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Advantages of Internet of Things (IoT) and It's Applications in Smart Agriculture System

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Abstract

As we know that Agriculture serves as the heart of Indian economy and half of the population in India survives because of agriculture is the main earning crops in India for this we want to make a smart agriculture system for easily farming and other processes. In this paper, advantages of IoT in Smart Farming and its applications are presented. Architecture of a fully automated agriculture system and a smart weather and Soil condition sensor are presented. Challenges in implementing an IoT based agricultural systems are highlighted. Durability of sensors and cost are mentioned.

Keywords: ***Internet of Things (IoT), Advantages of IoT, Architecture of Smart Agriculture System, Block Diagram and Challenges.***

1. Introduction

Coping with agriculture and its demands are really a challenging one nowadays. Agriculture sector is changing the social-economic environments of population due to liberalization and globalization. About 75% people are living in rural areas and are still dependent on Agriculture. About 43% of India's geographical area is used for agricultural activity. The Indian farmer had discovered and begun farming many spices and sugarcane more than 2500 years ago. Did you know that our country is the 2nd largest producer of agricultural products in the world? In fact, agriculture contributes as much as 6.1% (as of 2017) to our Gross Domestic Product (GDP). Official sources said that the agri-crisis was becoming worse due to poor rain and climatic conditions. From 2015 to till date farmers are suffering from severe scarcity and difficult to recover from drought. The IoT is a technology which serves as a solution to the problem. It uses various sensors which are connected through internet and also with the integration to the satellites; it does wonders in all sectors. It also uses various protocols by enabling the IoT to grow faster.

1.1 Smart Farming and IoT

Smart Farming [1], is the concept of managing farms using modern technologies to increase the quantity and quality of the agricultural products. With the advancement of the sensor technologies, miniaturization and cost reduction farmers have access to GPS, soil scanning, data management, and Internet of Things technologies. Accurate and precise measurement of climate conditions, crop growth and soil conditions within a field and adapting the strategy accordingly, farmers can greatly increase crop quantity and quality. Through analysis of the collected data farmers can also

increase effectiveness of pesticides and fertilizers, and use them more selectively. Use of smart techniques in farms can better monitor the needs of individual animals and adjust their nutrition correspondingly, thereby preventing disease and enhancing herd health.

IoT (Internet of Things) enabled devices, real time data collection and automation can vastly improve smart farming. Unlike embedded systems IoT enabled devices take advantage of cloud computing, Cloud data storage, advanced AI data analysis and mesh network of sensors. The IoT ecosystem also allows for remote monitoring for the farmers.

As maximum no of farmers are not familiar with smart phone, so, it's our proposal that after successfully implementation of the system, we can apply it through every Block level Agriculture department with the help of the respective state governments.

1.2 Application of IoT devices in Smart Farming

- **Climate Conditions:** Climate plays [2] a crucial role in farming. Improper knowledge about climate can affect quality and quantity of crop production. But IoT solutions enable the farmers to deploy sensors such as humidity sensor, temperature sensor, rainfall sensor and water level sensor in the field to collect real time data from the environment. The IoT ecosystem is made up of sensors that can detect real-time weather conditions like humidity, rainfall, temperature accurately. These IoT devices/sensors are very modular which allow them to fit any farming need. These sensing devices detect the condition of crops and the environment surrounding them. If any disturbing environmental condition is detected, it is then rectified by means of automation or an alert is send to the farmer. Use of these of these IoT devices eliminate the need of physical presence and increase productivity.
- **Data Analytics**: Once data is collected, it must be processed and analyzed as fast as possible to take action on any problems or change that may occur. Manual data analysis takes time, by the time the data is analyzed irreversible damage may have occurred. Here IoT devices can make the process fully automatic and seamless. IoT devices can directly send the data to cloud storage and off site data processing and analyzing can be done from there. Off site data processing enables us to use powerful computers and various processing techniques to optimize processing time. Analyzed data is then sent back to be used for automation and monitoring. Long term statistical analysis of the field data will eventually lead to better future predictions, increase in crop production and increase in farm efficiency.
- **Automation:** IoT enabled automation allows for autonomous and robotic labour, all standard and repetitive farming tasks can be easily carried out by them. As of now self driving technology has developed to a point that driverless tractors, seeding and planting equipment and harvesters are now feasible options for farms. Automatic watering and irrigation controlled by real time feedback improves plant growth and reduces water wastage. Effective and selective use of pesticides is also possible through automation. Drones can also be used for planting, crop spraying and real time monitoring. Automation driven by IoT reduces human labour, increases yield and efficiency.

2. Architecture of smart agriculture system

- **Climate and Soil Condition Sensor:** Climate sensor senses weather conditions like temperature, humidity and rain fall throughout the farm and warehouse. Soil condition sensor senses moisture content, pH, temperature.

- **Warehouse and Storage Silo Data:** This data consists of stock condition, stock storage climate and stock amount. The collected is used for inventory management and stock maintenance. Collection and record keeping of storage data reduces wastage.

- **Cameras and Camera Controllers:** Cameras capture raw footage which is used for live monitoring and security purpose. The cameras are controlled by the camera controller which keeps the cameras pointed at desired view and manage data from the cameras and send the data to the server. Image recognition is also be used for automated detection.

- **Server:** The server manages all the incoming and outgoing data from the various sensors, controllers, data processing nodes and cloud storage. It also controls the automation process via the automation controller.

- **Data Processing:** Data processing is done by an external computer connected to the server to reduce the load on the server. This makes the system modular and makes processing faster.

- **Cloud storage:** This is a large storage space in the range of petabytes. Here all the processed, unprocessed data and logs are stored. Unlike local data storage which is short term and susceptible to damage, cloud storage provides safer, larger and long term storage.

- **Automation controller and feedback:** The automation controller automates all the needs of the farm. It takes commands from the server and gives the server feedback of what is happing in the real world. The automation controller is connected to all farm equipment, machinery, driverless vehicle, electrical appliances and drones. Automating all parts of the farm saves energy, increases efficiency and productivity. That also eliminates the need of physical presence.

- **Human Interface Device with Display:** The HID device allows the farmer to monitor every aspect of the farm. All the data is presented here in easy to understand form like graphs and pie charts. The farmer can view live video streams of the farm areas from the cameras via this. Drones and other surveillance equipment can also be controlled via this HID device.

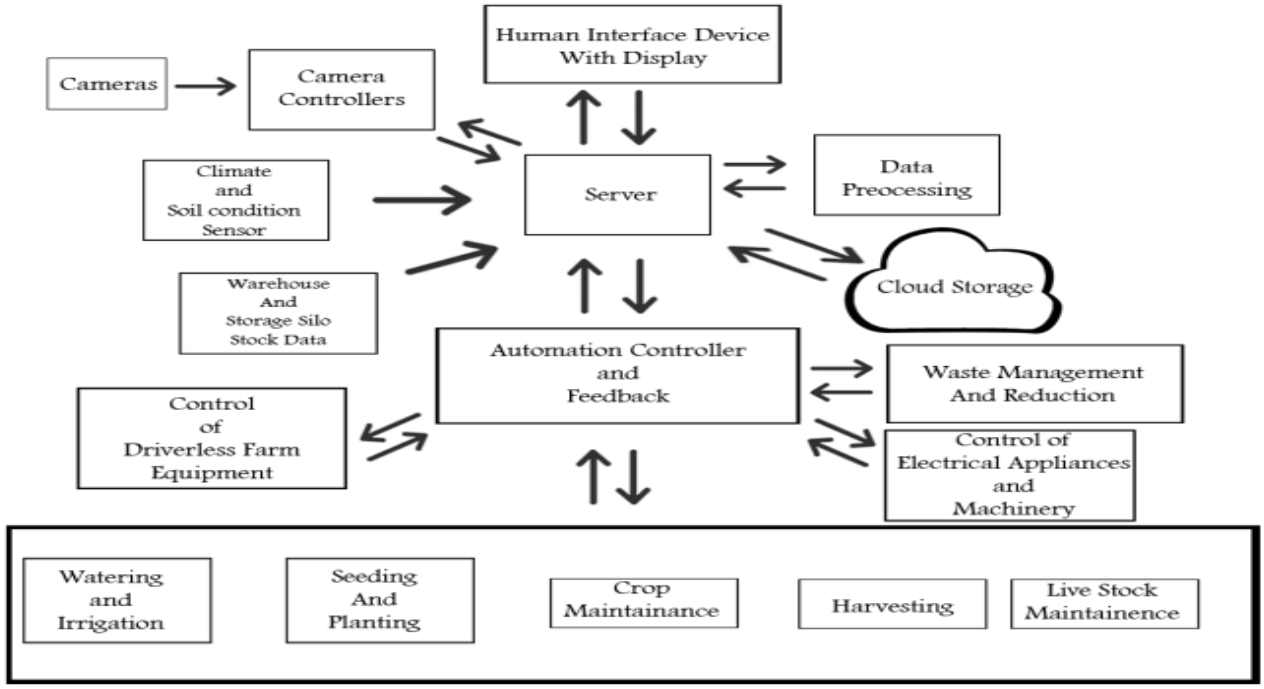

Fig.1. Architecture of smart agriculture system Block Diagram.

Advantages:

- High precession control of farm.
- Fully automated.
- Smart data collection and processing for future use.

Disadvantages:

- Failure in one block can cause the whole system to malfunction.
- High cost.

3. Smart and Green. Weather and Soil condition sensor

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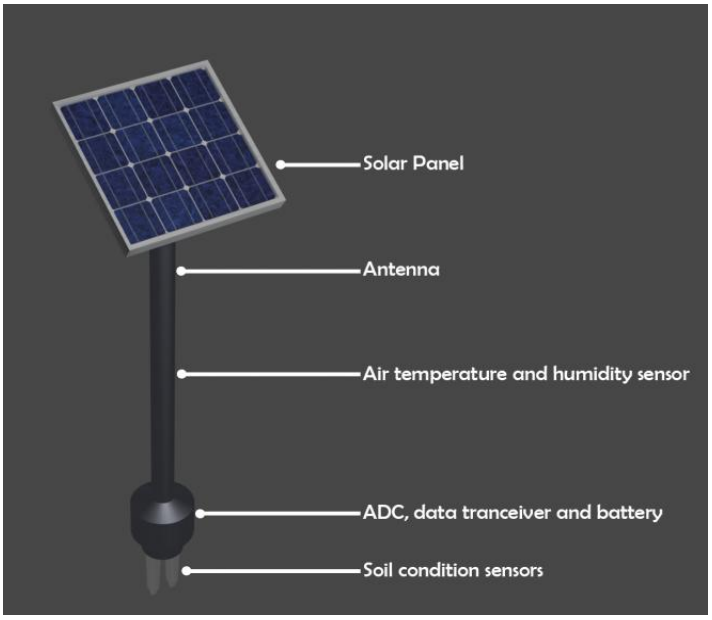

*actual structure may differ from the illustration.

Fig.2: Smart and Green. Weather and soil condition sensor.

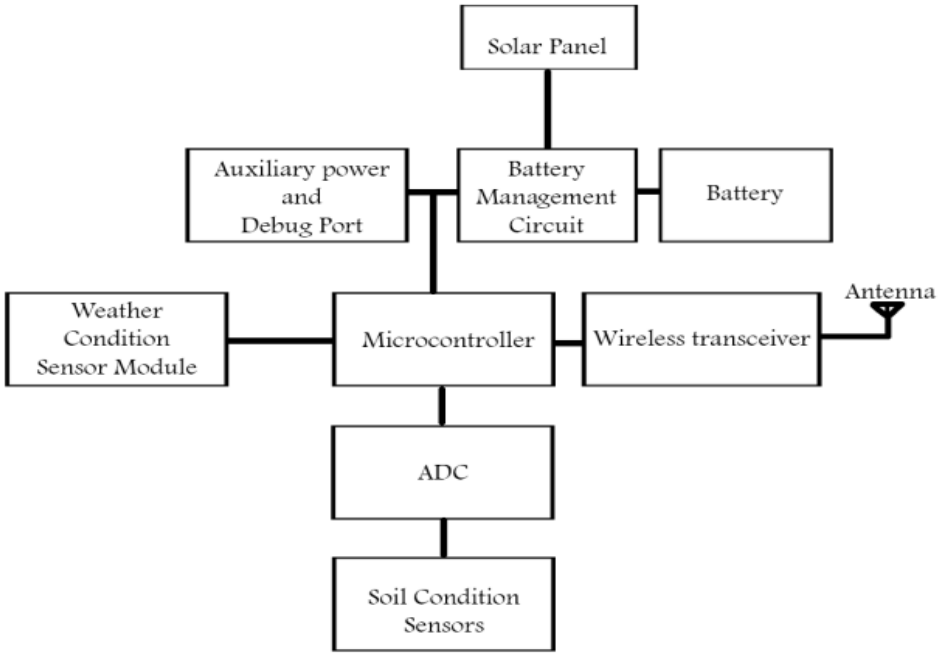

Fig.3: Block diagram.

The smart and green, weather and soil condition sensor is an easy to deploy sensor node with long range wireless capabilities. It senses air temperature and humidity and soil temperature, moisture and pH. Multiple of these sensor nodes can be deployed in the field to get data from various parts of the field. Strategic placement of sensors is necessary to avoid redundant use of sensors. These sensors connect to a local hub which is connected to the internet. Gathered data can then be stored or processed.

- **Construction:** The shell/body is constructed with durable waterproof material to withstand rain and submersion in the field. As shown on Fig 2. the base contains the electronics, battery and the soil sensors. A tube is provided on to which the solar panel is supported. The tube is made hollow to house the weather condition sensor module and the antenna. Perforations are made on the upper side of the tube so that air can reach the weather condition sensor module. The weather condition sensor is heat insulated from the tube to avoid false temperature readings. The solar panel is mounted on a pivot to position it as needed. For this application a non tracking solar panel is used.

- **Local hub**

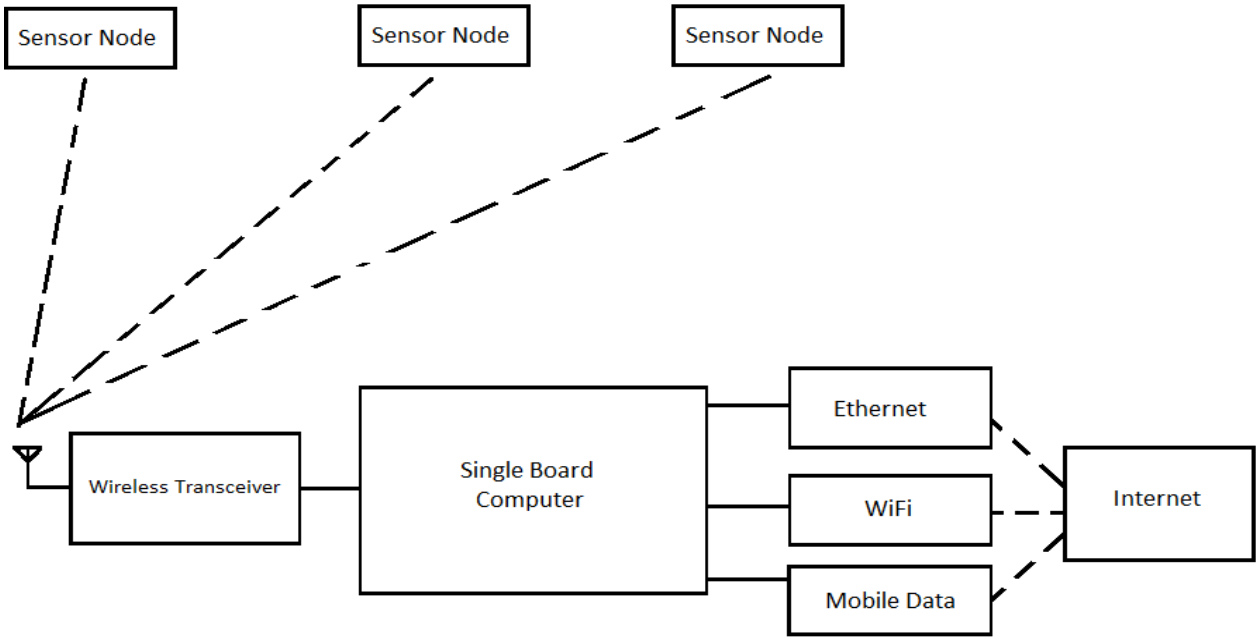

Fig.4: Local hub connected to sensor nodes.

The local hub collects data from each sensor node and sends the data to the server. The local hub is connected to the internet via Ethernet / Wi-Fi / Mobile Data. The local hub also checks for malfunction in the sensor nodes. It checks for erroneous sensor readings, battery health and temperature of the electronic components and the battery. It reports any bad sensor node and temporarily black lists its data. Therefore it ensures that the collected data is error free or within a set tolerance.

Advantages:

- Low cost.
- Runs on solar energy.
- Easy deployment.
- Completely wireless.
- Maintenance free.

Disadvantages:

- Low durability of sensors.
- Battery will require replacement after rated charge and discharge cycles.
- Risk of damage if water leaks in.
- It cannot work in prolonged darkness (depends on battery capacity).

4. Challenges involved in implementation of IoT

- **Durability:** Currently available miniature sensors/sensor modules are of poor quality and are meant to be used for one off prototypes or projects. Therefore no durability data or field test data is available on these sensors/sensor modules. Further testing and long term experiments must be done to get an idea of how these sensors/sensor modules will last in required application. With normal use testing, test for extreme conditions must also be done. Tests like exposure to prolonged sunlight and heat; extremely cold below freezing temperature condition; prolonged exposure to humidity must be done.

- **Cost:** To setup a fully automated IoT enabled farm, a lot of backbone infrastructure must be installed. That only is very expensive for someone who is starting from scratch. With the backbone infrastructure installed a lot new compatible automatic equipment must be purchased as all conventional equipment is incompatible. This can be solved by means of retrofitting old equipment but either way it adds up to the total budget. For initial installation and configuration a lot labour is required which is very also costly. Maintenance of said equipment must also be done regularly to prevent any down time as any faulty equipment/machinery will cause bottlenecks in the system. Therefore cost of equipment must be as low as possible with acceptable quality and functionality.

- **Availability of internet connection:** Getting a reliable internet connection in the most important part in setting up an IoT based system. The connection must have enough bandwidth to transfer the data according the to the application needs. Latency can be high as few hundred milliseconds but it must be jitter free. Therefore a wired connection is preferred to prevent any data losses or sudden stops in data transfer. But as of now no ISP (internet service provider) provides wired connection to rural/village areas where the fields/farms are located. And any special type of connection will be very expensive.
  Currently reliable mobile data (3G/4G) is available in these areas, although they are not ideal for a highly internet dependent system.

- **Availability of clean and uninterrupted electric supply:** Any IoT based system requires uninterrupted electric supply to function. Depending on the size it may require a lot of power. But in the rural/village areas getting such electric supply is difficult. Alternative energy sources like solar and wind must be used to satisfy the energy demand. This will also add a significant amount to the cost.
- **Training the farmers:** Farmers would require training of basic computer/tablet (HID device) usage and how the IoT system works. Proper education about the specific IoT implementation in their farm is also needed. Consultants must be assigned to help farmers setup their farm. In rural/village English is not a commonly used language, therefore the farmers must be educated in their local language. The HID UI (User Interface) must be designed accordingly so that it can be easily adapted to various languages. As the UI is designed according to local language farmers will have no problem navigating through the menus and basic usage. The farmers will also require training for basic data reading and farm management through IoT system. The goal is to make the training process as quick as possible and as effective as possible.

Conclusions

In conclusion, innovations in IoT technology are vital to precession and smart farming. Development in durable, miniature and energy efficient sensing technology is needed. Standardization in IoT based farm equipment must be done. To develop a IoT agricultural ecosystem, expertise across multiple domain such as engineering and technology, environmental sensing and monitoring, agronomy, soil fertility, entomology, machine learning and robotics are needed. Development is also needed to make sensing technology cost effective so it can be applied on a large scale. Development in backbone infrastructure is needed to make the system function. Availability of reliable internet connection in the rural/village areas is needed.

References

[1]. "Schuttelaar & partners BLOG: Smart Farming is key for the future of agriculture"Year: 2017, Full text available at: https://www.schuttelaar-partners.com/news/2017/smart-farming-is-key-for-the-future-of-agriculture
Content language: English

[2]. "Biz Intellia: 5 Applications of IoT in Agriculture - Making Agriculture Smarter" Full text available at: https://www.biz4intellia.com/blog/5-applications-of-iot-in-agriculture/
Content language: English