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Internet of Things (IOT) in Precision Agriculture

*Krishan Kant Gautam, Teena and Suraj Kumar
Research Scholar, School of Agriculture, Galgotias University, Greater Noida, Uttar Pradesh, India
*Corresponding Author's email: krishankant.gautam02@gmail.com

The Internet is experiencing explosive growth nowadays, with the number of devices connecting to it increasing rapidly. Before the Internet of Things (IoT), which connects everything to the internet, we only had personal computers (PCs) and mobile phones. Today, millions of devices are connected to the internet. The idea of machine-to-machine communication, which allows two devices to talk with one another, is a result of the Internet of Things' evolution. Additionally, any data that was previously stored on a private server is now accessible online, allowing users to access it remotely. IoT applications are possible in practically every industry, especially those where transmission speed is not a concern. The idea of precision agriculture essentially demands that the proper quantity of resources be provided at the correct time. These resources can include anything, including insecticides, light, and water. The suggested paper has used the advantages of IOT to apply precision agriculture. The basic concept is to detect all necessary parameters from the agricultural area and make the necessary decisions to operate the actuator. These agricultural characteristics include light intensity, temperature, and relative humidity surrounding the plants, as well as soil moisture. The sensor senses the reading and takes appropriate action. For example, the fogger valve (which sprays water droplets) is activated based on the relative humidity (RH) readings, and the irrigation valve is activated based on the soil moisture readings.

Keywords: Internet of Things (IoT), Machine-to-Machine Communication, Precision Agriculture, Relative Humidity (RH), Soil Moisture

Introduction

The agriculture industry accounts for a sizable portion of the GDP of developing nations. The population is growing at an accelerating rate, which puts this industry's capacity to meet the needs of rising technology and the growing population at risk. The world's population is expected to surpass 8 billion people by 2030 and approach 10 billion by 2050. Both China and India have more than one billion people, accounting for 19 and 18 percent of the world's total population, respectively, making them the most populous nations in existence. The population of China is predicted to surpass that of India by 2022. The economies of both nations depend heavily on agricultural production to provide a consistent flow of income for their expanding populations.

The Internet of Things (IoT) is a contemporary emerging mechanism that has supplanted networked cloud applications, including digital and electrical systems, mechanical devices, and people with unique identification numbers. The ability of the Internet of Things to send data without requiring a human transmission interface is by far its most significant feature. The ideal solution to the issue is the use of Wireless Sensor Nodes (WSN), which are attributed to the fact that the field is extended over a sizable area of farmland for agricultural or animal grazing. Due to their high-power consumption, which is lower than that of the sensor nodes, the actuator modules are connected to the Personal Area Network (PAN). An

Internet of Things (IoT)-based system can incorporate this extensive framework by making use of the current Internet and Local Area Network (LAN) infrastructure.

In most emerging nations, agricultural digitalization is progressing. Agricultural management, insect use, computerized crop breeding, and the creation of weather reports are all widespread in Japan. In addition to government databases for agriculture, research institutes, and libraries, farmers in the United States (US) have access to massive data cloud systems. Farmers can utilize the database to learn about crop improvement, current market prices, and emerging technologies and skills in the agriculture industry. By helping farmers choose which crops to plant, when to grow them, and what agricultural method to employ, computers may help create farms that maximize profits and yields.

Data Management in Agriculture

Smart agriculture, sometimes referred to as automated farming, is the newest paradigm based on agricultural data to appear. To increase operational accuracy, it was made feasible by developments in data processing and telecommunications, which were coupled with the previously accepted idea of precision agriculture. In this regard, smart agriculture is based on the same ideas, with farmers using technology that gathers data from agricultural areas and analyzes it to make appropriate managerial and operational decisions. Historically, in order to assess the condition of the plots and evaluate decisions that were taken without their previous knowledge, farmers had to physically visit the farmland. This approach has been ineffective for a number of reasons, including the fact that many sectors are too wide to be sufficiently covered by the legal standards framework. Advanced management technologies are offering useful applications in the area of smart agriculture. Apart from that, technology can offer an automatic method of identifying unforeseen flaws that are hard to detect through periodic visual inspection, even though some farmers have long-term experience accumulated through a range of situations. Because they will use smart devices or instruments to supplement their inadequate expertise, younger farmers are more likely than older farmers to use new agricultural technologies. But in recent decades, the average age of farmers has increased significantly: it is 58 in the US and Europe, 60 in Africa, and 63 in Japan. Fortunately, Europe is updating and expanding a number of measures to support generational change by expanding access to market advice, coaching, loans, and startup funding. Regeneration of generations is more than just lowering the retirement age of rural farmers. The most intelligent and engaged young farmers are also encouraged to employ technology to advance sustainable agribusiness practices. To achieve sustainable food security and food chain competitiveness, young farmers need to transform their existing land into more efficient and sustainable farms.

AI and IoT integration in smart farming

Smart farming is the integration of the Internet of Things (IoT) and Artificial Intelligence (AI) into cyber-physical systems for all-encompassing agricultural management. Applications of artificial intelligence span a number of domains, including weed control, disease detection, crop health monitoring, and soil management. Notable examples include computer vision systems, ANN-GIS, fuzzy logic-based Soil Risk Characterization Decision Support Systems (SRCDSS)(Fig.1), Management-Oriented Modeling (MOM), Artificial Neural Networks (ANNs), CALEX, PROLOG, Invasive Weed Optimization (IWO), and Support Vector Machines (SVMs). Mobile expert systems, which allow farmers to use smartphones for tasks like disease diagnosis, species identification, and soil health analysis using mobile applications, are an important use of artificial intelligence. AI makes it easier to analyze satellite photos in real time and track agricultural progress. Precision agriculture now has a scientific foundation thanks to these advancements, which increase its efficiency in maximizing agricultural yields.

Precision agriculture and smart farming rely heavily on the Internet of Things (IoT), a network of linked equipment and technology. Information and communication technology is integrated with agricultural sensors in an IoT architecture. (ICT) and unmanned aerial vehicles (UAVs), making it easier to gather crucial data for precision farming. In the context of the fourth industrial revolution, the increasing prevalence of mobile data and the Internet of Things is essential.

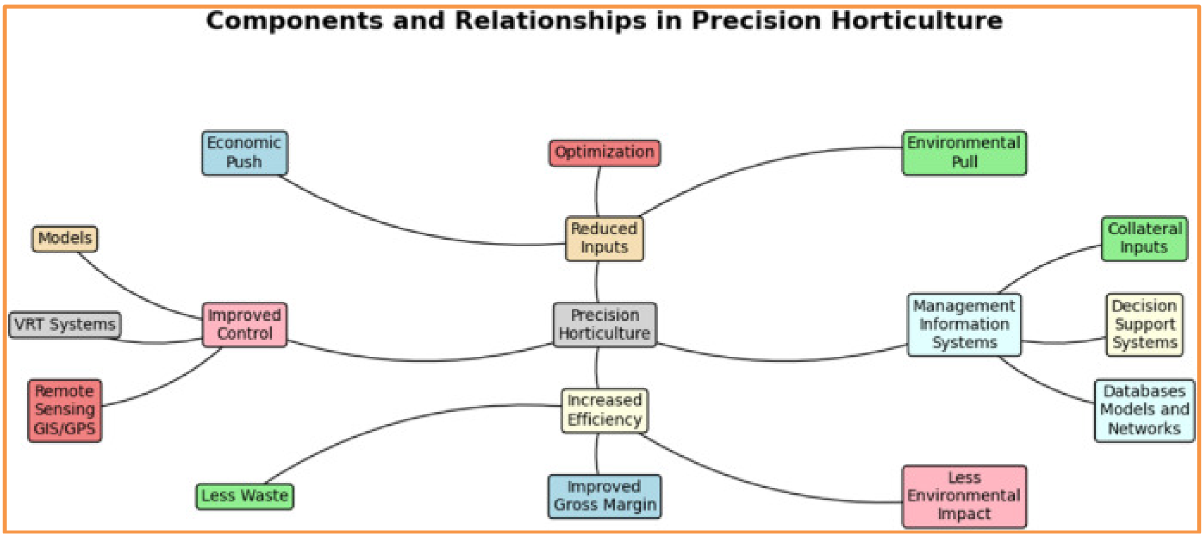

Figure 1: Element of Precision Farming

Technological infrastructure for advanced agriculture

Advanced agricultural technological infrastructure is the combination of institutional, mechanical, and digital systems that enable contemporary, data-driven, and sustainable farming. Strong digital connectivity is the first step, as it allows for real-time monitoring and decision-making through technologies like cloud computing, 5G, and high-speed internet. Precision sowing, watering, and harvesting are made possible by hardware and equipment used on farms, including GPS-enabled tractors, drones, IoT-based sensors, and automated machinery. Data analytics methods like artificial intelligence, machine learning, and remote sensing are used in conjunction with these to help forecast yields, identify pests and illnesses, and maximize resource utilization. These technologies are powered by reliable energy systems, especially renewable energy sources like solar and biogas, which are available in rural regions. Supportive policies that encourage adoption, agri-tech hubs, and extension services via mobile apps are examples of institutional and support structures that are equally crucial. Subsequently, farmers are directly connected to consumers and markets through logistics and market infrastructure, including digital marketplaces, smart cold chains, and blockchain-based traceability systems. When combined, this technology infrastructure forms a smart agricultural ecosystem that raises farmer incomes, lowers expenses, guarantees sustainability, and increases production.

Advanced technologies in field operations

Modern agriculture has undergone a revolution thanks to advanced field operations technology that increases sustainability, efficiency, and precision. Beyond conventional tractors and harvesters, mechanization has expanded to include autonomous tractors, GPS-guided equipment, and drones for crop monitoring, sowing, and spraying. Remote sensing, Geographic Information Systems (GIS), and Variable Rate Technology (VRT) are examples of precision agriculture systems that enable site-specific application of inputs like irrigation, fertilizer, and herbicides, lowering expenses and environmental impact. Farmers may make data-driven decisions thanks to real-time data on crop health, nutrient levels, and soil moisture provided by Internet of Things (IoT) sensors and devices. Advanced irrigation systems like drip irrigation and automatic sprinklers maximize water conservation, while activities like weeding, harvesting, and insect detection are increasingly being handled by robotics and artificial intelligence. By preserving resources and reducing ecological footprints, these advances collectively not only increase production and profitability but also support sustainable farming methods.

Conclusion

The practice of precision agriculture uses data sensors, networked devices, remote control tools, and other contemporary technology to provide farmers with more control over their fields and crews. Precision farming is gaining popularity. The present Internet of Things (IoT) applications in farming are thoroughly examined in this article. While most agricultural work was concentrated on basic data processing and decision-making a few years ago, this study showed that the trend toward systematic management systems—for example, cloud technology and big data, which are used to analyze enormous amounts of information—has recently gained traction. Furthermore, computer vision and artificial intelligence have emerged as new developments in agriculture aimed at enhancing farm management. Based on the various projects discussed in this article, the majority of IoT smart farming technologies were used to track crop data. Multiple network protocol types were used simultaneously by many of the apps covered in this article to enhance the functionality of their IoT solutions. A farmer will receive an extensive assessment of every facet of their business, including weather, soil quality, crop and livestock management, and employee performance.

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