Chapter 12

INTERNET OF THINGS (IOT) IN AGRICULTURE

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ABSTRACT

The exponential growth of the global data and information volume has given the impetus to the development of the Internet of Things (IoT) and the omnipresence of related devices. Today, the Internet of Things is an integral part of our everyday lives and this development cannot be kept away. As per Statista, there will be more than 75 billion Internet of Things (IoT) connected devices in use by 2025. Data volume created by IoT connections is projected to reach a massive total of 79.4 zettabytes by 2025. Wired or wireless networks will connect a variety of devices, machines, vehicles and almost everything. IoT makes way for unlimited

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business prospects in all fields, and agriculture is no exception. The use of IoT technology in agriculture will increase crop production to new heights. In this chapter, we will focus on the applications of IoT in agriculture. The chapter also discusses about the usage of IoT in the intelligent irrigation system and classifies different sensors.

Keywords: agriculture, drones, internet of things, predictive analytics, sensors

12.1. INTRODUCTION

Green computing seeks to use IT resources in an energy-efficient, economically-efficient and environmentally friendly manner by greening computers and computer products (using, disposing, designing and manufacturing), which in turn affect the development of a wide range of regions in the country. India is an agricultural country and agriculture and its associated activities are the main livelihoods for 80% of rural India's population. Therefore, agriculture is the core of India's economy and agriculture is a prerequisite for our domestic prosperity. It is the main source of livelihood for about the majority of the population of India, particularly in rural areas. According to IBEF reports, the Rs. 19.48 lakh crore ($ 276.37 billion) for agriculture, forestry and fishing was accessed in FY20 (PE) [1]. GVA growth remained at 4% in FY20 in agriculture and its allied sectors. In order to stabilize and increase growth, this agro-industry must be merged with the use of technology so that our country can develop smoothly. Even if the Government of India has focused and highlighted the need for progress in agri-business measures previously referred to, this is an indication of innovative technology and the implementation of this technology to increase crop productivity that would lead to overall system growth. With the implementation of the Internet of Things (IoT) in agriculture, crop production and other sustainable products are growing tremendously [2]. Various IoT Applications are used in farming which involves data collection on the humidity of the soil, temperature, climate, water levels, infertility of soils etc. This information

is gathered from the sensors and actuators and can be further stored on the cloud and can be assessed for various analytics to obtain meaningful information. Furthermore, this information can be used to automate agriculture techniques and make better decisions to improve the production of crops in terms of quality and quantity. With the use of IoT in agriculture the life of Farmer can be relieved and which would result in better production and reduced risks. For instance, there is no need for farmers to check the soil temperature for irrigation and would now be able to screen soil temperature and dampness from a far distance, they will be getting the entire information on their phones through alarms.

12.2. IOT TRANSFORMATION IN THE FUTURE OF AGRICULTURE

With the remarkable development of the world's population, as the United Nations Food and Agriculture Organization indicated, in 2050, we need to increase the consumption of food by 70%, for horticultural land use and the exhaustion of natural resources, the need to increase the yield of ranches has become essential. To solve the above problems, IoT solutions offer better product solutions, mainly aimed at helping farmers to shut down the inventory request hole by guaranteeing outstanding returns, benefits and climate assurance. IoT provides various solutions that lay the foundation for helping farmers to improve productivity, profitability and environmental benefits. In agricultural technologies Agribusiness IoT plays an important role, which includes specialized equipment, wireless connectivity, software and IT services. The use of technology led to intelligent farming, because technological advances have provided farmers with a better controlled ecosystem. Devices/computers identify the requirements for control of farm animals and farm crops [3]. This technique makes efficient decisions on the use of plants and animals. Decisions can be taken on a square acre or smaller tract of land that is capable of individually processing crops or animals. The business intelligence survey reports that IoT devices are expected to reach 75

million in the agriculture industry in 2020, increasing by 20% every year. Simultaneously, the global smart agriculture market is expected to triple by 2025, to 15.3 billion dollars (as opposed to just over 5 billion dollars by 2016).

Smart IoT-dependent agriculture enables farmers and growers to reduce waste and improve profitability, from the quantity of manure and fertilizers used to the number of excursions made by vehicles, and to enable the effective use of assets such as water, energy and so on. IoT intelligent agriculture solutions are a framework, which is designed to control yields with the aid of sensors (light, mugginess, temperature, soil damping, crop well-being, etc) and to mechanize the framework of the water system [4]. Farmers can monitor the conditions in the field from any place, including their homes or elsewhere. You can also choose between manual and mechanized alternatives to make important moves that depend on this information. For example, if soil moisture deteriorates, farmers can send sensors to start the water system. This mechanism, in contrast, is exceptionally productive and the regular manual methodology involves a lot of work. There are many different ways IoT applications change the way agriculture works, i.e., the future of agriculture.

12.2.1. Use of Smart Agriculture Iot Technology

Data collected by intelligent agricultural sensors, a key component of this agricultural management approach, includes sensors, control systems, robotics, self-supporting vehicles, automatic hardware, variable rate technology, movement detectors, button cameras and wearable devices. This information can be used to monitor general business conditions as well as the performance of employees and the efficiency of equipment. The ability to manage output allows for better product delivery planning. Agricultural landowners can use various wireless IoT applications to collect information about the location, well-being, and health of their cattle so that they can identify themselves sooner and remove them from the doctors' treatment group [5].

12.2.2. Usage of Greenhouse Can Be Automated Using Iot Applications in Farming

A smart greenhouse designed with the help of intelligent IoT monitors and simultaneously controls the climate and thus eliminating the need for manual intervention. The computer controls temperature, water and other factors that allow farmers to grow crops throughout the year. Information is stored and often requires very little manual work in changing or controlling the growing environment. It helps people located in rural areas to have better control over the weather. Climate change has changed the weather patterns in many places. These greenhouses give farmers the ability to grow crops regardless of weather or conditions. Many greenhouses are used to grow vegetables and fruits abroad.

12.2.3. Reduced Water Consumption in Agriculture

Water consumption can be reduced by the usage of soil sensors in agriculture. Plants are studied and data collected which is made available to other farmers who plant the same crop. Using this technology we can look underwater and over-watered plants can be exposed and their lives can be retained at greater ages. A wireless sensor was used at the farm which was the size of the crop.

12.2.4. Pest Monitoring

Pest monitoring is another area that technology now helps with – Farmers can monitor pests and act using wireless technology. Excessive use of pesticides on crops increases not only human health but also the environment. According to estimates by the World Health Organization, about 3 lakh people die every year and around 220,000 people die. Farmers are not aware of the exact application of pesticides and have harmful effects on other organisms including humans [6].

12.2.5. Livestock Tracking

Recently Samsung has partnered with Herdsy to develop technology that helps raise better cattle all over the world. This handheld tracking device will be used to collect data on cattle that can be used to improve raising them. A tag placed around the neck of the animal monitors its location, heart rate, temperature, movement, and activity level. The information is collected and used to improve raising the cattle. Alerts come when unusual activity is found. This data can be given to vets when the animals get sick. It uses geo-fencing to track animals to keep them from getting lost or stolen. The company has had many orders for this device around the world.

12.2.6. Big Data in Farming

The usage of big data technology brings a tremendous change in smart agriculture. It has the potential to increase production by 2050 which is needed to feed the world. Suppliers will be expected to do more with fewer resources available. Analyzing data in real-time will help farmers come up with a new solution to changing problems [7]. They can monitor current weather, soil, rain, and bugs to find the best solutions to the problems. They might be able to prevent outbreaks of disease or insects that destroy their crops. They can develop and tailor a specific product to certain market segments using big data. This data gives them a very competitive advantage.

12.2.7. Smart Agriculture Predictive Analytics

Crop predictions are of major importance to enable farmers to decide on future crop production plans, stockpiling, risk management and marketing techniques. Artificial networks use information collected from farm sensors to predict crop production rates. This information includes

parameters such as soil, temperature, pressure, precipitation and moisture. Farmers can obtain accurate soil information either via a dashboard or a custom mobile application. Farmers have begun to realize that IoT is a driving force for cost-effective increases in agricultural production [8-9]. Since the market is still developing, there are still plenty of opportunities for those who want to join the company.

12.3. APPLICATIONS OF IOT IN AGRICULTURE

Farming has made many technological advances since the agricultural age. Today, farmers can quickly determine what is best for their crops, understanding impending weather interactions and impacts, and produce a good product at a fast pace. With IoT making strides in the area of farming, it might not be too far off that the press of a button will be the force behind agricultural growth. In this section, we will discuss about the various applications of IoT in Agriculture.

12.3.1. Weed Robots

These are smart agriculture robots (agri-bots) uses digital image processing to go through the images of weeds in their weeds and spray them directly by using their robotic arms to detect similarities with crops.

Figure 12.1. Weed Robots.

They are treated as a boon for the ecosystem and also for farmers who are using pesticides for their lands.

12.3.2. Harvesting Robotics

The use of agri-business for crops resolves the labour shortages problem. These new machines can be operated 24/7 through the delicate selection process of fruits and vegetables. These machines use a combination of image processing and robotic weapons to determine fruit in order to control quality. Because of high operating costs for crops focusing on agro-based early harvesting, fruit is like apples. Greenhouse harvesting also applies to high-value crops such as tomatoes and strawberries with these bots. These bots can be used to properly determine the harvest stage in the greenhouse and harvest time [3].

Figure 12. 2. Harvesting Robotics.

12.3.3. Drones

Drones are majorly used by the agriculture industry for monitoring and make tasks easy for farmers and thus enhance their productivity. They are used to monitor soil, spraying, watering and planting. Monitoring the soil helps farmers connect what is needed to help their crops grow better [9]. Drones evaluate temperature, land slope, moisture, which gives them the right soil samples. Farmers use this information for decision making when

crops recur, and development improves. The benefits of IoT in farming have been shown using drones. They are built with different sensors and cameras used for taking images and surveying crops yield and fields.

12.3.4. Machine Navigation

Since remotely-controlled toy cars with a microcontroller are enabled, tractors and heavy tillage equipment can be operated automatically from home via GPS. These integrated automated machines are very précised and self-adjusting when differences in areas are detected and labor-intensive tasks is simplified. Both their work and progress can be easily monitored on your smartphone. These technology-driven engines are getting smarter and independent with features such as automatic obstacle detection with advances in maschine learning.

Figure 12.3. Drones Technology.

Figure 12.4. Machine Navigation.

12.3.5. Climatic Conditions

In agriculture, climate plays a very important role. And inappropriate climate knowledge exacerbates crop production quantity and quality. However, IoT solutions allow you to know the weather conditions in real time. The sensors are installed indoors and outdoors. They collect environment data for selecting the right crops that can grow and sustain under specific climatic conditions. The sensor data in terms of moisture, temperature, precipitation and dew detection help to determine the weather patterns in the fields to be grown for suitable crops.

Figure 12.5. Climatic Conditions.

Figure 12.6. Soil quality.

12.3.6. Soil Quality

The soil quality analysis helps to determine the nutrient value and drying area of the fields, the capacity of drainage and the acidity of the

soil, so that the water required for irrigation and the more profitable types of farming can be adjusted.

12.4. SENSORS USED FOR AGRICULTURE

Several historians suggested that the agricultural revolution was one of the most important innovations in human history, since settlers are able to effectively produce a sustainable amount of food. As populations around the world grow, however, agricultural operations have become increasingly complex, extensive, and customized. Technological inventions make farming more productive than ever before, harvest more crops per region and produce better quality products. There is a broad gap between the innovations created by research and development organisations and their actual importance in the field of farmers. Farmers' attention to innovations should be given to better exchange advances in exploration. In this technological revolution, sensors play a very important role [11-12]. In this section, we will explore the various sensors in the agricultural sector.

12.4.1. Agricultural Temperature Sensors

These are very important in two main classifications of intelligent agriculture - including observation of condition and mechanical property control. For example, ice wine collection is known to occur within a thin temperature window when first-rate temperatures reach -10°C to -12°C during the reaping season. For the ice wine industry, the highly precise temperature and dampness sensors and accurate conjecture temperature estimates are fundamental. Temperature sensors not only play an important role in monitoring the encompassing conditions in a real area but also play an important role in practically all smart farming resources observing applications.

12.4.2. Smart Cameras Use in Agriculture

While the technology for smart camera technology is far from a stereotypical analogue sensor, the technology has been used for a number of smart farming applications increasingly. Companies like John Deere's Blue River Technology have used intelligent camera technology to detect weeds and other plant locations to dispense herbicides and fertilizer automatically and accurately. This optimizes chemical use and improves overall productivity while reducing chemical use.

12.4.3. pH Sensors in Agriculture

The accessibility of supplements is fundamental for the development of plants for creatures and living beings. In streamlining the development potential of a plant and producing profoundly profitable harvests, a profound and quantitative understanding of the soil conditions from which agricultural products have been derived is essential. The use of pH sensors provides basic criticism of soil supplement deficiencies or the presence of unwanted synthetic substances. These sensors help savvy farming screens to keep track of horticultural business day by day, week by week, month by months and annual changes in soil pH and supplements.

12.4.4. GPS Sensors

Also for brilliant horticulture, the GPS sensors are typically connected to car and cell correspondence companies. It has always been extremely important to farmers to monitor their herds from old pilgrims who have grouped sheep with wooden staffs to the management of the old West. The existing GPS monitoring of animals has enhanced the ability to screen animals with a basic catching press. It can also be used in high-precision vehicle guides for plant harvesting and related GPS technology agricultural techniques.

12.4.5. Sensors for Resource Monitoring

The monitoring of resources is another application in shrewd agriculture where temperature detection takes on an essential part. Despite the control of plants, temperature sensors notice the hardware assembling these plants. Temperature sensors convey alarms at any point where a gear frame requires small support, does not satisfy expectations or is fundamentally flat. They are mainly used in any precious and receptive maintenance framework to protect against overheating and adverse deception.

12.4.6. Accelerometer Sensor

Similar to the use of temperature sensors in precise maintenance, accelerometers are widely used for anticipation and support by the intelligent agriculture industry. Accelerometers are mainly used on moving segments and motors to identify minor developmental varieties and vibration irregularities and to anticipate standard maintenance or substitution of the undermined part. Although not generally related to agriculture and other horticulture, accelerometers play a major role in support of essential shrewd farming equipment.

12.5. IoT Challenges in Agriculture

The uses of IoT in agriculture have brought a tremendous revolution in the field of agriculture and it has changed the working way in which farmers work and the yield increased. However, the integration of smart technology in the traditional methods of farming may result in several challenges discussed as under.

12.5.1. Connectivity

Connectivity in agriculture is one of the major IoT problems that we need to deliver in rural areas in all agricultural areas. In order to make the IoT system work, we need to connect the entire agricultural environment - farms, warehouses, barns, greenhouses, etc. And there's plenty of room to work with. Ideally, a reliable smooth connection should also be able to withstand severe weather events and open space. Unfortunately, connectivity remains generally a problem on the Internet of Things as various systems use various protocols and methods of data transmission. Hopefully, efforts to regulate the industry, the standards and the development of 5G technology and space-based Internet can solve this issue soon and provide Internet connection in a fast and reliable manner for each location, regardless of its size and conditions.

12.5.2. Design and Durability

Any IoT system used in agriculture must not only handle connectivity but also be able to handle outdoor conditions. The IoT must still have a functional design and a certain degree of robustness in its drones, mobile sensors, intelligent grids and weather monitoring stations to "work in the field." The complexity and characteristic of the design of an IoT product is not mentioned in general.

12.5.3. Limited Resources and Time

IoT plays a crucial role in agriculture although integration of smart technology is carried out in an environment and time constraints that are constantly changing. Companies designing and developing IoT for agriculture will have to take into consideration rapid climate change and

emerging weather conditions, such as limited availability of land and dying pollination.

12.5.4. Adaptability of Farmers' Technology

Most farmers in agriculture are rural with an educational background inadequate. They use the traditional methodology for a long time, and the use of smartphones and intelligent technologies is very difficult for them. This is particularly true of small farmers.

CONCLUSION

The intelligent agricultural sector is growing and expanding exponentially, with almost daily new horizons and technological solutions on the market. Capacity and importance constantly increase in devices that collect sensor data, transmit information to farmers and help optimize large-scale agricultural processes. IoT enabled agriculture solutions have contributed significantly to the implementation for time-tested knowledge of modern technological solutions. This helped us bridge the gap between production yields, quality and quantity. The receipt and transmission of information from multiple sensors in the database in the real time ensures faster action and less damage to crops. With smart operating seamless end to end and the execution of business processes, production is processed faster and reaches supermarkets as quickly as possible. Despite any increase and fall in the market, demand for agricultural products will always be present. People will never stop eating or drinking so that IoT use leads to another level of the green revolution. Despite various IoT challenges, this technology is widely accepted in agriculture. Therefore, development in sectors such as food and agriculture, especially in view of the pace we are seeing in the world today, will always be a priority. IoT in agriculture therefore has a very promising future as the driving force for efficiency, stability and scalability in this industry.

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