Advancement of mechanical automation in the agriculture sector and overview of IoT

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Abstract. In the increasing population scenario, the agriculture sector is playing an important role to overcome the food scarcity conditions for the food safety of the whole world. Mechanization in the agriculture sector has increased the production of different crops and opened a new era of precision agriculture. Recently, the conventional use of farm machinery has been changed with the automation of agricultural devices. This innovation has revolutionized the field of precision agriculture. Different type of high-quality effective sensor has been installed in the field for efficient use of irrigation water, fertilizers, fungicides and disease prevention in different crops. This technique has increased the agriculture yield and lowered the cost of production. The use of IoT technology in agricultural farms has relieved the farmer through the use of mobile Apps and high-speed internet connections. These systems provide all the necessary information through the comparison of data collected from the farm with already stored standard charts in the database for a farmer during the management of a crop in a precise way. So, this innovation in the automation of agricultural devices is playing an important role in precision agriculture and also helping the farmers to increase the production to overcome the food scarcity of the world.

1. Introduction

Recently, the census 2018 counted 7 billion people in the world and it has been estimated that the world population will reach up to 9.3 billion at the end of 2050. This rapidly increasing population is demanding more food to fulfill the requirements. According to an estimation of researchers, the food demand will increase up to 60 percent in 2050. Agriculture production is the direct source of food for most of the living organisms, especially for humans and animals. So, the increasing demand for food also requires for the rise in agriculture production. Food scarcity increases the importance of the agriculture sector throughout the world. While the economy of the agriculture-based country depends upon the yearly agriculture production. The prestige of the agriculture sector and demand for extra food production requires the farmers to move from conventional methods of production to modern farming systems. In the modern farming system, a farmer uses modern technologies to control all the factors including biotic and abiotic stresses to increase the production, thus the financial benefits of the farms. In this system, the farmer is adapted to new innovations from time to time and continues to improve the production losses. The aim of the modern production system is to reduce the
production costs and also to increase the yield from a small piece of land. It mostly focuses on the quality and quantity of the product through efficient use of production management [1].

Exact information is considered very important in agriculture sector related to fluctuating environmental conditions, the requirement of plants and demand for irrigation, etc. This knowledge leads the farmer for timely decision in the management of the crop. The knowledge management system has been used by the farmer to answer cropping problems. In developing countries, information and communication technology is being used to promote the agriculture sector. Investors are interested to improve this technology to overcome the lack of man-power and other resources in many countries. A significant improvement of the technology is needed in the agriculture sector to monitor agriculture production on a daily basis on lower costs. However, the automation of mechanization in the agriculture sector is the new innovation that has improved agriculture production and allowed the farmers to use the information and timely help. The precision agriculture demands the knowledge of sustainable agriculture production for the farmer that is very difficult to find out. The application of web system is the important solution to locate the required knowledge for the problems in precision agriculture [2].

The aim of this review is to cover the recent innovations in agriculture sectors for the automation in mechanization. It also covers the advancements in the use of IoT technology in agriculture sector for the availability of important information for the farmer in precision agriculture to improve the production and overcome the production losses.

2. Automation of Mechanization in Agriculture Sector
In last few years, the agriculture production has been increased due to the modification in mechanical devices for farm practices. This section covers the recent automation in mechanical devices for farm practices:

2.1. Automation for the evaluation of soil parameters
Soil testing on a regular basis is a very important factor because 60 percent of the crop performance depends on the fertility of the soil. So, soil fertility is considered a major component in precision agriculture. Fertilizer application and crop fertilization pattern are based on the fertility status of the soil. Farmers have to go to the nearly soil testing laboratories that is a time consuming and very tough procedure for the busy farmers. These laboratories test the soil fertility on the basis of the soil pH, biological, physical and chemical properties of the soil. To overcome this difficulty of soil testing for the farmers, a device based on the sensors has been developed by Kumar that attains all the parameters by the use of ESP 8266 [3]. A website system has been attached that compares the parameter obtained through sensors with the existing parameters in the database. This website system helps the farmer to obtain information about the fertility of the soil and suggest different crops for various soils on the basis on the soil fertility status. The better selection of crops for the soil helps the farmer to get maximum production and so on in the precision agriculture.

2.2. Moisture Monitoring System in Precision Agriculture
Smart monitoring in Precision Agriculture is an important technique that is being used in a developed country to increase agriculture production to overcome the situations of food scarcity. This system includes the use of different communication and information tools to increase the quantity and improve the quality of agriculture commodities. This system uses automatic tools and sensors to control different farm machinery automatically to increase the working efficiency. Kamelia used YL-69 sensor for the automation of sprinkle irrigation system [4]. This sensor measures the soil moisture and automatically initiates the pump of the sprinkling system when the soil moisture level decreases below 15%. However, it stops the sprinkle pump when the soil moisture reached up to 45 percent. This system improves energy efficiency, time-saving and also conserves the water utilization. All the readings of the system are displayed on an LCD screen for the farmer that is compared with the values on a website system.
2.3. Use of Cyber Physical Monitoring System in Precision Agriculture

Cyber-Physical System is a new innovation that is being used in the modern world to improve the quality and quantity of agricultural crops. It has been seen that the mechatronic system changed with the CPS technique from the last twenty years. According to Rad, CPS system plays a significant role in the improvement of information and communication system for the farmer to advance the crop management in precision agriculture [5]. CPS system involves the use of necessary methods, devices along with automatic sensors, hardware systems and software programs that are dependent on the transdisciplinary mechanisms including valid principles of prototypes and testbeds. All this system helps the farmer in the implementation of precision agriculture by good agriculture practices to enhance the quantity and quality of crops through the use of improved information and communication system.

3. Advancements in the use of IoT Technology for Precision Agriculture

Internet of Things is a new technology that is used in the modern world for Precision Agriculture. This section covers the recent advancements in the use of IoT technology to enhance the efficiency of mechanical devices and systems in agriculture sector:

3.1. IoT Based Irrigation System Automation

Rajalakshmi and Mahalakshmi proposed a model of automation in Irrigation system by the use of IoT techniques. Internet of Things is basically a network of items that involves internet connection to play a role in the evaluation of a procedure. It is being used in the agriculture sector to enhance the performance of farm-level practices to increase the yield for the production of food for 9.6 billion people up to 2050 that are dependent on agriculture sector [6]. Agricultural practices like irrigation have been automated through the use of moisture monitoring sensors, Temperature sensor, humidity, and light intensity sensors. These sensors sent the measuring data to the webserver that have the standard charts already saved in the data server. This data is automatically evaluated by the programmer running in the web system and the results are then sent to the mobile App of the farmer. So, the farmer can easily assess the conditions of his crop and control the irrigation system automatically from anywhere.

Rao and Sridhar developed a Raspberry Pi based irrigation model automated on the basis of the IoT system. This system improves the production of the crop with the efficient use of irrigation water in the area of water scarcity. Two types of sensors work in this model in the circuit that measures the temperature, humidity and sunshine time during the day and sent the measurements to the database. Database quantify the requirement of irrigation water for the crop during the day and automatically initiates the irrigation system (Sprinkle or Drip irrigation system) if the crop needed water. This system conserves the water losses during irrigation and provides a sufficient amount of water that a crop needed, thus best suited in the area of water deficiency [7].

3.2. Application of IoT System in the Disease Prevention of Crops

Biotic stresses like insects, pests, and diseases are the major cause of agricultural losses. Disease prevention is a critical process that a farmer has to face. A new disease prevention system has been developed that is known as a decision support system (DSS) and proved to be effective against the control of potato diseases. This system has been effectively used against the control of fungal diseases in potato through the use of sensors to predict the environmental conditions. High-quality sensors are used to collect the climatic data and are then transmitted to the database through the use of IoT technology. This collected data is sent to the cloud IoT framework through an internet connection that assesses the data and evaluates the results. After that, farmer mobile receives all the information about climate and requirements for the application of specific fungicide for the prevention of disease. This system minimizes the cost of fungicidal applications and also prevents the disease on time [8].
3.3. Use of IoT Technique to Enhance Growth and Development in Plants

Through the application of real-time monitoring system in agricultural farms to improve the yield and quality of agriculture production, Scientists and Technologists are mainly focusing on IoT based precision agriculture. Different type of high-quality sensors is used to collect the data and then sent it to the database of a website system by IoT technology through the use of an internet connection. Recent research proposed duty cycling data analysis algorithms that enhance the energy utilization of a cropping system in greenhouses during cloudy or sunny days accordingly. This system has been proved very effective in the control of the energy system in a greenhouse thus reduces the energy cost and also decrease the production losses [9].

4. Conclusion

So, it has been concluded that the automation in agricultural farm machinery and devices has increased agricultural production as compared to the conventional use of farm machinery in the agriculture sector. Different type of high-quality sensors along with the use of IoT technology and high connection internet has revolutionized the agriculture production systems. These automation techniques have decreased the cost of production along with the increase in the yield of many crops. Thus, the development of new automation techniques and high-quality sensors has opened a new gate in the field of Precision Agriculture.

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