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Artificial Intelligence and Internet of Things In Agriculture – A Survey

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Abstract

Artificial intelligence(AI) and Internet of Things(IoT) are the most emerging technologies nowadays and has made technological breakthroughs in almost every sector. AI and IoT finds their applications in important areas of concern like healthcare, military, agriculture etc. In agriculture, increasing demand of productivity is endangered by different challenges like limited resources, climatic conditions etc. IoT make use of variety of sensors to monitor the field and AI on other hand is assisting agriculture experts to develop systems that can find efficient solutions to overcome different challenges. The combination of these two fields can help to achieve the concept of smart agriculture and will resolve lot of issues related to this field. This paper discusses the importance and applications of IoT and AI in agriculture field.

Keywords
Artificial Intelligence, Machine Learning, Internet of Things, Agriculture.

1. Introduction

Agriculture is the primary source of income in India and to some extent, development of India is hindered by the issues concerning farmers and agriculture. Due to environmental and climatic conditions, traditional farming results in low yielding of crops. The main issues that are faced by the farmers are soil moisture, inadequate water supply, attacks by pests and rodents[1], lack of mechanisation, soil erosion etc. which in turn results in low production. So, it is very important to introduce modernisation in agriculture with help of different technologies. IoT and AI are the major fields that are contributing in transformation of agricultural practices.

IoTis formulated from two words i.e. “Internet” and “Things”. Things refer to heterogeneous devices that are capable of performing sensing, actuation and monitoring and these devices in IoT are connected through Internet[2]. All these things are different from each other in terms of their capabilities, functionalities which impose great challenge to IoT experts to design communication protocols due to incompatibility issues. According to [3], by 2020 there will be 50 billion devices connected through IoT technology. These devices will be in different size and shape, some examples are wearable sensors, smart health tracker and watches, home monitoring, security and surveillance.

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IoT is an extension of Wireless Sensor Networks with scalability and heterogeneity as important parameters.

Artificial Intelligence is a technology by which human can make a machine intelligent. AI is the most emerging technology nowadays. Some of the sub domains of AI are machine learning, Artificial Neural Networks, Deep Learning, Expert Systems etc. AI has penetrated in almost each and every sector. Some of the examples are healthcare, agriculture, industry, education, surveillance etc. AI is a theoretical concepts that involves programming and algorithms and to implement these practically we need a hardware software interface known as embedded systems. So, using cross-disciplinary approaches based on computer science, mathematics, psychology etc., AI can be implemented in an efficient way. AI can be categorised into Weak and Strong AI. A system is designed to do a particular job. Examples can be video gamings, Alexa etc. whereas strong AI on the hand solves problems that do not require human intervention like self driving cars etc.

In thispaper we will discuss the importance of IoT and AI in agriculture. Section 2 discusses Importance and applications of IoT in agriculture followed by importance of AI in section 3.

2. Internet of Things in Agriculture

From farm to fork, IoTtechnologies could transform the sector, contributing to food safety, and the reduction of agricultural inputs and food waste[4]. Use of IoT in agriculture can bring solution to lot of problems. Easy to access and cost friendly platform for sustainable agriculture will help to provide an interface to share information regarding old sustainable methods and tools and helps interactivity between people[5] . Centralized repository for different kind of information such as traditional sustainable farming techniques, crop diseases, etc. extracted via different sources helps the user to follow interactive farming via user friendly interfaces such as mobiles, computers providing multi-lingual support of traditional practices with modern value.
Using IoT, different types of sensors can be deployed to measure humidity, temperature, gas concentrations, pressure, and vital signs, etc. [6][7]. Product information like model and name of product can be accessed along with the information like operating temperature etc. This sensor data has helped the researchers to implement smart agriculture systems. Using multiple sensors, humidity, moisture and density of soil can be measured which can be helpful in better understanding of soil conditionsand the use of various machineryand fertilisers etc.

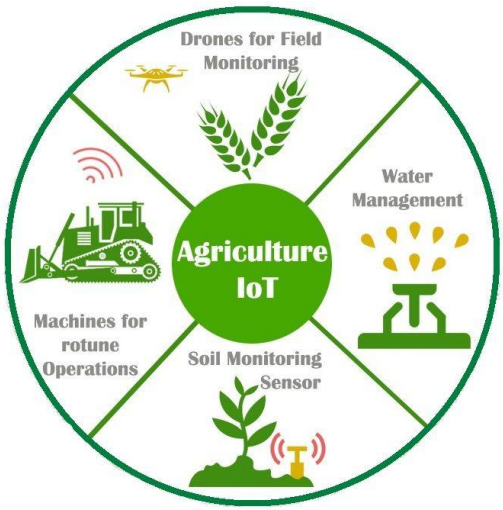

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Fig 1: IoT applications in agriculture

IoT has resulted in increase in profit, safety of food, sustainability, environment protection, better use of fertilizers, pesticides etc.

2.1 Applications of IoT in agriculture

a) Precision agriculture using remote monitoring systems in Brazil[8]

The experiment in this work was conducted in brazil with IoT device where system consist of the central node, monitoring node and the cloud and all these nodes have sufficient energy as they are equipped with solar panel to provide continuous energy. Water irrigation processes are detected by sensors and the collected readings were very close to the measurements taken by professional devices. Temperature of soil, conductivity and humidity were measured to monitor the soil conditions. Then, the collected data is transmitted to the cloud. This technique was helpful in preventing soil erosion.

b) IOT Based Monitoring System in Smart Agriculture[9]

This work focuses on smart agriculture application. It is used in measuring temperature and humidity of the soil through sensors using CC3200chip which consist of processor, micro-controller and Wi-Fi on the same die. Temperature and humidity data is captured and if it exceeds or fall below the threshold range, it is sent as MMS to the farmer. This experiment can improve crop harvesting and live monitoring of crops can be performed and if needed, corrective actions can be taken. It is low cost experiment that requires very less power. Architecture is shown in Fig.2.

c) Agro- tech: A digital model for monitoring soil and crops using internet of things (IOT)[10]

This work is based on both sensing and actuation. Different sensors monitor different parameters like temperature, water level, humidity etc. and these readings are combined and are stored and record is maintained which is accessible by farmers so they can monitor their crops. Based on the sensor reading, decisions are taken for actuators. For example, if moisture of soil is low then threshold value, motor is triggered to maintain water level. Important information is sent to the farmers. This work is find useful where crop growth is very power and sacristy of water is the problem.

d) Smart water dripping system for agriculture/farming[11]

This work also deals with water scarcity problem in agriculture. pH, moisture and temperature sensors are used to measure water level and based on the reading motor is derived by the micro controller. this helps in supplying accurate water supply to the crops. Information is sent to the farmer

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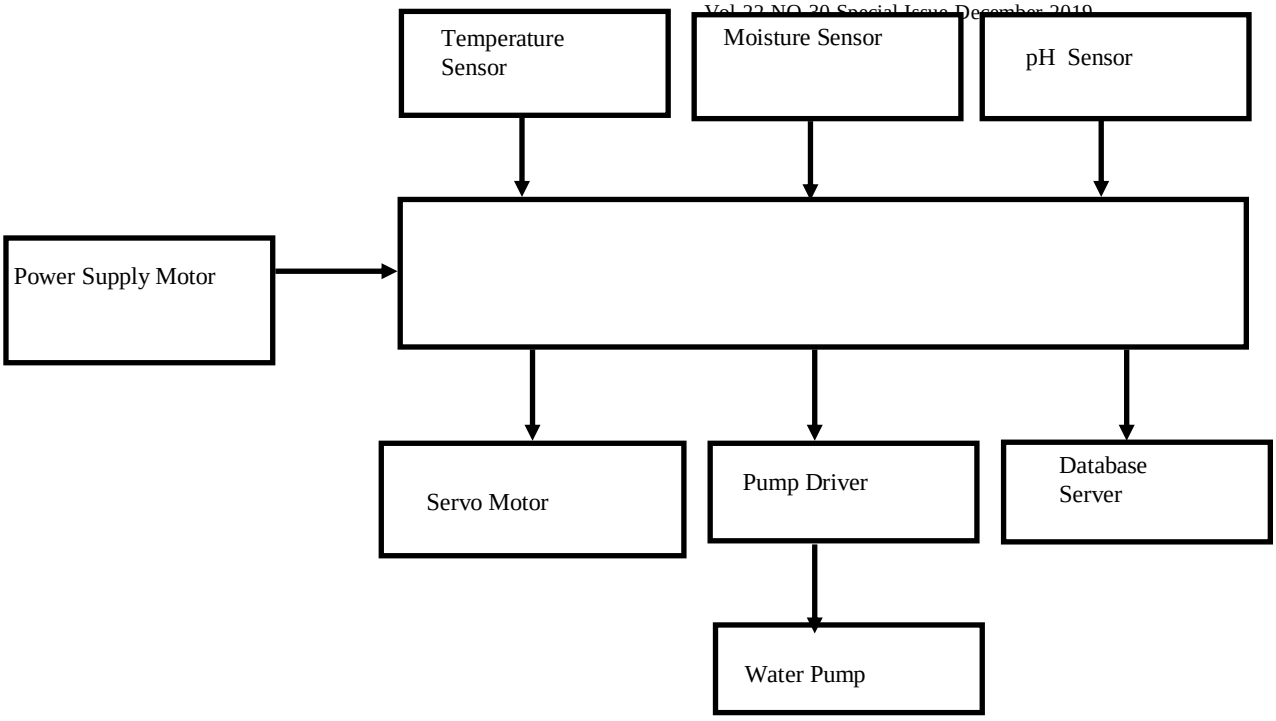

through the MMS. This approach is useful in reducing the human effort for monitoring and taking care of crops. But the approach is not energy efficient, as it consumes a lot of power.

e) Rice crop monitoring system—A lot based machine vision approach[12]

Rice crop is one of the main production in India. But around third seven percent of crop is affected by a disease named "Xanthomonasoryzaepv(XOO)".This work deals with the prevention of spreading of the bacteria so that crop can be prevented from damage and productivity be increased. When a plant is effected by the above disease, the infected part is detected and pesticide is sprayed automatically on the infected area. So, by this approach pesticides are only sprayed on affected area which in turn reduces human effort. Multicolor detection is used to detect the crops at any stage.

Fig 2: Block Diagram of proposed system[11]

3. AI in agriculture

Among all AI domains, expert system is the most widely used field in agriculture applications. Expert system is a computer program that solves the problems at level equal or greater than human expert[13]. Expert system simulates the judgment and behaviour of a human that has expert knowledge and experience in a particular field. Knowledge base is the most important part in expert sys-

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tem. In agriculture there is a need of expert system as sometimes decision needs to be taken according to the currents situation of the field or crops. In agriculture, there are a number of implementations of expert system mainly in pest control and disease diagnosis. We will discuss some of the applications of AI in agriculture using expert system.

a) An Expert System for Diagnosis of Diseases in Rice Plant[14]

In this work, expert system is developed using ESTA. First the problem is identified and its characteristics are understood. In this work, they have considered diagnosis of rice plant disease.
First problem is analysed then knowledge acquisition is performed. For a given problem first the solution is seemed from human experts. Knowledge received is analysed to reach possible conclusion, then it is transferred to IS experts for further amplification. When possible conclusion is reached, expert system model is developed based on that. After this step, knowledge is represented using knowledge base. In ESTA, it is represented using if-then rules. Knowledge base will be generated for different diseases of rice which will help farmers to solve such problem without an agricultural expert.

b) Expert System on Barley Crop Management[15]

For barely crop management and production, an expert system is developed in [e3]. This expert system contain a knowledge base and respond to queries of the users. Farmers can interact with the expert system and their problems are given solution. Solutions are provided based on if-else based on area, sowing condition and time. Required information will be provided to the farmers in need and based on that decisions will be taken.

c) Study on Expert Systems Developed at CLAES [16]

The Central Laboratory for Agricultural expert Systems(CLEAS) [e4] deals with maximising agriculture production by helping farmers with optimal use of resources. In CLEAS, different experts systems are developed. For Cucumber Crop Production, expert system is developed known as Cuptex.For orange production, it is known as Citex which help the farmers with diagnosis and treatment of diseases related to oranges.For tomatos, expert system is known as Tomatex. For lime production, it is Limex.

d) AGRIDAKSH[17]

AGRIDAKSH is a expert system tool for various crops that provides solution with minimum involvement of experts. This tool can be accessed from the site http://expert.iasri.res.in/agridaskh. First this tool was used for maize crop known as MaizeAgriDaksh. The interface is user friendly with images so that user can get detailed information about insect identification, variety selection and post harvest technology.

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Conclusion

This paper presents the importance of IoT and AI in agriculture. IoT and AI are the emerging fields with applications in almost all major sectors. In agriculture, these fields can bring a great revolution altogether. IoTcan be used to detect the conditions and parameters of crops with the help of sensors. Data will be generated using IoT that can be used by AI to provide expert system knowledge to farmers so that they can take decisions for their crops with intervention of human expert.

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