A Review of Agro-Industry in IoT: Applications and Challenges

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Abstract

IoT and WSN, the two emerging fields, introduced efficient and reliable agricultural and livestock monitoring. Researchers are focusing these fields to introduce several new trends and techniques for agricultural automation industry. The automation industry is now seeking new opportunity in the field of agriculture and livestock. The idea of IoT is to embed a particular framework by adding computer software, sensors, and actuators and to establish the connection over internet for the purpose of uploading and processing the data over a cloud. However, IoT devices require less processing power, limtited life, heterogeneity support, platform independence, RFID, WiFi and blutooth. This support made IoT devices more suitable for the remote sensing. It is used to perform rapid and quick response on decision managment. Micro-controller technology has several application areas in agriculture where IoT devices can be implemented for the further monitoring, processing and upload semantics which improve the agriculture automation industry and crop product. In this paper, IoT in agricultural and its respective applications and challenges are discussed.

Keywords—IoT, machine learning, agriculture.

1 Introduction

Internet of things (IoT), also called internet of everything (IoE), is a growing network of smart physical devices with the integration of the sensors, actuators with smart energy . IoT is the network of physical objects having heterogeneous nature which can work together for a specific purpose. IoT is one of the leading technologies these days for the development of industry, education, health and agriculture. Monitoring and recording the events in real-time has made it easier and convenient to get up-to-date information about the agriculture. The smartness of the devices brought a revolution in human life with several real-life applications [3]. IoT covers almost all fields of life. Any device, any time, can be fixed anywhere without any restriction for getting the things better. The idea of IoT is to embed a particular framework by adding computer software, sensors, and actuators and to establish the connection over internet for the purpose of uploading and processing the data over a cloud. However, energy is a main concern due to limited battery life and it constraints the processing power of IoT, but at the same time it makes IoT suitable for remote sensing and processing [4]. Micro-controller technology has brought new trends and developed in several application areas where IoT devices can be implemented.

1.1 IoT and the World

IoT became more prominent technology since last decade. The population of IoT devices has been increasing day by day. According to international data corporation (abbreviated as IDC), the 2013 prediction about the IoT devices was an estimated number of 41 billion IoT devices till 2020. This increase of the IoT devices may lead a revenue of about $8.9 trillion in the world. The purpose of the increase growth of the IoT technology and smart devices is to switch from the problem of manually developed methods to smart automatically controlled systems. Furthermore, connectivity of the internet made it easy to upload statistics over cloud for further assessment [5]. Cloud computing is the part of internet of things which offers the remote data access facility over the internet without the problem of distance. It is basically a solution to

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remote data access problem and offers several features such as security, reliability and authenticity of the data access. IoT with integration of different technologies offers efficient and reliable methods of automation without the human involvement.

2 Related Contribution

IoT's major contribution related to the latest methods and techniques brought remarkable changes in computational science and several applications are made in this regard for the easiness. It covers almost all fields of life such as the robot-based model designed in [9] which works in the field and performs several tasks automatically. In their study, a remote GPS-based robot system has been introduced to work in the remote places. The robot can perform a number of tasks in a field such as weeding, spraying, soil monitoring and moisture monitoring, etc. Furthermore, it can also control irrigation system by statistics of soil status [6]. The important parameters monitored in this study include temperature, humidity and theft detection. The study in [6] focuses on agricultural soil monitoring with the effective usage of the soil monitoring using soil sensors. Soil sensors are deployed in the field for monitoring agricultural soil status. The objective of this study is to enhance the quality of soil and improve the crops production. The concept of remote monitoring is focused in this study for the evaluation and monitoring of the soil. Smart irrigation control is focused in [12] where a smart module of the Wi-Fi kt is deployed for the internet connectivity to upload and connect the IoT kit with internet. In their work, a number of sensors are deployed in the field where all the sensors are connected with smart micro-controllers [7]. The automation industry is now seeking new opportunity in the field of agriculture and livestock. Agricultural crop disease diagnosis has become easy which is a crucial part of the researchers' focus in these days.

The concept of remote monitoring is focused in another study [17] for the evaluation and monitoring of the soil. Smart irrigation control is focused in this study where a smart module of the Wi-Fi Kit is deployed for the internet connectivity to upload and connect the IoT kit with internet. In their work, a number of sensors are deployed in the field where all the sensors are connected with smart micro-controllers. After connectivity, the data is uploaded over an android application for updating the status of agricultural soil which is obtained from the soil and temperature sensors.

3 Applications of IoT in Agriculture

IOT is gradually becoming the important stockholder of the industry due to its reliability, efficiency and smart working principle. With help of other emerging technologies such as sensor, micro-controller and actuator [1], IoT framework can sense the data from environment.

3.1 Agricultural field Monitoring

The traditional methods of monitoring agricultural fields are very time consuming and also have lack of accurate field monitoring. The sensitive parameters of the agricultural fields cannot be monitored with acceptable accuracy. Plants diseases are very important factor and have direct impact on agriculture product and it is very difficult to diagnose them manually. IoT technology is one of the interesting aspects of the IoT smart frame work. The automated calculation of the product samples and the quality measure features can easily be implemented by the help of smart monitoring of the precision agriculture frame work [2]. The harvesting in fields are very critical for the IoT based agent like robots. These robots can work efficiently with the implementation of sensor based technology and actuators for moving and performing the harvesting tasks. For this purpose, a number of sensors are needed to implement such as temperature, humidity, human detectors, locomotion, etc.

3.2 Green House Monitoring

IoT technology, with emerging role of the related fields, have brought a revolution in automation of the real life. Agriculture science is one of the most important area of focus in these days. The parameters includes temperature, humidity, soil monitoring and evaporation rate of water, etc [13]. These physical parameters can be measured with implementation of the micro-controller based smart devices having integration of different types of tiny sensors. Sensors are smart devices used to measure the physical parameters of the environment. Improving smartness of the agricultural farming LM–35 temperature sensor is used to measure the temperature of the fields. PIR sensor is used to measure the radiation from the devices. Likewise, soil moisture sensor are used to monitor the real time status of the agricultural soil.

3.3 Agricultural Drones

IoT with drone technology has become very popular in modern technology which can monitor and regulate the activities of any environment. In agricultural

S.No	Author Name & Year	Contribution
1	Goldstein, A., Fink, L. (2018).	Crop yield prediction from the collected data form soil and environmental variables which applied on eight plots. However machine learning algorithms applied different for the classification and regression of the efficient crop yield.
2	Ana Laura Diedrichs (2018)	Presented a model of machine learning algorithms which predicts the agricultural frost prediction system on the basis of different condition of the crop yield. They monitored thermodynamics conditions from the environment to predict suing training set of the data obtained from sensors.
3	Anat Goldstein1 , Lior Fink1, Amit Meitin1(2017)	The study is about predicting irrigation recommendations. Different regression and classiïňĄcation algorithms were applied on this dataset to develop models that were able to predict the weekly irrigation plan as recommended by the agronomist.
4	Keith H. Coble (2018)	An efficient analytical techniques related to the agricultural and applied economics contribution. Big data concepts are discussed in detailed which is part of the research and development of the agricultural data analytics.
5	Tiantian Yang et.al (2016)	A robust reservoir outïňĆow simulation model is presented, which incorporates one of the well-developed data-mining models (ClassiïňĄcation and Regression Tree) to predict the complicated human-controlled reservoir outïňĆows and extract the reservoir operation patterns.
6	Sami Khanal et. al (2017)	A review focuses on the application areas of thermal RS in agriculture discussed here include irrigation scheduling, drought monitoring, crop disease, detection, and mapping of soil properties, residues and tillage, field tiles, and crop maturity and yield. Some of the issues related to its application include spatial and temporal resolution, atmospheric conditions, and crop growth stages.
7	Rehman, T. U.(2019)	The study is to review the statistical machine learning techniques including supervised and unsupervised learning for the agricultural environment. The study is to apply machine vision approach in agricultural data and suggest some future implementation of the machine vision approaches.
8	Park, S (2016)	The study is to research six drought factors were selected based on the relative importance by their category to develop drought indicators that represent meteorological and agricultural drought by using the relative importance as weights. While TRMM showed higher relative importance for meteorological drought, LST and NDVI showed higher relative importance for agricultural drought in the arid and humid regions, respectively.
9	Vineela, M. T (2018)	Automated irrigation control with the same approach is also discussed in (Vineela et al.). The study also focused on the implementation of the IoT and WSN technology for the monitoring of the water stress in the pipe, water need in the agricultural field with the water arrival of the each and every part of the crops.

TABLE 1: IoT and Machine Learning Research Contribution

science, the drone technology can be used to monitor the activities of the agricultural crops [1]. The drone technology brought revolutionary changes in the agricultural monitoring activities with accuracy and frequent updates which is difficult to manage by using traditional methods. A number of activities can be monitored using the drone technology such as spraying the plants with desired amount of pesticides, and monitoring the theft of the crops from the premises of the agricultural farm, to name a few. Drone technology can be implemented in the agricultural 3D maps which are very important for seeding and spraying the fields. Pod shooting with the nutrition of the plants and the soil level nutrition can be monitored by using the drone technology. Drone technology is also useful for the remote sites monitoring of the agricultural fields to monitor which area is dry and which one is wet, so that the necessary measures can be taken for the improvements of agricultural crops.

3.4 Livestock Monitoring

IoT, with the implementation of the emerging fields, has turned out to be an efficient way of the livestock monitoring [10]. Livestock monitoring is used to monitor location and health parameters such as temperature, blood pressure measurement, etc, and the environmental parameters of the animal farm such as temperature, humidity and carbon dioxide of the farm area where animals are kept. The herd area can be monitored easily using the sensor technology and IoT has made it easy to perform real time monitoring time to time. Animal monitoring has become easier to implement with the help of GPS system for the detection of animal location. The animal location with

continuous monitoring is very important for an animal farmer. In the area where animals are moving and have the proper grass monitoring is also important in this regard. The feasibility of grass status can also be investigated by the implementation of a smart IoT framework.

3.5 Smart Irrigation Control

Water supply regulation and controlling the water usage in agricultural field is a very important area of research. The time management of the water pouring in the field is very important for the soil. This gives the need of IoT to give the automated status of the soil. The soil update and water level measuring is important for the automated water supply management. IoT gives a method of smart agricultural field monitoring to check whether the agricultural area is completely poured [14]. The implementation of the smart IoT framework can enhance the capability of the agricultural field monitoring better than the traditional methods. Polluted water is a big issue in Pakistan, especially for the agricultural crops. The water quality can also be measured easily with the implementation of water quality sensors that measure the water pollution.

3.6 Agriculture Warehouse Monitoring

In agriculture water monitoring, IoT has brought the concept of smart warehouse monitoring. IoT enhanced this capability with a very rapid and fast threat detection. Agricultural warehouse can be monitored real time with the implementation of the human detection sensors, temperature status of the warehouse by the temperature sensors, and other important parameters related to the staff monitoring and owner awareness related to the warehouse status [16]. This can be achieved by the implementation of the IoT devices with cloud connectivity and having the proper updating mechanism for the owner. Anything, any time, can be connected and monitored with real time update. IoT made it an easy and smart solution to monitor the real-time environment of the warehouse and detect potential threats to the products.

3.7 Soil Monitoring

Soil is a key component for the agricultural crops. For monitoring the soil, IoT made it easy to control and coordinate the changes in soil. Nitrogen (N), CO2 and other important parameters can be monitored and updated to the cloud in real time. A robust recommendation system can be designed for the betterment of the soil fertilization [18].

4 IoT Challenges

The challenges in the field of IoT are summarized as follows.

4.1 IOT Security

In IoT, security and privacy are one of the most critical issues and special focus of research these days. Some of the things can be more important with the aspect of security. It is a real challenge to integrated proper security mechanisms in IoT devices due to their heterogeneity. Several security threats have been found in the smart IoT devices during the environment monitoring. According to the report of enterprise firm in 2013, 25% of the device manufacturers are not computer related firms and have no professional knowledge of the computer security risks. They manufacture the devices like game devices, monitors like toys and other home usage electronic products. This has led to the weak security management for the implementation of the IoT in smart monitoring to provide security against the unwanted attacks. The personal information and important data can easily be captured if the weak security policies are followed in the smart framework, despite of the fact that IoT devices are very smart and can perform rapid and efficient job in any environment of real life. The device infrastructure deployment needs certain parameters for the focus of the study.

4.2 Battery Life

There are several factors which which can directly impact the battery life of the IoT devices such as heterogeneity of the devices, large data processing, less energy power and longtime processing. In remote areas, IoT devices are often deployed with the sensors and actuators to monitor certain parameters in real time. In this sense, the power consumption is very important and devices are deployed with chargeable battery. However, in remote places, it is very difficult to provide the proper power for the devices. It is important to manage the power source for the battery life time. A plethora of research has been conducted on the energy efficiency and energy efficient protocols for the IoT technology deployment. It is also very important research area in this regard for the future improvement of the IoT technology in real sense.

4.3 Heterogeneity of the Devices

Heterogeneity refers to the devices having different nature and architectural structure with different features of working capabilities. IoT provides flexibility in terms of heterogeneity, but also introduces few issues

Sensor	Application
Soil sensors Volumetric water content sensors Tension meters Soil profiling	Measures soil water volumetric content, soil water potential, soil moisture respectively
GrainPro EcoWise Standard	Wireless system designed to remotely monitor the temperature and humidity
Wind Speed (PK 100-02) and direction (110 âĂŞ 2) sensors	Measures the speed and direction of the wind
Pyrometer (PK 200 - 03) and solar radiation (200 - 04) sensors	Measures the intensity of the solar radiation
Water sensors: OTT Orpheus Mini Water Level Logger OTT ecology 500 Water level logger OTT CTD sensors	Used to measure the water pressure, water level, water pressure and water conductivity

TABLE 2: Agricultural IoT devices

which can be difficult for the real time monitoring, e.g., security and connectivity issues. The security in IoT is very crucial due to different nature of the devices having their own vendor configuration, connectivity, memory and security policies which may not be compatible with other devices and can cause serious problems in IoT devices connectivity.

4.4 IoT Agricultural Advance Sensing Devices

Some of the IoT devices are related to the specific applications that are sometime called application specific devices. These application have their own merits and demerit related to the platform and device compatibility.

5 Conclusion

The study presented in this paper provided an overview of IoT and emerging technologies which covers the agricultural monitoring with several IoT devices. The new applications were discussed which are latest focus of the study in the research community. Furthermore, it can be more comprehensive if other areas of the livestock is merged for the further implementation of the study. The new applications can also be developed if required. IoT provides the ease of heterogeneity, but still has certain issues which can be difficult for the real time monitoring, e.g., security and connectivity.

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