

## **IOT AND AGRICULTURE IN INDIA- A REVIEW**

**<sup>1</sup>Prof. P. A. Ganthade, <sup>2</sup>Prof. A. S. Gadre, <sup>3</sup>Prof. S. B. Malani**

Assistant Professor, Department of Mechanical Engineering, Sipna College of Engineering and Technology, Amravati, Maharashtra, India<sup>1</sup>, Assistant Professor, Department of Mechanical Engineering, Sipna College of Engineering and Technology, Amravati, Maharashtra, India<sup>2</sup>, Assistant Professor, Department of Mechanical Engineering, Sipna College of Engineering and Technology, Amravati, Maharashtra, India<sup>3</sup>

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### **ABSTRACT**

India is a country of farmers. With maximum population living in rural areas, the livelihood of most of the people depends on agriculture. The geographical location of India makes it among the regions of different seasons/weathers. Due to adverse weather conditions, farming is not a piece of cake, and due to lack of knowledge and resources in the rural area, many farmers end up losing their yield. With the advent of Internet of Things, the farmers can go hand in hand with experts, which will be helping the farmers understand the specific period and proper techniques to get maximum yields- crop monitoring. In the cases, when it is difficult for farmers to visit the field, they can easily operate their machines and/or motors remotely using Internet of Things. The review paper focuses on the technological developments in the field of Agriculture using the most recent and useful technology- Internet of Things.

**Keywords:** - *Internet of Things, Agriculture, Crop Monitoring, UAV, Communication, Rural India, Sustainable Development*

### **1. INTRODUCTION**

India is an agricultural country and the livelihood of most of the people depends on farming. With expanding growth in technologies, agriculture has become more significant and efficient. For the development, ample tools and techniques are available. Though we have various tools available, yet the produce is not enough to fill the void of hunger from the citizens completely. Number of processes require human labour to keep an eye in the field such as irrigation, crop monitoring, amount of pesticides/insecticides, management of manure/fertilizer, etc.

Change in climate has also become one of the major challenges in farming as the crops may fail. Failure of crops lead to suicide by farmers. In order to avoid all the mentioned problems, we need to come up with advancements in the techniques of farming.

Smart farming can be one of the best suited alternatives as it will help farmers knowing about all the progress the crops are making in their lifecycle. A farmer might become able to irrigate the soil only when the humidity of the soil reduces to the bare minimum level required by the crops [1]. A farmer will be able to look after the crops and spray pesticides without physically being present in the field.

All this can be made possible by using the technology named Internet of Things.

### **2. INTERNET OF THINGS**

The internet of things, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analysed or analysed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them

instructions or access the data [2]. IoT evolve from different building blocks which includes lots of sensors, software's, network components and other electronic devices. Also it makes data more effective. IoT allows to exchange the data over the network without human involvement.

Once added cloud computing with IOT a changes has occurred in computer network base technologies and mobile based technology [2]. Now days other networks are 3G, LTE, GSM, WLAN, WPAN, WiMax, RFID, Zigbee, NFC, Bluetooth that develops IOT so smart system and operate system at remote places.

The IoT technology is more efficient due to following reasons [3]:

1. Global Connectivity through any devices.
2. Minimum human efforts
3. Faster Access
4. Time Efficiency
5. Efficient Communication

An IoT system is comprised of a number of functional blocks to facilitate various utilities to the system such as, sensing, identification, actuation, communication, and management. These functional blocks as described below [4] [2]:

**Device:** An IoT system is based on devices that provide sensing, actuation, control, and monitoring activities. An IoT device may consist of several interfaces for communications to other devices, both wired and wireless. These include (i) I/O interfaces for sensors, (ii) interfaces for Internet connectivity, (iii) memory and storage interfaces and (iv) audio/video interfaces.

**Communication:** The communication block performs the communication between devices and remote servers. IoT communication protocols generally work in data link layer, network layer, transport layer, and application layer

**Services:** An IoT system serves various types of functions such as services for device modelling, device control, data publishing, data analytics, and device discovery.

**Management:** Management block provides different functions to govern an IoT system to seek the underlying governance of IoT system.

**Security:** Security functional block secures the IoT system by providing functions such as, authentication, authorization, privacy, message integrity, content integrity, and data security.

**Application:** Application layer is the most important in terms of users as it acts as an interface that provides necessary modules to control, and monitor various aspects of the IoT system. Applications allow users to visualize, and analyse the system status at present stage of action, sometimes prediction of futuristic prospects.

### **3. IOT BASED AGRICULTURE APPLICATIONS [4] [5] [6]:**

– Irrigation management system: Modern day agriculture requires an improved irrigation management system to optimize the water usage in farming and related activities. Four factors are popularly being used in smart irrigation system such as, integration of real-time weather forecast data, control of farmer's system from anywhere in the world using home, enabling Wi-Fi and Ethernet connection, adding synchronization with moisture sensors installed in farmer's yard, and reducing farmer's monthly bills while helping to conserve limited water resources. IoT is constantly getting popularity in irrigation management related systems around the world.

– Pest and disease control: Controlled usage of pesticides and fertilizers helps increasing the crop quality as well as minimizing the farming cost. However, for controlling the usage of pesticides, we need to monitor the probability and occurrence of pests in crops. To predict this, we also need collecting disease and insect pest

information using sensor nodes, data processing and mining, etc. with help of IoT infrastructure. A three layered IoT architecture is proposed that may identify the disease occurred and take necessary actions to point out the responsible pest which has caused the disease. Farmer can imply upon the required medicine to save the crop.

Cattle movement monitoring: A herd of cattle grazing a field can be monitored using IoT.

Thus, real-time monitoring of any cattle is also achieved.

– Dairy monitoring: IoT based cloud solutions, such as, Connecters are being currently popular to monitor dairy in smart way. It is able to provide multiple behaviour detection and predictions

Including animal heat & oestrus cycles, health analysis and also provide a forward looking prediction of the next cycle start dates. Further, individual activity assessment and location aware functionalities can be added on top of the services.

– Water quality monitoring: Placing sensor nodes empowered with wireless communication help in monitoring the water quality. A recent article develops a real time monitoring of the water quality using IoT. The system measures physical and chemical parameters of the water such as, temperature, pH, turbidity, conductivity, dissolved oxygen. The sensor data is viewed on Internet using cloud services [4].

– Greenhouse condition monitoring: Greenhouse and agriculture are closely related to each other.

Greenhouse gases are responsible for increasing the climate temperature, and thus has direct impact on agriculture. On the other hand, greenhouse gas emission depends on pH, temperature,

CO<sub>2</sub>, etc. HarvestGeek provides an IoT cloud based services to monitor the greenhouse condition remotely which can further be controlled by the user or by self autonomously.

– Soil monitoring: Soil property is crucial for agricultural domain. Knowledge of soil adds an advantage to the production of crops. [7] has incorporated 6LoWPAN technology with IoT to remotely aggregate the condition of soil while implementing various sensor nodes. SNMP is used to monitor the network in real time.

– Precision Agricultural by UAV: Agricultural precision can be obtained by utilizing advanced technologies such as, UAV and Drone, for productive outcome of the farm. PrecisionHawk

(www.precisionhawk.com) enterprise leverages UAV, GIS and sensors enabled IoT cloud platform to deploy artificial intelligence through in-the-air flight path calculations for detection of weather conditions in the air. Further, in-flight diagnostics and monitoring processes continually monitor its own status while in flight and counts on the operational weather/wind limitations, land mapping, and real time analytics supports.

– Agricultural means production supply chain management: Agricultural products need to be efficiently managed so that farmer can gain profit, hence the operating efficiency on it. Supply chain management on the agricultural products can be monitored by IoT. [8] analyses the application of IoT in product supply chain business processes, and the driving factor in the adoption of agricultural products by supply chain effects in IoT. It further provides a reference framework for the node enterprises of the product chain for necessary implications.

Table.1

Comparison of the existing communication technologies

| Parameters         | WiFi                    | WiMAX   | LR-WPAN                | Mobile Communication                              | Bluetooth                          | LoRa         |
|--------------------|-------------------------|---|------------------------|---|------------------------------------|--------------|
| Standard           | IEEE 802.11 a/c/b/d/g/n | IEEE 802.16                                   | IEEE 802.15.4 (ZigBee) | 2G-GSM, CDMA, 3G-UMTS, CDMA2000, 4G-LTE           | IEEE 802.15.1                      | LoRaWAN R1.0 |
| Frequency Band     | 5 GHz–60 GHz            | 2 GHz–66 GHz                                  | 868/915 MHz, 2.4 GHz   | 865 MHz, 2.4 GHz                                  | 2.4 GHz                            | 868/900 MHz  |
| Data Rate          | 1 Mb/s–6.75 Gb/s        | 1 Mb/s–1 Gb/s (Fixed)<br>50–100 Mb/s (mobile) | 40–250 Kb/s            | 2G: 50–100 kb/s<br>3G: 200 kb/s<br>4G: 0.1–1 Gb/s | 1–24 Mb/s                          | 0.3–50 Kb/s  |
| Transmission Range | 20–100 m                | <50 Km  | 10–20 m                | Entire Cellular Area                              | 8–10 m                             | <30 Km       |
| Energy Consumption | High                    | Medium  | Low                    | Medium  | Bluetooth: Medium<br>BLE: Very Low | Very Low     |
| Cost               | High                    | High  | Low                    | Medium  | Low                                | High         |

The key advantages of using IoT in enhancing farming are as follows [3] [6] [8]:

1. Water management can be efficiently done using IoT with no wastage of water using sensors.
2. IoT helps to continuously monitor the land so that precautions can be taken at early stage.
3. It increases productivity, reduce manual work, reduce time and makes farming more efficient.
4. Crop monitoring can be easily done to observe the growth of crop.
5. Soil management such as PH level, Moisture content etc. can be identified easily so that farmer can sow seeds according to soil level.
6. Sensors and RFID chips aids to recognize the diseases occurred in plants and crops. RFID tags send the EPC (information) to the reader and are shared across the internet. The farmer or scientist can access this information from a remote place and take necessary actions, automatically crops can be protected from coming diseases [2].
7. Crop sales will be increased in global market. Farmer can easily connected to the global market without restriction of any geographical area.

## CONCLUSION

Agriculture is an important part of Indian economy. The IoT smart device as described and discussed in the paper plays a vital role in improving farmer life as well as increases the crop production efficiency. Educating farmers with visual alerts helps them to make better and efficient decisions. Different devices connected with each other help in evaluating the better data points and analysis which will help Indian government to make better policies for farmers [6].

Indian farmers are still unfamiliar with the properties a soil possesses and the best crop that can be grown in the respective fields. This IoT device will help them to easily know each detail of their soil, water level and fertilizer required for the field, thereby, providing sufficient knowledge as required for them to enhance the yields. Weather forecasting and theft protection with visual alerts in their own language is added as an advantage to their understanding.

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