Framework of Precision Farming: A Review

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ABSTRACT

Precision Farming is the new age technology, one should adopt to boost the process of farming and receive better output. Here, A Framework is proposed for obtaining the desired standard quality of the crop providing all the required conditions to achieve this. Some Parameters related to soil, environment can be considered to observe the crops for their well-being and to check the original status of the crop. Using IoT device, with in-built sensors to detect temperature, humidity, soil moisture, and soil nutrients such as nitrogen, potassium, and phosphorus, data goes to Cloud Server for further processing by running algorithms. Here, a deep review is presented so as to gain the insight in the technologies being adapted till now for the betterment of the agriculture

Key words: Precision Farming, IoT device, sensors, Cloud Server.

INTRODUCTION

For understanding the framework for precision agriculture that we intend to create, we need a thorough understanding of what is agriculture. What was the need for bringing Precision Agriculture? What are the digital technologies that can be used with Precision Agriculture to make it fruitful for farmers?

1. FARMING

Farming is growing crops and keeping animals for food and raw materials. Farming is a part of agriculture.

Agriculture [28] is the art and science of cultivating the soil, growing crops and raising livestock. It includes the preparation of plant and animal products for people to use and their distribution to markets. Traditionally, farmers have used a variety of methods to protect their crops from pests and diseases. They have put herb-based poisons on crops, handpicked insects off plants, bred strong varieties of crops, and rotated crops to control insects.

Farming methods often vary widely around the world, depending on climate, terrain, traditions, and available technology. Low-technology farming involves permanent crops: food grown on land that is not replanted after each harvest. Higher-technology farming involves crop rotation, which requires knowledge of farmable land. Scholars and engineers not only use crop rotation and irrigation, but plant crops according to the season, type of soil, and amount of water needed.

There are lot of challenges in the way of farming. Biggest challenge is overpopulation. Agricultural practices in developed and developing countries have led to a severe loss of valuable topsoil, water, and other resources. Many countries need better programs for replanting forests.

There is a need for upgradation of traditional farming methods so as to make proper use of the limited resources, fulfilling the increasing demands of food and that too with sustainable environment. It is where Precision farming comes into picture

1. PRECISION FARMING

Precision Farming is a farm management concept that revolves around the process of observing, measuring, and responding to various inter-and intra-field variability inputs for modern agriculture[39].

‘Precision agriculture is a management strategy that gathers, processes and analyzes temporal, spatial and individual data and combines it with other information to support management decisions according to estimated variability for improved resource use efficiency, productivity, quality, profitability and sustainability of agricultural production.’ The International Society of Precision Agriculture adopted the above definition of precision agriculture in 2019.

Emerging technologies, such as geospatial technologies, Internet of Things (IoT), Big Data analysis, and artificial intelligence (AI), could be utilized to make informed management decisions aimed to increase crop production. Precision agriculture (PA) entails the application of a suite of such technologies to optimize agricultural inputs to increase agricultural production and reduce input losses.[13]

Precision agriculture is described in the literature by various terms such as Precision farming (PF), Site-Specific input Application (SSA), Site-Specific Agricultural Technology and Variable-Rate Treatment (VRT). In the following, these terms will be used synonymously. A broader term is Smart Agriculture that also appears to cover later technical developments such as auto steering systems, controlled traffic farming and autonomous systems like agricultural robots.

Precision farming incorporates information and communication technologies into machinery, equipment and sensors used in agricultural production systems. Technologies such as the IoT and cloud computing are advancing this development even further by introducing more robots and artificial intelligence into farming[40].

For example, farmers can use smartphones and tablets to access real-time data about the condition of almost anything involved in their day-to-day operations like soil, plants, terrain, weather, location of assets, conditions of assets, livestock, resource usage.

1. INTERNET OF THINGS

Internet of things (IoT) is considered to revolutionize the way internet works and bring together the concepts such as machine to machine (M2M) communication, big data, artificial intelligence, etc. to work under a same umbrella such that cyber space and human (physical systems) are more intertwined and thus ubiquitous giving rise to cyber physical systems. This will involve billions of connections and smart products communicating with each other mostly without human intervention to achieve smart objectives. The idea of IoT has enticed significant research attentions since the massive connectivity bring varieties of challenges and obstacles including heterogeneity, scalability, security, big data, energy requirements, etc

IoT works [29] with various enabling and emerging technologies such as wireless sensor networks (WSNs), sensor technologies, machine learning and artificial intelligence (AI), big data and analytics, etc. At the heart of IoT is WSNs, consisting of sensors deployed in a sensing area to monitor specific phenomenon (such as environmental monitoring) and collect data. Furthermore, even more pervasive network configuration are being developed where all possible devices (mostly of heterogeneous nature) connect with each other to sense, gather and analyze data of different nature to act upon the intelligence gained from deep insights of the data. These actions are mostly without human interaction.

The results from IoT Total Addressable Market (TAM) reveal that the number of IoT-connected devices in the overall world will grow from 7.6 billion to 24.1 billion and will lead to the revenue tripling from USD 465 billion to over USD 1.5 trillion[1].

IEEE explains IoT as a network that connects uniquely identifiable Things to the Internet. The Things have sensing/actuation and potential programmability capabilities’’ [1]. IoT essentially uses connected devices to perform a group of tasks like process monitoring, environmental sensing, and health monitoring. Wireless Sensor Network (WSN) are the most crucial underlying technology for IoT. A WSN is a network formed by deploying sensors to collect and forward the data to the enterprise or cloud for further processing. This precise data from the sensors, aerial devices, and IoT solutions are used for increasing farm productivity with environmental sustainability, predicting climate change, , monitoring, and having a proactive reaction to crop performance. It also helps in choosing a suitable crop by observing and measuring the demand or dependent factors.

II LITERATURE REVIEW

In [1], a design of a multidisciplinary agriculture solution model for Precision Agriculture AgriFusion combining emerging technologies like Machine Learning (ML) and Artificial Intelligence (AI), edge computing and other emerging technologies is proposed. With the use of Blockchain and IoT, a trusted food traceability system is presented [4]. Blockchain is used for security reasons for proposed Blockchain based Producer- Consumer Model (BPCM)[5]. Blockchain and IoT together analyse agricultural data. The survey shows that the duo helps in Precision agriculture smart apps[6]. Four-tier green IoT-based agriculture architecture with smart agriculture is being described. Usage of technologies is also highlighted[7]. A generalized Blockchain security architecture is proposed[8]. [9] presents supply chain architecture using IoT and Blockchain detailed with concerns and security threats of the existing system. [10], [11],[17] details about UAV applications in crop monitoring process and data acquisition and technologies are discussed.

In [12], a low-cost farmland digital twin framework named as AgriLoRa for smart agriculture is proposed for low budget farmers with wireless sensor network cloud servers to run the algorithms. [13] gives a survey on vegetation indices and their latest use in Precision agriculture, covering studies between 2015 to 2020. [14] summarizes agriculture related UAS applications. Also discussed the AFarCloud project from Europe. AI and Big Data applications made familiar in Precision Agriculture [15]. [16] Analyses how to accurately place the sensors in the field and the height of the drone to catch the data.

Applications of Machine Learning in the field of agriculture are reviewed with respect to prediction of soil parameters, prediction of crop yield, disease, and detection of weed in crops and species [19]. A deep learning framework AgriSegNet for automatic detection of farmland anomalies is proposed to boost Precision Agriculture Potency. A fair description of web of things, wireless sensing element networks, knowledge analytics and machine learning in agriculture[23]. In [24], IoT-based sensible Agriculture observation model is planned for properties like Temperature, Rain Wind, Acoustic, pH levels of the cornfields, Humidity, Location and Chemical for sensible agriculture applications. The researcher invents a brand-new model of high-performance-based edge computing, conjointly useful in economical offloading of knowledge with swish work flow improvement [25]. A low-power embedded system with a Neural Accelerator able to capture and process images and machine learning functionalities worked towards continuous pest infestation inside fruit orchards [30]. A case study regarding computer vision for commercial drones studies opportunities and challenges[32]. The Researcher presented a comprehensive survey on the latest developments of precision agriculture with UAV RS and edge intelligence and concluded edge intelligence as the convergence of artificial intelligence and edge computing [33]. An embedded sensing system enriched with the AI is presented, ensuring the continuous analysis and in situ prediction of the growth dynamics of plant leaves [34]. A systematic review that aims to identify the applicability of computer vision in precision agriculture for the production of the five most produced grains in the world: maize, rice, wheat, soybean, and barley. The Authors also used advanced AI techniques Deep belief network for the making of new methods[35].

III COMPARISON

A thorough study of the research papers related to precision farming is performed. There are several technologies that have been adapted for the purpose of the improvement of the agriculture. There is a vast number of combinations that have been reviewed and applied and then analysed for their performances. A comparative study is presented in the form of table.

**Table 1: Comparison between different technologies used or reviewed in research papers.**



IV CONCLUSION

Extreme Research is done to uplift the status of farming being executed all over the world. All the emerging technologies play vital role in the improvement of agriculture. To make it more efficient, productive, with the goodness of sustainable environment we need to adapt with the new techniques. Precision Farming is something which is inevitable these days. Some significant technologies to be used for PA are AI, ML, Edge Computing, IoT, WSN. Based on these, one can easily achieve the goals of precision farming.

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