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A Survey of Internet of Things (IoT) in Agriculture

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Abstract

This paper ventilate the use of Internet of Things in Agriculture applications. Internet of Things (IoT) enabling the platform for the research in agriculture and environmental monitoring domains. IoT enable Technologies now become the most boon of farmers. In contravention of newer concept in the agriculture industry, there has been a tremendous popularity in the agriculture with the benefit of smart farming. IoT helps farmers to in- crease the quantity, quality, conservation and cost effectiveness of agriculture production. The trending and future technologies like IoT, Digital Image Processing, wireless sensor networks has demonstrate their evitable accomplishment in different applications individually. The idea of work manages combining these advancements in agriculture sector which requires present day mechanical impressions.

Keywords: Internet of Things, Precision Agriculture, Wireless Sensor Networks, Arduino, Drones.

I. INTRODUCTION

Agriculture is one of the rare industries where the technologies has not been accepted in the large scale, one of the reasons behind that is the economic condition of most of the farmers in India or any developing country.

II. LITERATURE SURVEY

2.1 Need

Increase the yield of crops is the current need of any farmer. This is possible if he do continuous monitoring land parameters and disease identification for taking further corrective action. So using Internet of Things technologies in agriculture applications for increasing the yield of crops.

2.2 Internet of things (IoT)

The internet of Things (IoT) [1] is the latest buzz word in everywhere. Internet of Things objects are connected with sensors or controlled remotely across existing network and create direct integration to computer. IoT is continuously getting momentum rapidly and predicted to be the most significant factor that impacts fundamental business logic in the future in all the industry. Through the Internet of Things, improved efficiency and more accuracy can be obtained with the result of economic benefit in addition to reduction of human intervention.

Internet of Things (IoT) applications can be evolved between the people, between people and things, between things and things. Presently there are about 4.6 billion connected devices (excluding phones, tablets and laptops) and also expected to increase to 15.3 billion in next five years according to the Ericsson mobility report. According to Business insider intelligence report, in worldwide 34 billion number of IoT connected devices will be in use by the year 2020. IoT applications [2] can be found in every industry including application for smart homes, smart buildings, transportation, Health and personal care, retailing, smart farming, construction industry and so on.

Since the Internet of Things (IoT) continues to gain momentum rapidly, IoT ensures benefits in

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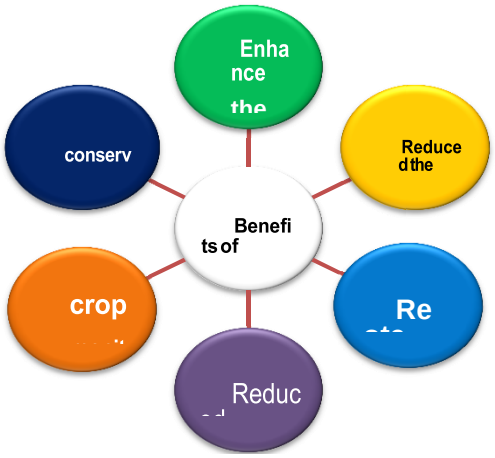
different horizons in every industry.

2.3 IoT in Agriculture

Internet of Things (IoT) has made the tremendous changes and gained prominent role in agriculture. Internet of Things (IoT) is a shared network of objects or things which can interact with each other provided the Internet connection. Agriculture will become more important than ever before in the next coming decades. According to the UN Food and Agriculture report. The world will need to produce 70% more food in 2050 in order to meet the need of estimated world population of 9.6 billion people .To meet this demand, there are so many technologies are being adopted in IoT. Smart Agriculture helps to reduce wastage, effective usage of fertilizer and thereby increase the crop yield. IOT technology can reduce the cost and enhance the productivity of farming .Agriculture industry is accountable for fulfill the need of food.

2.4 Need for digitization of agriculture

Internet of Things (IoT) plays a crucial role to meet the growing needs of food in agriculture and resulting of improving the efficiency by effective use of inputs like soil, fertilizers and pesticides, monitoring the livestock, predict the pest and diseases, scanning storage capacities like water tank level , monitor the crops are fed and watered well. Smart farming increases the productivity with a reduced cost. Smart farming is a rapid catch concept in the agricultural business. Farmers are using various technologies including sensors, drones, smart irrigation, terrain contour mapping, self-driving and GPS enabled tractors, robota to get the result of efficient food production and conservation more sustainably.



Need for Digitization [23]

There will be heavy pressure on existing agricultural land to ramp up the adequate production for future decades. Agriculture has a significant role as it has witnessed profound changes during successive decades using IoT. Internet of Things (IoT) has made tremendous changes and gained prominence role in agriculture [3] as to improve the farming and there by farmers can improve the productivity with cost reduction and aslo can be monitored the field even in remote. Besides crop monitoring weather monitoring and smart irrigation many farming activities easily access in smart farming using IoT. In smart farming [4] , farm land can sense process and precisely measure the environmental data in platform where the technologies includes sensors, microcontrollers, transmitters

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and drones and more.

2.5 Productivity

Smart farming is a buzz word popular among agriculturalists. IoT plays phenomenon role in making agriculture smarter, economy. Now a days it's very critical to yields from every acre of land dedicated to food production. In order to overcome the farming issues as to meet the demand, farmers are implementing various IoT enabled techniques to enhance the productivity with existing farm land. IOT technology helps in collecting information about conditions like weather, moisture, temperature and fertility of soil, Crop online monitoring enables detection of weed, level of water, pest detection and animal intrusion in to the field, crop growth, and agriculture. IoT enabled Smart farming Benefits of IoT smart farming Enhance the productivity Reduced the human intervention Remote access Reduced the cost crop monitoring g conservation n sensors, drones, smart driving and GPS result of efficient food production and conservation more sustainably. There will be heavy pressure on existing agricultural land for future decades. a significant role as it has witnessed angels during successive decades using) has made tremendous changes and gained prominence role in agriculture[3] as to improve the farming and there by farmers can improve and also can be the field even in remote. Besides crop monitoring weather monitoring and smart irrigation as farming activities easily access in smart farming , farm land can sense, the environmental data in platform where the technologies includes sensors ,micro and more. Smart farming is a buzz word and getting plays phenomenon efficient and very critical to maximize yields from every acre of land dedicated to food the farming issues and are implementing the various IoT enabled techniques to enhance the productivity with existing farm land. IOT technology helps in collecting information about conditions like weather, moisture, temperature and fertility of soil, Crop f weed, level of water, pest detection, animal intrusion in to the field, crop enabled Smart farming systems.

2.6 Pest Control

Every crop requires different atmosphere and should be monitored in appropriate time. Crop should free from pest and weed .Healthy crop yield the maximum production or else farmers have to suffer from big financial loss. It's very critical to identify the pest in whole crop production. Pest control sensors monitor the pest population and environmental parameter [5]. Implementing the IoT enabled pest control sensors, farmers can track the complete record of pests attack .Based on the data, and pesticides are automatically sprayed in to the field. Wireless sensor networks monitor and detects the pest population is high, its metered chemical delivery system automatically activates and keep crop healthier.

2.7 Conservation

Farming is crucial to carry out the various farming activities and ensures the maximum yield. It's entirely depending on right irrigation based on perfect weather, pest management, crop management and more .Despite even right irrigation facility and traditional activities, sometimes farmers should face the drought and flood condition or pest attack. In order to overcome such problems, farmers require precise. Internet of Things enabled technology helps to make precision and collect real time information to help minimize waste, prevent over and under watering and proactively manage water costs. Besides, IoT embedded wireless devices and soil monitoring systems helps farmers can measure moisture detect

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leaks and more efficiently, manage energy usage, pest management, everything in real time. Smart technology makes easier that all the activities can be done from a distance. Implanting remote sensor, farmers can plan cultivation, irrigation and harvesting time, according to soil temperature, humidity, weather condition. In such perfect environment, farmers can conserve the crop and can enhance the productivity.

2.8 Applications and Contribution of IoT in Agriculture

The Internet of things (IOT) is reconstructing the agriculture industry by enabling the farmer with wide range of techniques to face challenges in the field. With the IoT enabled Techniques, Farmers get connected to his farm from anywhere and anytime. Wireless Sensor Networks are used for monitoring the farm and micro controllers are used to control and automating the farming processes. Wireless cameras and sensors have been used to view the farm remotely and to can determine the conditions in the form of images and video. A smart phone can also empowers farmer to update with the ongoing conditions of farm land using IOT at anytime and anywhere of the world. IOT enabled technologies can reduce the cost and enhance the productivity .Smart sensors have been placed for monitoring, irrigation, pest management and prediction of weather to ensure the quality crop cultivation. a series of some other IoT enabled technologies are also used for Tracking the condition of farming equipment's; Smart irrigation system fueled by information related temperature and humidity; auto temperature for storage space; Detect and tracking of pests to instantly regulate the pest control system; Internet of Things applications are getting more prominence in agriculture which include precision Agriculture, crop ,field monitoring, farm vehicle tracking, livestock monitoring, storage monitoring, and much more. For example Soil sensors will alert farmer's about the abnormal and irregular conditions like high acidity, which leads to give time to farmer for reconcile the issue and produce crops in better .Some of the applications and contributions of IoT as discussed.

2.9 Precision Agriculture

Precision agriculture is the farming technology using IoT. It predominantly involves the processing and analyzing of gathered data in the field to determine efficient crop production. In precision agriculture farmers collect the data using sensor and analyzed for forecast. Collected data helps to plan the farming activities and helps farmers to know what seeds to plant, the amount of fertilizer they need to use, the best time to harvest and the expected crop outputs. Implementation of IoT, farmers can also monitor the field using sensors to detect soil moisture, crop growth and livestock feed levels. The sensors are able to remotely manage and control irrigation equipment. The IoT connected devices analyses the collected data on the land allowing datain formed decisions on planning the resources and harvesting of crops. The traditional method of farming to increase yield and protect crops was dependent on physical evaluation and sometimes is there any problem, it can be rectified mostly after severence affecting the farm and can be resulted in trial and error basis. But in Precision agriculture using IoT applications, everything can be precise earlier and can act as per collected data accordingly. ioT technologies which are helping farmers to increase the quantity with quality, sustainability and cost effectiveness of agricultural production. Farmers should face with a number of challenges such as water shortages and flood; the limited availability of suitable lands for crop plantations; and management of costs. By implementation of internet of things system and related technologies helps the farmers reduce potential missteps and maximize yields.

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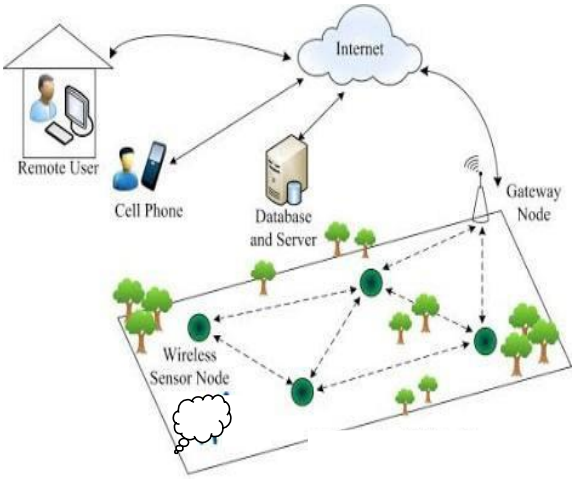
2.10 Crop- Field monitoring

IoT sensors are capable of providing information about soil moisture, temperature, humidity, Light crop yields, rainfall, pest , and soil nutrition are invaluable to production and provides precise data to improve farming techniques over the time. The data collected from sensors ensure that all the farming operations are executed well and effectively. In IoT enable crop-field monitoring system, farmers can easily precise the activities as per the information transmitted. In smart field system using IoT, sensors will be placed in field [23]. Data will be collected from the Sensors and collected data will be sent to Web server database using wireless transmission. The data are encoded in JAVA Script Object Notation (JSON) format in server database.



IoT in Farm

Agriculture Internet of Things ensures accurate and timely communication of real time data Thereby farmers can take the appropriate and dynamic decision in agricultural processes like plantation, irrigation, harvesting and farmers are able to plan their course of action prior and take preventive measures for future contingency

In Smart Field monitoring system, Different Sensors have been placed in the field like

- Sensor for soil moisture.
- Sensor for Controlling water irrigation according to need of plant.
- Sensors for Detect the pest and appropriate level of fertilizers.
- Determining the optimal time to plant and harvest.
- Sensor for knowing weather conditions.

Sensors and connected devices have been used farming as to achieve best result in production.

2.11 Smart irrigation system

Adequate water is an essential for agriculture and the crops can be damaged in either situation of excess of water supply or scarcity of water supply. Water supply at the right time at the right quantity is vital for crop's growth. Internet of Things enabled technology works on integration of Web Map Service (WMS) and Sensor Observation Service (SOS) and provides a solution about water requirement, supply for optimum irrigation. Agriculture Internet of Things analyses the water requirement of crop and utilizes the water resource as to reduce wastage of water and conservation of crop.

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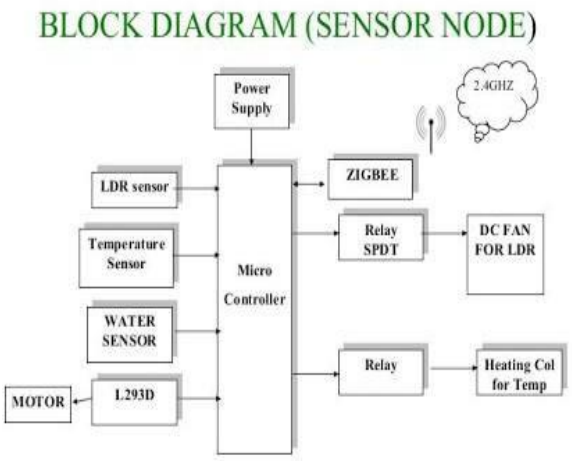

SMART IRRIGATION SYSTEM - SENSORS

With the use of connecting humidity sensors, water valves can easily manage water supply of irrigation. Humidity sensor smartly measure the soil moisture and operate automatically as per the data without any human interventions. Leakage in the water pipes can also be detected. In drought areas Crop water management operates efficiently and IoT proves its great value as it manages the limited water supply smartly with least wastage of water resource by calculating the valve operation timing and building optimum irrigation strategy. Unauthorized water consumption also detectable (if any). IoT technology helps conservation of water resources by monitoring irrigation through remote sensing technologies. Smart connected sensor sprinkles the water supply work with smart way is a great example of the application of IoT in agriculture [23]. Smart irrigation works with the water meters and sensors and work automatically as per moisture level, smart water meters and sensors are connected with motor and farm land. Smart connected meters notify about the water level and usage can help prevent misuse and underutilization of water resources. The smart sensors helps to know about the moisture level in lands and sensor data can operate in the meter by switching it off or on. The meter can be automatically switched on or off depending on the need of irrigation and level of the water resource. Moreover, smart sensors alert the farmers when detect the faults in the irrigation system in a real time and can easily prevent draining of water.

2.12 Livestock monitoring

Livestock monitoring system is Cattle Watch system. This hardware/software cloud-based technology is used to remotely monitor the health status of livestock and helps to identify location of livestock under power sensor and communication platforms. Alert system is implied under this system. The users are alerted by phone, text, or email if any condition falls outside of a preset parameter. As a result, users can easily access the real-time data from their homes or offices even by smart phone. IoT livestock monitoring system involves the placement of devices in the animals which assembles comprehensive information about their bodies and gathers data on health of the livestock. Livestock monitoring systems are used for cattle, broiler, swine and milk production. Wireless IoT applications helps farmers to gather the data related to health and location of livestock and farmers are able to track position, counting and other related information of livestock in cattle. Livestock monitoring system ensures the real time data to identify sick animals and they can be pulled from the herd, also prevent the spreading of disease.

2.13 Weather monitoring system

Climate and weather is most influencing factor in production of crop. Based on IoT enabled weather monitoring system, farmers can determine the optimum time for Plantation, irrigation,

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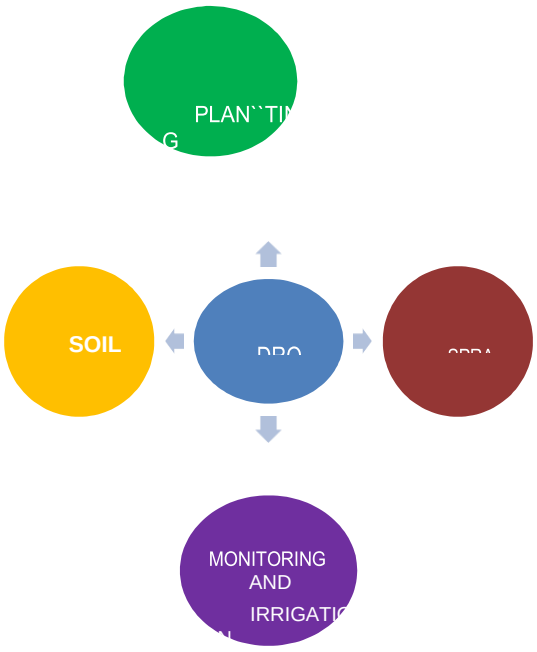
harvesting. In IoT application, Predictive weather models are constructed using sensors. By implanting the remote sensors which are placed in field, farmers are able to know the data about weather conditions including status of the soil temperature, humidity, air temperature. Based on the data, farmers can plan accordingly and change the harvest and irrigation time to improve the plant. By organizing and analyzing collected data, farmers can take pre-emptive action for healthy harvest of their crops.

2.14 Smart Drones

Precision agriculture is based on the incorporation of advanced technologies in the crop management and smart cattle management to increase the effective output. Drones are part of the technology solution.



Internet connected drones can help the farmers in the following ways Drones are used in the field for precise early soil analysis, which are helpful in planning of seed planting patterns. After planting, drone-driven soil analysis provides data for irrigation management. Drones are useful in planting in which farmers can shoot pods with seeds and plant nutrients into the soil. Drones scan the ground and spray the correct amount of irrigation and also monitoring the crops in the fields. Drones enable better crop management and can improve the production efficiency. Based on the weather condition, drones make the irrigation accordingly. Besides connected drones can be used for spraying pesticides when it detects the pest and weeds and monitor the crops over time. Drones taking care of orchards and fields Offering high-precision crop control, useful data collection, and automated farming techniques, there are clearly many advantages a networked farm has to offer.

2.15 Self-driving and GPS enabled tractors

Smart farming is a concept quickly catching in the agriculture. PS based navigation for Tractors monitor in a timely efficient manner. GPS devices and connected sensors on the field and in farming equipment such as tractors generate real-time data that is stored in cloud based systems that can be accessed by farmers via charts and reports to improve crop yields and water utilization. Self-driving and and GPS

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enabled tractor is another IoT enabled application and results in efficient and reduce the human intervention.

III. CONCLUSION

The world is being inter connected and all the industry becoming smarter, intelligent and efficient. One of the newest trends in agriculture is IoT technology in order to make smarter decisions, reduce the costs, and boost production. IoT is new approach to driving efficiency and improving operations and helps the farmer's .IoT technologies to create a more efficient operation to improve production output. The International Food Policy Research Institute reports reveals that agricultural technologies could increase global crop production. In the next ten years, the smart agriculture market is predicted and expected to witness a 4X growth (by the end of 2026, it will be a $40+ billion market). The hardware component of the industry will be at the forefront of this growth, with more than 50% share in the overall technological solutions for agriculture.

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