and logistics, and smart cities and businesses, thanks to the expanding use of the Internet of Things (IoT). As a result, it's clear that IoT, linked devices, and automation will find use in agriculture and, as a result, will vastly improve many aspects of the industry. Agricultural methods in the previous few decades, agriculture has undergone numerous technical changes, growing increasingly sophisticated, technology-driven and industrialized. This paper presents a review on the need and major applications and current and future trends of IoT in agriculture.

KEYWORDS: IoT, Smart Agriculture, Automation, Applications.

1. INTRODUCTION

To sustain the world's population, modern agriculture and civilization require increased food production. In the agricultural area, new technologies and solutions are being used to give an optimal alternative for gathering and processing information while increasing net productivity. According to the United Nations Food and Agriculture Organization, the world would need to produce 70% more food in 2050 than it did in 2006 in order to feed the planet's rising population. Farmers and agricultural businesses are turning to the Internet of Things for analytics and increased production capacities in order to meet this demand.

Agriculture is without a doubt India's most important process provider. Given the immensity of the agriculture sector, it needs scientific and precise solutions with the goal of long-term sustainability and minimal environmental impact. According to statistics and research studies, the population of India, as well as the rest of the world, will expand dramatically. This presents the issue of how to feed this growing population. Increased crop yield quantity and quality are required for this. This requirement can be met by employing efficient and intelligent technologies in agricultural processes. Agriculture equipment is currently supplemented by a variety of autonomous tractors, harvesters, and unmanned aerial vehicles (UAVs). Sensors can be used to gather and analyze data. The Internet of Things (IoT) has recently emerged as a promising technology in a variety of sectors and industries, providing a means to improve a user's perception and abilities by altering the work environment.

There have been four distinct revolutions in agricultural development: 1) the age of traditional agriculture, which was characterized by human and animal power, 2) the age of mechanized agriculture, which was characterized by rumbling sounds, 3) the age of automated agriculture, which was characterized by high-speed development, and 4) the age of smart agriculture, which was characterized by emerging technologies. As a result, smart farming provides a technologically-assisted path to sustainability. The applications of IoT in agriculture attempts to equip farmers with the right tools to help them make better decisions and automate their processes by providing goods, knowledge, and services that improve productivity, quality, and profit.

Because of the integration of different technologies, real-time analytics, machine learning commodity sensors, and embedded systems, the Internet of Things has evolved. Embedded systems, wireless sensor networks, control systems, automation and other traditional sectors all contribute to the IoT's success. This technology is most commonly linked with products related to the concept of the "smart home," which includes equipment and appliances that support one or more common ecosystems and may be controlled by devices associated with that ecosystem, such as smart phones and smart speakers.

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, the introduction of the paper is provided along with the structure, important terms, objectives and overall description. In Section 2 we discuss related work. In Section 3 we discuss about the concept of internet of things in agriculture. Section 4 tells us about the methodology and the major applications. Section 5 tells us about the future scope and concludes the paper with acknowledgement and references.

OBJECTIVES

Agriculture is extremely important to India's economy. Agriculture is the primary source of income for more than 58 percent of rural households. Agricultural exports account for 10% of the country's total exports. So, if there are no suitable yields owing to a lack of awareness of the soil nature or timely unavailability of water, the farmer's and even the nation's economy will be wrecked. As a result, the government should take steps to improve irrigation and make it more viable. It is a smart farming system based on IOT (Internet of Things) technology, which has revolutionised every aspect of the average person's life by making everything smart and intelligent.

The aim of this project is to assist farmers in getting live data like soil moisture, water level which helps them to increase overall yield and quality of products.

2. RELATED WORK

The research review focuses on building devices and solutions that exploit the advantages of a wireless sensor network technique to manage, display, and alert users. Its goal is to use automation and IoT technology to make agriculture smart and modern. It provides a low-cost and effective wireless sensor network technology for acquiring soil moisture and temperature from numerous farm locations and deciding whether or not to permit irrigation based on the needs of the crop controller. It provides a concept for how an automated irrigation system was created to maximize the use of water for agricultural crops. A gateway unit also manages sensor data, and the atmospheric conditions are monitored and managed online via Ethernet IEEE 802.3. It's made for an IoT-based monitoring system to analyze the crop environment and a strategy to increase decision-making efficiency by analyzing harvest statistics. Agricultural applications like seed sowing, sloughing, water irrigation, crop cutting, and other operations were administered using IOT. Various firms in INDIA and around the world have proposed using microcontroller-based controllers for a variety of applications and have developed unique automated systems. (www.smartagriculture.com).

However, in the sphere of agriculture, technology plays an important role in both raising production and lowering manpower. Some of the research efforts are aimed at improving the lives of farmers by providing systems that use technologies to boost agricultural yields. The cloud computing devices combine sensors and tools to form a complete computer system that monitors data from agricultural fields and accurately feeds it into repositories. The current work presents a revolutionary smart farming technique that utilizes wireless communication technology to integrate smart sensors and irrigation systems. It proposes a low-cost, high-efficiency wireless sensor network technology for obtaining soil moisture, humidity, and temperature from multiple fields and as needed. The study also provides a theory on how automated irrigation systems were created to maximize water consumption for agricultural reasons.

3. CONCEPT OF INTERNET OF THINGS IN AGRICULTURE

The use of the Internet of Effects in husbandry is easily the most intelligent way to feed the world's population. But the Internet of Effects (IoT) has much lesser pledge. It's one of the many feasible options for feeding an expanding population. IoT improves crop monitoring and ensures that crops are grown to their full eventuality. The Internet of Effects (IoT) and connected widgets have an unmistakable impact in moment's world. It has now spread to virtually every aspect of life, from the home to the health care assiduity, smart metropolises, fitness, and the artificial sector. Its influence can be observed in nearly every assiduity, and husbandry is no exception. IoT and connected bias have the eventuality to revolutionise husbandry processes, barring the need for nags and bullocks. The Internet of Things (IoT) is becoming increasingly popular as consumer-connected gadgets, although the market is still quite volatile. The use of IoT in farming encourages high output from a lower rate to a higher rate, which is a result of good farming. In the delicate world of technology, about 75% agricultural production maintains accomplishments for farmers' profitability. Integration of Internet of Things technology in agricultural operations reduces the need for manual labour through automation, speeds up machinery commands through remote & real-time monitoring, and allows farmers to use resources more efficiently through preventative maintenance and environmental forecasting. Once these innovations are applied in the agriculture industry, they will almost certainly increase earnings while also allowing farmers to manage additional land. Farmers can have more control over the process of cultivating crops and keeping livestock thanks to smart agricultural technology. This method achieves huge scale efficiency, lowers costs, and aids in the conservation of precious resources such as water. Farmers and growers can minimise waste and boost output in a variety of ways, ranging from the amount of fertiliser used to the number of trips made by farm vehicles. It is critical to choose sensors for an IoT system for farming and agricultural purposes. This is ultimately determined by the type of data you wish to collect and the purpose for which you intend to use it. Ensure that the sensors are of excellent quality, as this is critical to the success of any IoT solution. After all, success is contingent on the precision and reliability of the data gathered.

4. METHODOLOGY

Every aspect of traditional farming processes can be significantly transformed by incorporating the latest sensor and IoT technologies into agricultural practices. Currently, the seamless integration of wireless sensors and the Internet of Things in smart agriculture can take agriculture to previously imagined heights. IoT can help to enhance the answers to many traditional farming challenges, such as drought response, yield optimization, land appropriateness, irrigation, and insect management, by implementing smart agriculture methods. A hierarchy of important applications, services, and wireless sensors utilized in smart agriculture applications is shown in Figure 1. While important examples of how new technology are helping to improve overall efficiency at various phases are mentioned here.

A. SOIL SAMPLING AND MAPPING

Soil is a plant's stomach, and sampling it is the first step in obtaining field-specific data, which is then utilized to make a variety of essential decisions at various stages. Soil analysis' principal goal is to identify a field's nutrient status so that corrective action can be done if deficiencies are discovered.

Comprehensive soil testing should be performed at least once a year, ideally in the spring; however, depending on soil conditions and weather conditions, they can be performed in the fall or winter. Soil type, cropping history, fertilizer application, irrigation level, topography, and other variables are important to consider when analyzing soil nutrient levels. These variables provide information on the chemical, physical, and biological conditions of the environment. These factors provide information about the chemical, physical, and biological conditions of a soil, allowing for the identification of limiting factors and subsequent crop management. Soil mapping allows farmers to sow several crop varieties in the same area, allowing them to better match soil attributes such as seed compatibility, sowing timing, and even planting depth, as certain crops are deep-rooted while others are not. Furthermore, cultivating numerous crops at the same time could result in more efficient agricultural practices, just by maximizing resource utilization.

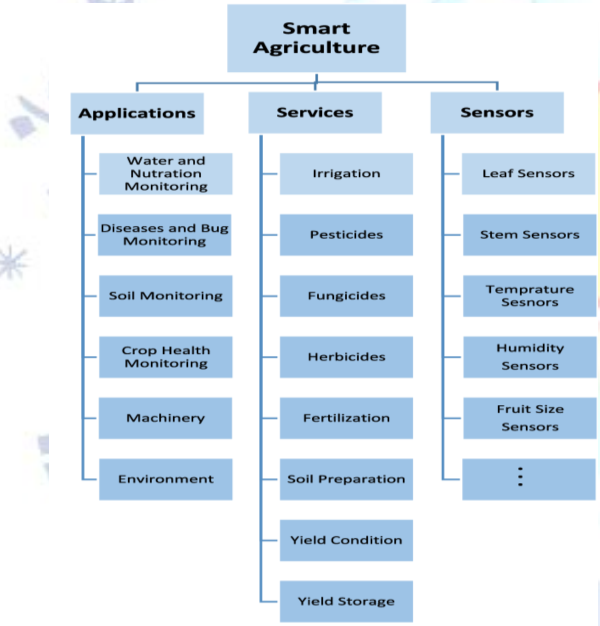

Figure 1. General hierarchy of possible applications, services and sensors for smart agriculture

Remote sensing is being utilized to gather frequent soil moisture data, which helps to analyze the agricultural drought in far regions, to deal with this issue, especially in very rural locations. In Spain in 2014, Mertinez et al. [2016] used SMOS L2 to calculate the Soil Water Deficit Index (SWDI). Vegan et al. [2016] employed the moderate resolution image spectroradiometer (MODIS) sensor to measure several soil functional characteristics in order to evaluate the danger of land degradation in Sub-Saharan Africa. The prediction models were built using soil maps and field survey data from all of the continent's major climate zones. Sensors and vision-based technology aid in determining the distance and depth required for effective seed sowing. Santhi et al. [2017] developed the Agribot, a sensor and vision-based autonomous robot for seed sowing. The seed flow rate is calculated using the signal information related to the passing seeds.

B. IRRIGATION

Only 3% of Earth's water is fresh water, which is locked in glaciers and polar ice caps. It's worth noting that the agriculture business alone consumes over 70% of all available fresh water for sustainable food and agriculture. Water wastage issues were also observed in traditional irrigation methods such as flood irrigation and furrow irrigation, so other controlled irrigation technologies such as drip irrigation and sprinkler irrigation are being advocated to combat them. When there is a water deficit, both crop quality and quantity suffer, as inconsistent watering, even excessive irrigation depletes soil nutrients and causes microbial diseases. When elements like crop type, irrigation method, soil type, precipitation, crop needs, and soil moisture retention are involved, precisely estimating the water demand of crops is not an easy process. Given this, a precise soil and air moisture control system based on wireless sensors not only makes the best use of water but also improves crop health. Not only that, but data from other sources, such as meteorological data and satellite imaging, is fed into CWSI models to analyze water needs, and a unique irrigation index value is generated for each site.

C. FERTILIZER

A toxin may be a natural or synthetic product that contains essential minerals for factory development and fertility. Shops primarily bear three macronutrients nitrogen (N) for splint growth; potassium (K) for root growth; and calcium (C) for root growth. Fertilization in smart husbandry aids in just estimating the specified cure of nutrients, hence reducing their negative environmental consequences. Fertilization necessitates point-specific soil nutrient position measures counting on a spread of criteria, including crop kind, soil type, soil immersion capacity, product yield, fertility type and application rate, rainfall, and so on. New IoT-grounded fertilizing approaches help to estimate the spatial patterns of nutrients conditions with a better delicacy and minimal labor conditions. The Normalized Difference Vegetation Index (NDVI) (Benincasa et al, 2018) uses upstanding/satellite filmland to assess crop nutrient status. NDVI may be a dimension of crop health, foliage vigor, and viscosity that is supported the reflection of visible and near-infrared light from foliage. It also helps to probe soil nutrient situations. Similar exact prosecution can vastly boost toxin effectiveness while also reducing environmental side goods. Numerous new enabling technologies, like GPS delicacy (Shi J et al, 2017), geo mapping (Suradhaniwar et al, 2018), Variable Rate Technology (VRT) (Colaco and Molin, 2017), and independent vehicles, are making a big donation to IoT- grounded smart fertilization.

Figure 2. Some key inputs, processes involved and possible outputs of smart farming

D. CROP DISEASE AND PEST MANAGEMENT

Pests and conditions are estimated to beget 20 – 40 percent of global crop yield losses each time, according to the Food and Agriculture Organization (FAO) (www.fao.org). Ultramodern IoT- grounded pest operation delivers real- time monitoring, modeling, and complaint soothsaying, making it more successful than traditional timetable or tradition- grounded pest treatment approaches. Advanced complaint and pest discovery styles calculate on image processing, with raw images collected across the crop area exercising field detectors, UAVs, or remote seeing satellites. Vehicle perfection scattering and automatic VRT, both of which are routinely used in smart fertilization, can also be used for complaint treatment and other fungicide operations. Likewise, advancements in robotic technology give fresh options. When an agrarian robot is equipped with multispectral seeing bias and perfection scattering snoots, it can more precisely find and deal with pest problems while being controlled by a remote IoT complaint operation system. This IoT- grounded pest operation system has a number of benefits, including the capability to lower total costs while also aiding in the restoration of the natural climate. For illustration, it was lately discovered that the lack of pollination is hanging the yield of colorful crop kinds (Stein et al., 2017).

E. YIELD MONITORING, FORECASTING AND HARVESTING

Production monitoring refers to the process of analyzing several characteristics of agricultural yield, such as grain mass flow, moisture content, and harvested grain quantity. It assists in accurately assessing crop yield and moisture level to determine how well the crop fared and what to do next by documenting the crop yield and moisture level. Yield monitoring is regarded an important aspect of precision farming not just during harvest but also prior, as yield quality monitoring is critical. Many factors influence yield quality, including adequate pollination with high-quality pollen, which is especially important for projecting seed yields under changing climatic conditions [Muhammad Ayaz et al, 2019]. Crop forecasting is the art of predicting the yield and productivity of a crop before it is harvested. This forecasting aids the farmer in planning and making decisions in the near future. Analyzing the yield quality and ripeness is also an important component in determining the best harvesting time. This monitoring includes various stages of growth IJESC, May 2020 25878 http:// ijesc.org/. It makes use of fruit characteristics such as colour, size, and shape. Predicting the best harvesting time not only helps to improve crop quality and yield, but it also allows you to tweak your management plan.

Despite the fact that harvesting is the final step in this process, effective planning can make a significant difference. Farmers must know when crops are ready to harvest in order to reap the full benefits from them. The figure below is a snapshot of a farm area network (FAN) that can provide a real-time depiction of the entire farm to the farmer.

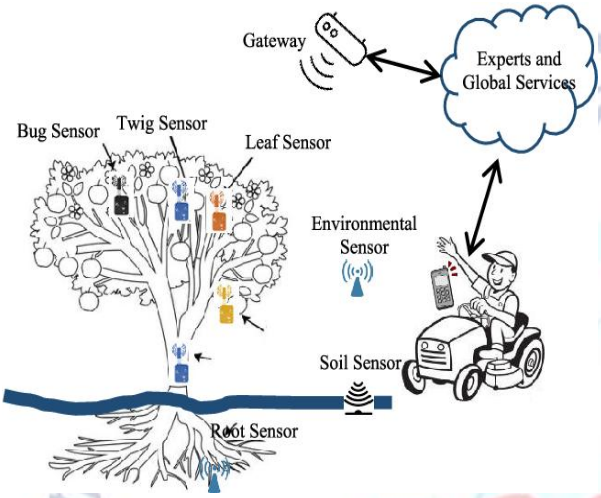

Figure 3. An IoT-based Farm Area Network (FAN)

A yield monitor from [www.farmtrx.com] may be put on any harvester combine and linked to the FarmRTX mobile app, which displays real-time harvest data and instantly uploads it to the manufacturer's web-based platform. This tool can create high-quality yield maps and share them with an agronomist, and the farmer may also export the maps to other farm management software to study them. Fruit growth measurement can be extremely useful in accurately estimating yield production and quality. This concept was developed by Luigi et al., [2015], who utilized fruit growth as the most basic and relevant metric for estimating how well the crop is progressing. Satellite photographs can be a useful tool for monitoring the output of large-scale crops. Trobick et al. [2017] employed Sentinel-1A Interferometric pictures to map rice crop production and intensity in Myanmar, and they applied this method. Z. Wang et al, [2017] used colour (RGB) depth photos to track the varied fruit states in mango farms, as we described earlier in this section. Fruit size plays a vital role in estimating its development, making decisions about harvesting, and targeting the correct market. Several optical sensors are used to monitor the shrinking of papayas, especially during drying circumstances.

5. FUTURE SCOPE AND CONCLUSION

To boost agricultural output, it is required to install sustainable communication technologies and sensors based on the Internet of Things. Unmanned aerial vehicles, wireless sensors, and cloud computing have all been demonstrated to be useful instruments for ensuring long-term agricultural output. Smart devices can automate several activities throughout the production cycle, including irrigation, soil sampling and mapping, fertilizer or pest management, yield monitoring, forecasting, and harvesting, resulting in increased crop quality and growth potential. This study looked at the main demand, important applications, as well as existing and future IoT developments. In the future, this study will be expanded to cover security and privacy concerns in smart agriculture using IoT approaches.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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