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Agricultural Production System Based On IoT

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Abstract: Internet of things (IoT) is not a single word, but it has gathered billions of devices in the same lane. The Internet of things has given the lives of things. Machines have a sense now like a human. It works remotely as the program has been settled inside the chip. The system has become so smart and reliable. The Internet of things has brought out changes in most of the sectors of humankind. Meanwhile, agriculture is the main strength of a country. The more the production of agricultural products increased, the world will be more completeness from food shortage. The production of agriculture can be increased when the IoT system can be entirely implemented in the agricultural sector. Most of the approaches for IoT based agriculture have been reviewed in this paper. Related to IoT based agriculture, most of the architecture and methodology have been interpreted and have been critically analyzed based on previous related work of the researchers. This paper will be able to provide a complete idea with the architecture and methodology in the field of IoT based agriculture. Moreover, the challenges for agricultural IoT are discussed with the methods provided by the researchers

Keywords: Agriculture System, Internet of Things (IoT), Power Consumption

1. Introduction

Agriculture plays a vital role in developing the country as an agricultural country. The Internet of Things (IoT) has brought out a revolution in the agricultural field. The established IoT system has become profitable, time and energy saving. IoT has reopened suitable and productive ways for cultivating the soil and raising livestock using the cheapest and most available installation sensor. This high technology in the agricultural field increased harvest production and benefited the farmers and growers more. The implemented system is automated and works 24/7 with its concerns [1]. For the human species, agriculture can be named a basis of life. Most of the time, a country's economy depends on agricultural land production. By developing the economic condition, the growths of agricultural products need to be increased too. Modern science is a way to change the conventional agricultural system of thousands of years using the

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IoT. Now, the farming sector is also getting smarter. The IoT utilized is smart farming, precision farming, or satellite farming [2].

Agriculture using IoT is about to push the whole agricultural system to a new level that can be easier and more efficient for both the growers and farmers. The agricultural field with IoT is performing well and working very smoothly, encouraging millions of farmers to use the IoT system in agriculture. Many scientists and researchers have talked about the IoT's implementation in the agricultural field. The way has been given still there has some lack of age as the system is working correctly, but it has some issues that are needed to be addressed to make the farmer and growers more benefited. This paper discusses the IoT in agricultural approaches and analyze the challenges (power consumption issues) and their strategies.

2. Recent Trends in IoT Based Agricultural System

Worldwide, more than 800 million people are faced with food shortages, one in nine. The United Nations expected to end hunger by 2030 in the "2030 Sustainable Development Agenda". Apart from the supply, food quality is another significant and even more critical problem. The significant challenges facing potential agriculture in 2050 are highlighted in Fig. 1. The diagram shows three critical problems: feeding over 10 billion people; without using additional land and reducing greenhouse gas emissions by over 60 percent. [3].

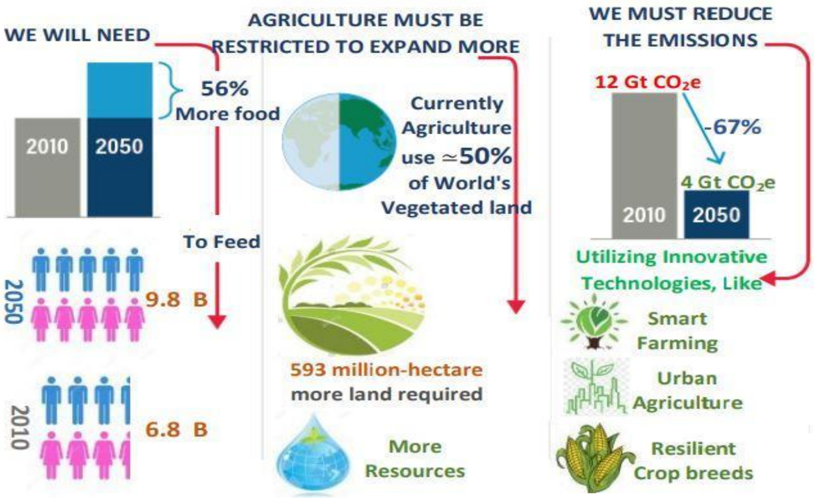

Fig. 1 - Major Challenges for Sustainable Future Agriculture [3]

Fewer and fewer younger growers need to take responsibility for small rural labor, arable land constantly shrinking, water scarcity, and harsh weather. It is not necessary to use more fertilizers and pesticides. Future agriculture should therefore grow as a hi-tech industry in which automated structures profit from the advantage of artificial intelligence and extensive data facilities. The IoT-based agricultural system is spreading faster. With the grace of the IoT, the farmer and grower now can get the conditions of the field by sitting ever anywhere [4]. The device collects the data on the field conditions. After analysis and optimization, it provides the instruction. As per instructions, another mechanism is taking a step. All of this is happening very preciously and actively. The remarkable development of wireless sensor networks (WSNs) shapes the future of IoT and the 5th-generation (5G) mobile cellular technology to provide farmers in every part of the world with real-time data and information [5].

In addition, machine learning and analytics are used to mine trend data. Machine learning in agriculture is used to forecast which genes are best suited to crops and unavailable products. This gave a valuable indication for the farmer for future agriculture. Farmers increasingly utilize drones to track crop growth and tackle malnutrition and other adverse effects on the environment. They are also used to efficiently pump water and other pesticides, particularly in crops with different heights, considering complex fields. [5].

3. Agriculture IoT Approaches

Agricultural IoT monitors the whole agricultural field as a human does. The absence of humans allows it works without tiredness. The best IoT applications in agriculture have been discussed in this section. Firstly, precision agriculture mapping is essential for effectively applying resources, as discussed in sub-section 3.1. Then, smart farming and water conservation are highlighted in subsections 3.2 and 3.3, respectively. For protection, livestock tracing is explained in 3.4, and arm machinery and sensors on crops are presented in 3.5. For safety purposes, the safe pesticide environment is pointed out in 3.6. Finally, the delivery process is explained in 3.7.

3.1 Precision Agriculture Mapping

A small drone uses to take images of the agricultural field, and the images are being analyzed. As per the Food and Agriculture Organization, the world's population will be 34% more. To ensure the expected production, satellite agriculture mapping is being used to improve world agricultural management [6]. Fig. 2 shows the implementation of the approach.

Fig. 2 - Precision Agriculture Mapping [7]

Geographic Information Systems (GIS) tools and online web resources services can assist farmers in field forecasts and control by using multi-spectral maps to monitor agricultural production. They are collected by Satellites, fix wing Aircraft, or Unmanned Aerial Vehicles (UAVs) and processed to provide Normalized Difference Vegetation Index (NDVI) and other vegetation soil indices to identify crop stress. Such data can be used in national GIS or CAD web portals and management systems. GIS has proved to be very helpful for those involved in the farming industry in analyzing and visualizing agricultural environments and flows [6].

UAV technologies have been successfully employed in various applications for Precision Agriculture, such as site-specific herbicide applications, water deficiency identification, detection of diseases, etc. Using the information acquired by the UAVs, several decisions can be made to handle the problem(s) detected and optimize harvesting by estimating the yield. The most common applications of UAVs for Precision Agriculture, as recorded in the literature, are the following:

• Vegetation health monitoring and diseases detection [8]

UAV-based data processing technologies use crop imaging information to identify changes in plant biomass and their health. Therefore, diseases can be detected in their early stages, enabling farmers to intervene to reduce losses.

• Vegetation growth monitoring and yield estimation [9]

Regular collection of information and visualization of crops using UAVs provides increased opportunities to monitor crop growth and record the variability observed in several field parameters.

• Irrigation management [10]

Precision irrigation techniques can improve the efficiency of water use so that the resource is applied effectively: (a) in the right places; (b) at the right time; and (c) in the correct quantity. The areas where major irrigation is needed can help the farmers save time and water resources.

• Corps spraying [11]

Crop spraying is essential in cases where diseases have been identified, and it is essential to reduce pesticide use without affecting crop yield. In conclusion, UAV-based systems can contribute to crop spray management.

3.2 Smart Farming

Precision Agriculture [12] is also called smart farming or satellite farming. Precision agriculture is not a new word. In 1992, precision agriculture was first introduced. Precision agriculture has been designed to increase the production probability and efficiency of the whole farm. This system cannot minimize the risk and optimize the quality of the product. Till now, precision farming can crop, climate, and soil monitoring. This system has self-decision support systems. The most used component in precision farming is a sensor.

The parameters of precision farming are [12]:

- Measuring Air Temperature & humidity
- Measuring Soil temperature & moisture
- Measuring Wind speed and getting the direction
- Measuring solar radiation and its effect

- Measuring the Atmospheric pressure
- Rainfall & Leaf Wetness
- Greenhouse monitoring system using WSNM measuring Temperature, light, Carbon dioxide (CO2)
- Measuring Rainstorms using reactive Soil Moisture Network

Precision farming is a technique or method that increases the accuracy and control of the farming procedure for livestock raising and growing crops. In this approach, the application of IT and objects such as sensors, autonomous vehicles, automated hardware, control systems, and robotics are essential components. Precision agriculture has become one of the most common IoT technologies in agriculture in recent years, and a growing number of organizations around the globe have begun using this technique. IoT systems products and services include soil humidity tests, variable rate irrigation (VRI) optimization, and PRO computer optimizer. VRI optimization is a process that maximizes productivity in irrigated crop fields, improves yield, and increases water and soil quality [13].

One example is the Aluminum Greenhouses, as shown in Fig. 3, a greenhouse company based on Agri-Tech, which hires IoT and innovations to provide services. The IoT sensors are solar-powered, and it creates efficient and sustainable greenhouses. Greenhouse and water use can be monitored by sending the farmer an online portal with message warnings. The IoT sensors in the greenhouse notify about temperature, sound, moisture, and light.

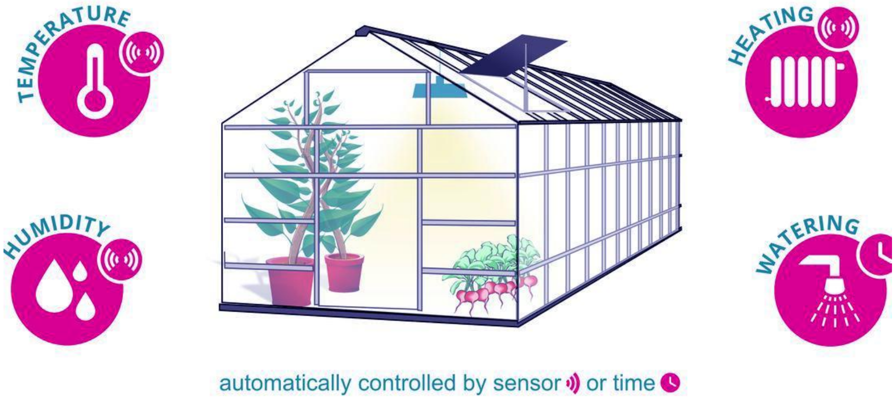

Fig. 3 - Aluminum Greenhouses [13]

Among the technologies available for present-day farmers, as presented in Fig. 4, there are
i. Sensing technologies, including soil scanning, water, light, humidity, and temperature management.
ii. Software applications — specialized software solutions that target specific farm types.
iii. Communication technologies, such as cellular communication.
iv. Positioning technologies, including GPS.
v. Hardware and software systems that enable IoT-based solutions, robotics, and automation; and
vi. Data analytics, which underlies the decision-making and prediction processes.

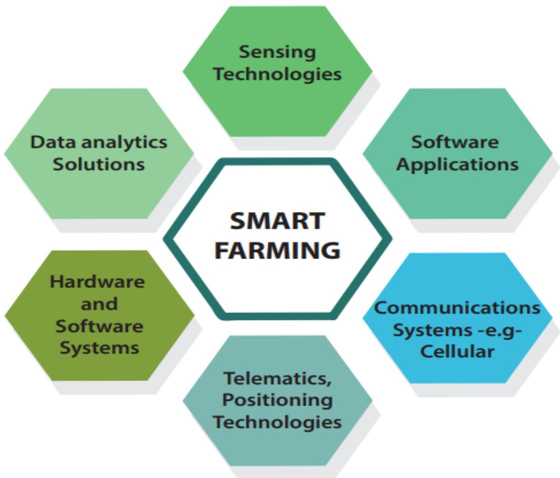

Fig. 4 - Technologies involved in smart farming [14]

3.3 Irrigation & Water Conservation

In this system, soil moisture and temperature sensor have been introduced to measure along with the temperature. The system can save water and money as it is enough to help the corps with the irrigation. Sometimes a man can make mistakes, but there is no mistake by the system even if it provides the exact amount of water needed by the soil. That helps the crop grow healthy, which is how the production increases. Furthermore, this system can do cloud monitoring. It can collect information from the WEB about the weather [15]. Fig. 5 shows how the system is functioning.

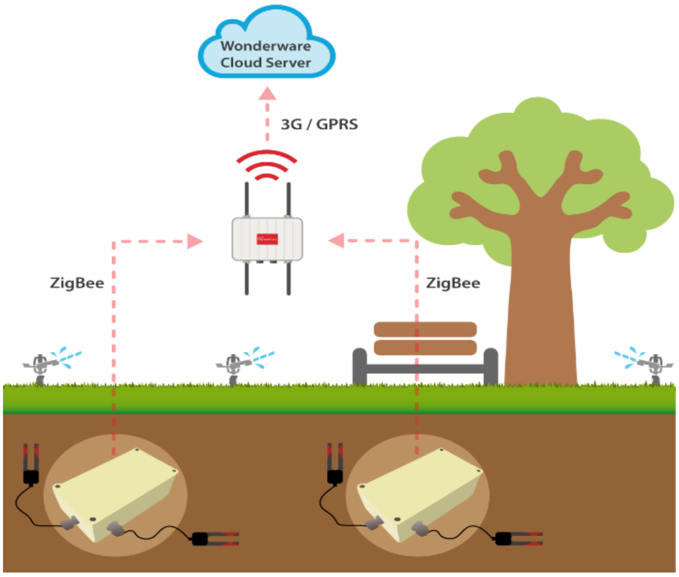

Fig. 5 - Function of cloud monitoring system [16]

The measurements are based on the Waspmote Sensor System, with third-party sensor samples. The versatility of this device is evident from this fact. It connects to a wide variety of sensor samples that do not belong to the same service. In the intelligent irrigation project, the soil moisture sensors, and the Waspmote Sensor Platform, within waterproof boxes to guarantee high durability, are situated underground. In addition, these systems are powered by a one-year autonomous long-life battery. Data from the Waspmote Sensor Network may be sent directly into the cloud or through a gateway. The communication protocols can be used in several ways: GPRS, 3G, 4G, LoRaWAN, ZigBee, Wi-Fi, RFID, NFC, or Bluetooth 4.0, as shown in Fig. 6.

Fig. 6 - Visualizer developed by Barcelona Council and Wonderware [16]

3.4 Livestock Tracing

The Internet of things has provided the opportunity to keep tracing the livestock. The tracing is done by using an RFID chip connected with a tag, and that tag is usually attached to the animal's ear or fixed inside the animal's body. The insertion of the RFID chip depends on animal to animal. The farmers use the mobile monitoring system to trace them. Sometimes, these systems use wireless camera sensors and RFID for a closed place like a zoo. The work can do with the same work with the IoT devices, and it is doing the work continuously [17].

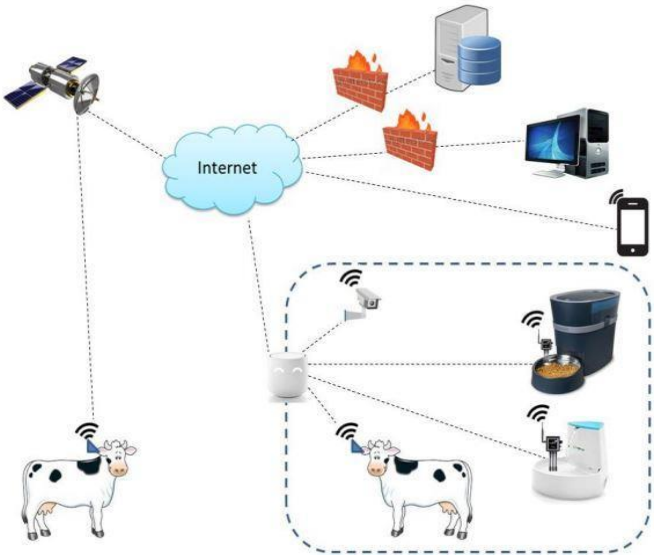

Fig. 7 - Livestock tracing approaches [17]

IoT applications help farmers collect information about their animals ' location, well-being, and health. This data helps them recognize their livestock's condition, such as finding sick animals to separate them from the cattle, preventing the disease from spreading to the whole livestock. The feasibility of ranchers using IoT-based sensors to locate their animals reduces labor costs considerably [13]. North America is an example of an IoT system used by an enterprise. Cow tracking allows livestock owners to track their pregnant cows and be born, as shown in Fig. 7 and Fig. 8. A sensor-powered battery is removed when its water breaks out, then the rancher or herd manager gets information. Thus, the sensor allows farmers to concentrate more.

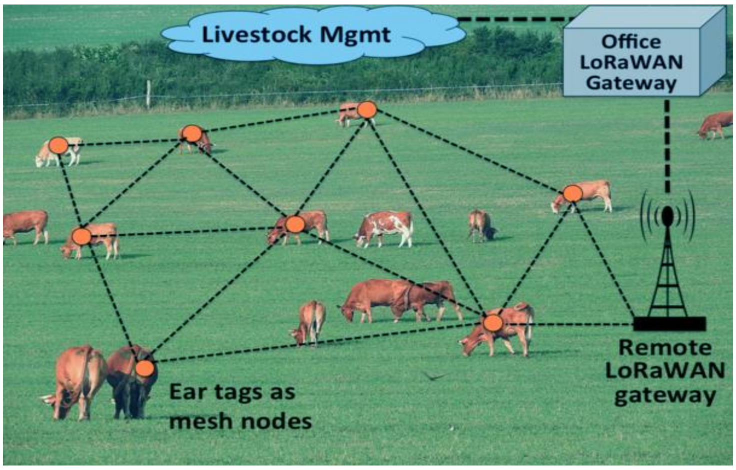

Fig. 8 -Example of Livestock tracing approach [17]

3.5 Farm Machinery & Sensors on Crops

Various internet of things on machinery systems is being used and implemented in the agricultural field to update the agricultural field in real-time. All the processing and the procedure are being done autonomously. Using the analysis and optimization layer, the system decides its following action. Collected data is being converted as instruction by the system. Various sensors are also being used in the agriculture fields for different purposes. To measure the moisture of soil, the moisture sensor is used. According to Fig. 9, the collected image of the agriculture field is converted into a mapping model. At the same time, the device or source station is collecting the information about the weather and all other things, and the instructions are being sent to the other machine or devices [18].

Diseases and weather hazards are observed throughout IoT sensor networks, and various other health consequences are detected. Communicating and storing this information with AfarCloud middleware allows quick reaction and adaptation, chartering and monitoring long-term trends simultaneously, and comparing manufacturing and conditions over the years. Automated vehicles compensate for the reduced workforce and enable precise farming by shutting down the retroactive circuit between identification, control, and intervention. Pesticides and fertilizers focused on measuring small parts of an entire agricultural production device can be used for autonomous agricultural vehicles, working with a distributed sensor network.

To enable the future of agriculture, Afarcloud will develop a distributed autonomous agriculture framework to enable cyber-physical systems to be integrated and cooperated in real-time, increase efficiency, productivity, food quality and reduce the cost of agricultural labor. The overall view of agriculture and food production, including production, energy, food quality, and services, is a crucial aspect of this approach. Considering the entire value chain from farming equipment to the final product allows a complete approach. Farmers can render autonomous farming vehicles useable and collaborate to make new technologies feasible so simple vehicles will function together for complex tasks without human interaction. The architecture allows multiple devices and systems to communicate together with a cooperative network of systems [19].

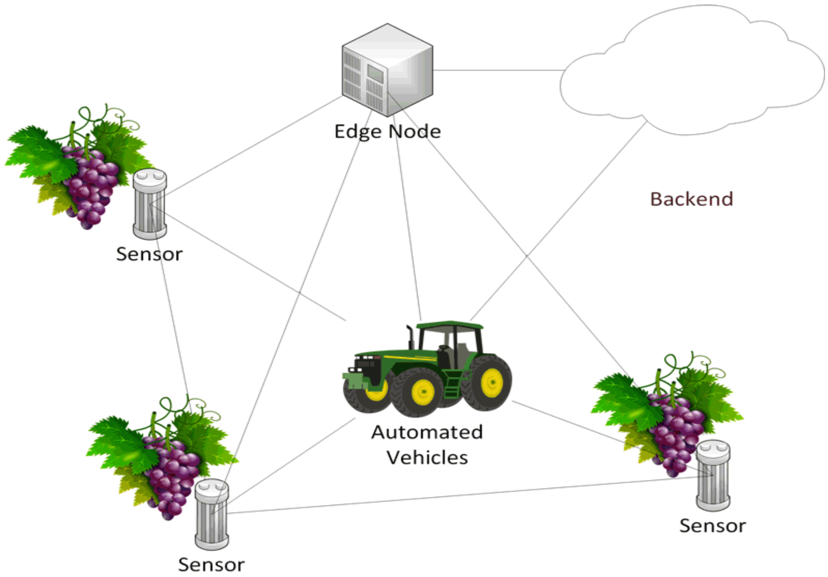

Fig. 9 -IoT sensor networks in the agriculture field [19]

3.6 Pesticides Safe Environment

To improve plants quality, this system is being implemented. The unwanted plants or pests in the agricultural field are destroyed using the pesticide process [20]. In commercial agriculture, the pesticide is being used to increase productivity. The biosensor is being used here. The biosensor sends the current signal to the Hypogynous computer. Through the wireless, this signal is being sent to the epigynous computer. Then, the epigynous computer detects the signal of pesticides for a different location and presents it as a database. The QR code technology is also used in this system. Fig. 10 shows how the pesticide process happens.

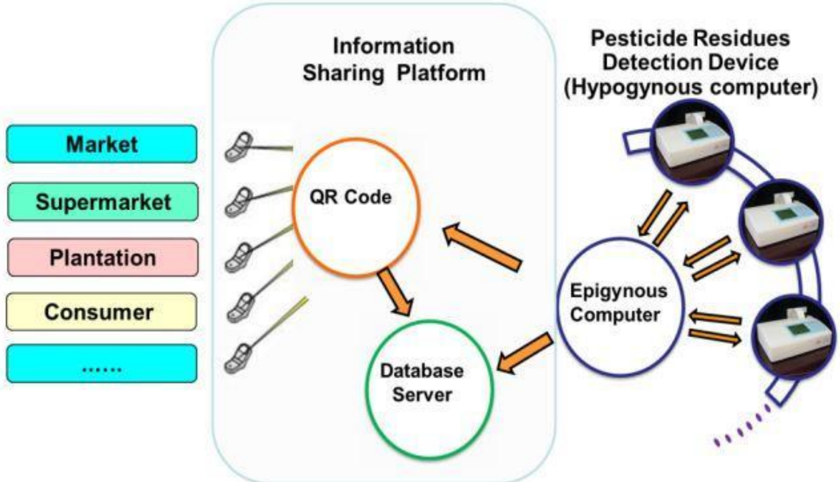

Fig. 10 –Architecture of the detection system [20]

The system's architecture can be split into three components, as shown in Fig. 11: AChE Biosensor-Hypogynous Computer and LabVIEW Platform-Based Epigynous Computer. AChE was immobilized on the working electrode to produce the low current signal. The Hypogynous machine sensing tool obtained the AChE Biosensor's low current signal and converted it into a regular 0-5V voltage signal as an output symbol. Based on the change in voltage signal, we could obtain the pesticide residue concentration. The detection data were transmitted through Wi-Fi to the epigyne computer. Then epigynous information is processed from computer detection devices placed in various locations, and import detection data into the database is obtained from the hypogynous. The QR code has been printed concurrently with a bar code printer. Citizens will scan the QR code that encodes a date relation to enter the identification details.

Fig. 11 - The prototype of the detection system [20]

3.7 File Naming and Delivery

An agricultural robot is being used in the agricultural field to do multiple tasks. These robots work like human beings. It can do the work as it is instructed. Autonomous vehicles are expected to be the core of all precision farming applications soon [21]. The objective of agricultural robotics is more than just the use of robotics in agriculture. Most of the automatic agricultural vehicles used to detect weeds, agrochemical dispersal, land leveling, irrigation, etc., are currently in manufacture. These vehicles are autonomous and require continued field surveillance, as environment knowledge can be collected autonomously, and the vehicle can then conduct its role accordingly.

An agricultural robot is being used in the agricultural field to do multiple tasks. These robots work as human beings. It can do the work as it is being instructed. More than thirty agricultural robots are being used nowadays in agricultural fields. The agricultural robots are responsible for establishing automated harvesting methods, weed controlling, the automated navigation system in the field, sorting, row cropping, thinning, seeding, mowing, pruning, packing, and spraying. Some of the agriculture robots are Iron-Ox Lettuce Robot, MIT Robot Gardener, WP5, Berry lovely, AgBot II, Hamster Bot, Rowboat, Kompany, LettuceBot, Aquarius, Prospero, Armadillo, Vine robot, Conic System Pro-300, Gripper Inspired by Octopus, PRO Packing Robot, Multi-Product Palletizing System, Grizzly, ASI Forge Platform [22].

AgBot II is a robot that helps farmers decide on herbicide, pesticide, fertilizer, and watering applications, as shown in Fig. 12.

Fig. 12 - AgBot II [22]

The robot arm of the Multi-product palletization system performs automated palletizing tasks, as shown in Fig. 13. The cargo stacks, splitting, and piling boxes on the relevant pallets are intelligent enough to detect.

Fig. 13 - Multi-Product palletizing system [22]

The Spray Robot is another automatic spray greenhouse machine in Fig. 14. The 30 cm wide robot is moved across the greenhouse with a tuber rail system. It can be used with tomatoes, cucumber, pepper, aubergines, roses, gerbera, anthurium, alstroemeria, and orchids.

Fig. 14 - Spray robot [22]

Wall-Ye is a lightweight, metal-armed wheeled robot in Fig. 15. It has GPS sensors and six web cameras for vine navigation. The soil can be tested, and grapes checked with different sensors.

Fig. 15 -Wall-Ye [22]

The main current capabilities of automatic agricultural vehicles can be divided into four categories:

i. Guidance (i.e., the way the vehicle navigates within the agricultural environment)

The low-level central processing unit (CPUs) represents the positioning system. The high-level CPU route controllers produce driving motion commands based on the positioning and environmental information obtained from the service department sensors. Obstacle avoidance and emergency stops are also included in this stage.

ii. Detection (the extraction of biological features from the environment)

The two laser sensors, the Stereo Visual System and the high-level CPU, shown in Fig. 16, are depicted.

iii. Action (the execution of the task for which the vehicle was designed, e.g., radicchio harvesting [23])

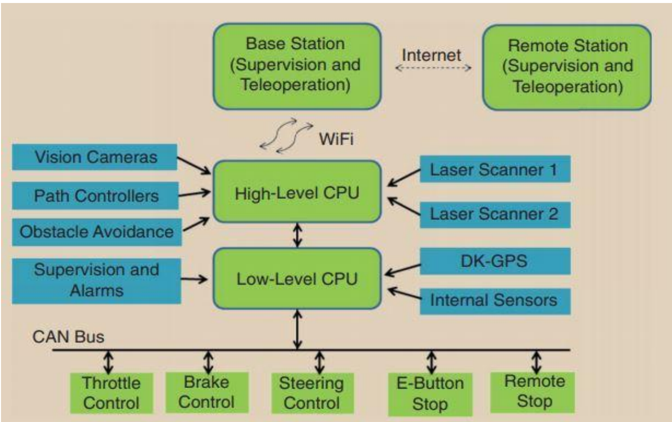

Fig. 16 - Functional structure of the autonomous vehicle [25]

Fig. 16 shows that the service unit was designed to monitor a grove. The robotic arm can be mounted onto the vehicle for handling purposes, however, under the guidance of a high-level CPU. A ground station also allows the vehicle to be teleoperated.

iv. Mapping (the construction of a map of the agricultural field with its most relevant features) [24].

The previously listed detection capability and location system are represented at that stage. The high-level CPU produces a map of the world using the sensors and location data from the low-level CPU. However, those four cores are not independent. The vehicle needs to know its position in the field and surrounding elements (maps) to ensure safe and successful navigation; bad detection could lead to an incomplete or unreliable map. Therefore, an agricultural vehicle may not successfully perform its duties if the elements are not adequately placed within the diagram.

Because of the risk of collision, an imperfect map should not be used to navigate. As can be seen in the automatic design of agricultural vehicles, the knowledge regarding the location of a vehicle in the environment and its elements in the environment is crucial. Without solving localization problems, the essential capabilities to build robotic vehicles for weed control are suggested [24].

4. Agriculture IoT Systems/Model

4.1 Agriculture IoT Generic Systems

What is happening in the agricultural field is getting the update and the information by sitting at home through the Internet of things. All the actions are being executed very perfectly and without any errors. Farm management and data collection are the head of farming IoT. The sensors or other IoT devices are beings embedded with some other IoT devices. The sensor or IoT devices collect the data from the agricultural field. IoT devices can send the data to the controlling room through an internet gateway. There always has a centralized agriculture control system for a wide area of agricultural farms as it works as the management of the system [26]. Fig. 17 shows the whole system functioning and subsystem involve.

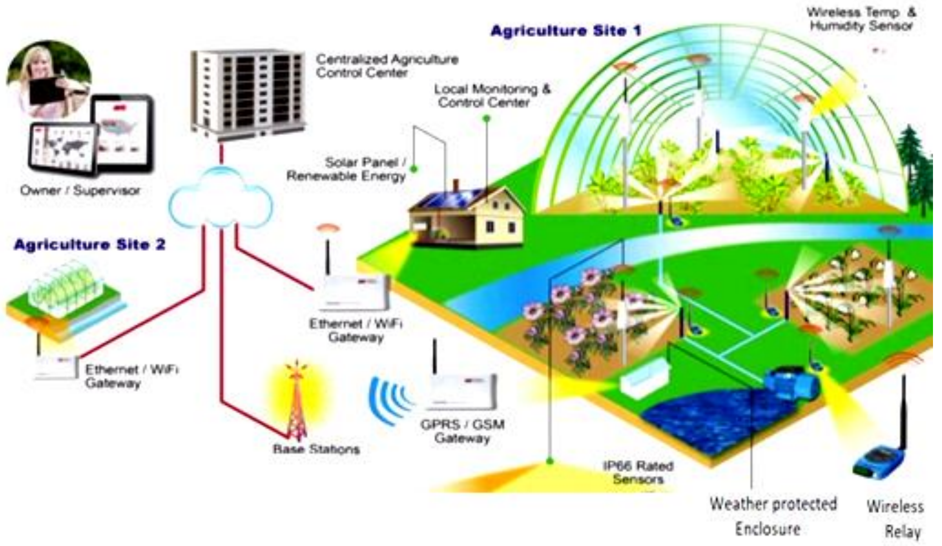

Fig. 17 - Agriculture IoT Generic Systems [26]

The agriculture IoT generic system includes wireless temperature and humidity sensors to monitor the relative humidity, temperature accurately, and dew points of the air and IP66 rated sensors for ingress protection. All the information will go to the centralized agriculture control center and will send to the supervisor. With one centralized agriculture control system, many agricultural projects can be monitored, and all the systems work autonomously. The farmers or growers can get the information from anywhere. The information is being shared through the internet, so the control room automatically sends the information even to the farmers' or growers’ mobile phones. The plants are monitored automatically by observing the cloud, temperature, irrigation, humidity, rain falling, pesticide control, and solar radiation. Different kinds of sensors are responsible for collecting the data automatically. The sensor in IoT is as intelligent as they can sense like a human [26].

4.2 Agriculture IoT Layered Model

IoT Internet of Things usually uses four-layer models to do the entire task and all the commanding. Sensing, data aggregation, network, data analysis, and cloud services. All the layers work as the gateway for the IoT devices to enter and communicate by sharing and connecting. The sensing layer works as the IoT device to collect data from the agricultural field in real-time. Sensors with IoT devices relate to the internet system like WIFI or Ethernet. Data aggregation layer work as the management of the network system and the gateway to enter the collected information from the sensing layer to the network layer [27]. Fig. 18 shows the implementation of the layered model to help the system function efficiently.

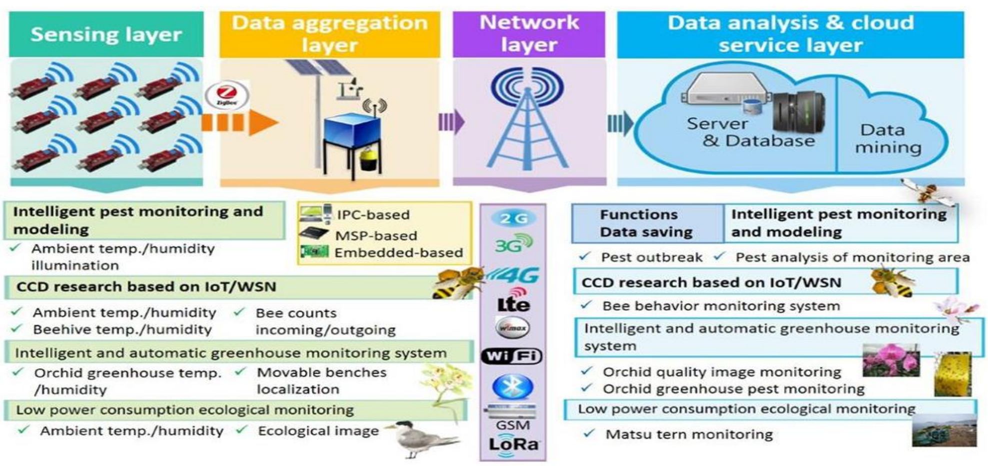

Fig. 18 - Agricultural IoT Layered model implementation [28]

Data aggregation also automatically sends the information or situation to the farmers or growers. The network layer works as the gateway to enter the networking system to share the information to the nearest base station and find the instruction from the internet. Data analysis and the cloud service layer work as the system analyst. The data collected is sent to the farmers or the internet to find the instructions. Then, once any instruction is received, the system sends the instructions to the sensing layer to take action.

5. Power Consumption Problem in Agriculture IoT Based System

The Internet of Things using agriculture systems has been more straightforward than the previous conventional systems. But after the implementation of the internet of things system in the agricultural field, productivity has not increased much. Some of the sectors in IoT still have similar productivity to the previous system. More research is needed for every different field in agriculture to increase productivity as early as possible to challenge the world food demand. So many experiments and proposals have been given to enhance productivity using IoT systems in the agricultural field, which is not so worked ideally. Some of them work perfectly but with less accuracy and less percentage of productivity.

In this section, the reputed approaches to increase productivity have been described as the scholar or reader would understand the total view and what he needs to do, and he will get the understanding as well. The research and experiments have been done for some of the aspects. Sometimes some of the components need to be changed to do the experiments. IoT will benefit the growers and farmers once the production increases with time and money-saving. Some of the addressing approaches are mentioned below to reduce power consumption in the system. Firstly, ZigBee and LoRa technology is explained based on power consumption. To save the power consumption, SigFox, duty cycle model, WiPAM, DZ50, monitoring system, header node, and wireless network sensor system are discussed in sub-sections 5.2 to 5.8, respectively. AODV and DSR protocols, radio optimization data mitigation, and caching algorithms are explained for data obtaining and data collection.

5.1 ZigBee and LoRa

Haider Mahmood & his team [29] have discussed the used wireless technologies and identified that ZigBee and Low Range Radio Protocol (Lora) are the most suitable wireless technologies. Their power consumption is high compared to other technologies. Fig. 19 shows a comparison of ZigBee and LoRa with other wireless technologies.

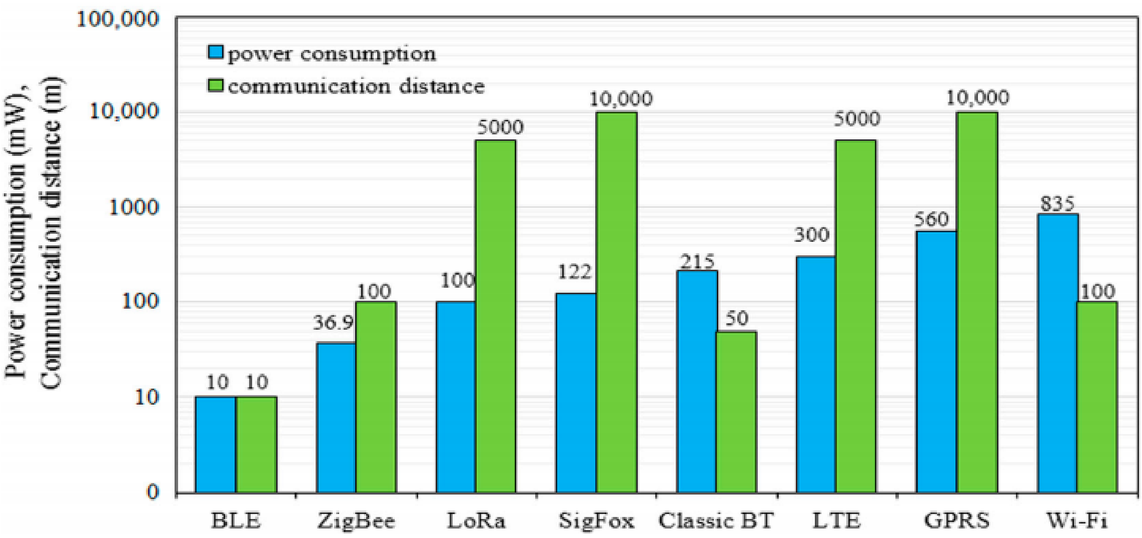

Fig. 19 - Power consumption comparison between wireless technologies [29]

Based on Fig. 19, ZigBee and LoRa have a low power consumption compared to other wireless technologies with their distance. They also said that ZigBee performance is suitable for monitoring animal behavior like walking, grazing, standing, and other modes. The system is working with 83.5% accuracy compared to other technologies with the recent methodology. They proposed an algorithm, and they expect that implementing a new algorithm in this system may improve the accuracy by 95.4%. Besides, they also mentioned that the irrigation process in ZigBee can save the entire cost from 1.24% to 6.72%. That saves energy from 2.05% to 8.21% and from 0.71% to 6.46% for water-saving.

5.2 SigFox

Llaria, Terrasson, Arregui, and H. Hakala [30] have proposed architecture to save the power and make the system power efficient. They used the wireless cellular network SigFox to experiment. They used the lowest cellular network applications to suit the methodology with the Internet of things and machine communication systems. They used SigFox with TV, telephone, mobile, and security applications. They used the SigFox system to monitor animals in the mountain during the summer season. They proposed a system to help the farmer and enhance their production.

5.3 Duty cycle model

Zhang & his team [31] proposed a duty cycle model to show the power consumption. They mentioned that the network's energy is being dissolute during the transmission and reception procedures, and at that time, the radio sensor enters sleep mode to save some power. This method is called the sleep/wake strategy. There will be no data communication when the system is in sleep mode. After a specific time, the sensor will wake up and start sending the data. Their proposed model was to measure soil moisture by analyzing the feature to measure moisture. This process is being done for the irrigation procedure. They proposed that the soil moisture sensor is in sleep mode until the data is not asked.

5.4 WiPAM

Million & his team [32] proposed and designed a wireless sensor network for PA, named WiPAM. The system was able to do the auto irrigation and establish an auto irrigation management system. They used the ZigBee and IoT devices named ZED. Three sensor nodes were configured with ZigBee, and the other was the gateway node. Another node was used to collect the information and evaluate the irrigation process. The energy also comes from the solar system & the sensors node went to sleep until any call came from the data aggregation node. This was a complete energy-efficient approach for IoT agriculture technologies.

5.5 DZ50

Ouadjaout, Lasla, Bagaa, Doudou, Zizoua, Kafi, Derhab, Djenouri, and Badache [33] present an energy-efficient wireless networking IoT system for irrigation. They added a new platform named DZ50, consisting of a transceiver and microcontroller. This platform can be run by providing less energy and saving more power in sleep mode. They made a comparison among DZ50, TelosB, and MicaZ. But the DZ50 performs well by saving more energy, and the DZ50 battery life was seven times longer than TelosB and MicaZ.

5.6 Monitoring System

Nguyen and Thanh [34] proposed monitoring environmental issues like temperature, humidity, wind direction, pH, wind speed, and rain level. They used solar cells to power up several sensor nodes deployed in areas 500m to 5km. Transceiver C1120 and GPRS mode 3G transmitted the agricultural field data and environmental conditions. The energy was saved by 3.3% via the low-duty cycling process. Another solar cell of 2W was helping to carry energy to the whole process, saving 207 mW of power in total. This process was also famous for power consumption.

5.7 Header Node

Nesa Sudha, Valarmathi, and Babu [35] proposed an energy-efficient system for the TDMA algorithm-based WSN. The system can establish an automated irrigation method. They introduced a header node that collects the information, and after processing it, they resend it to the controlling unit through the data and aggregation layer. Their technique saved 10% power for the distance of 10 Kilometers where the controlling unit and node were situated. But with the increase in distance, the power consumption also increases.

5.8 Wireless Network Sensor System

Lopez & his team [36] has proposed and designed a wireless network sensor system to monitor g horticultural yields. They did it for a distance of 10 KM. They collected the air & temperature information for ten weeks. They used the MAC protocol to conserve the power consumption process & used transceiver CC2420.

5.9 AODV and DSR protocols

Aneeth and Jayabarathi [37] have proposed a system that uses AODV and DSR protocols with a different ZigBee wireless network sensor protocol. The network nodes are responsible for sending the agricultural field information through the ZigBee wireless communication network. The information has been sent to the controlling system, and the controlling system resends it as the instruction to the irrigation valve system.

5.10 Radio Optimization

Several scholars have described the radio optimization process, and various experiments have been done like power control transmission (TPC), scheming modulation, and radio cognitive. They did the experiments for the agricultural sensor nodes to do the power consumption.

5.11 Data Mitigation

Data Mitigation is one of the methods to reduce power consumption. Date mitigation processes are gathering data and comparison of data and data-driven methods. Gao, Zuo, and Zhang [38] have described the data gathering method. Their proposed method has shown that the system only will collect the data. Whatever the base station only needs data means the system will be in sleep mode to save the power.

5.12 Caching Algorithm

Musanze, Bulega, and Lubega [39] described and introduced a caching algorithm that can optimize the sleep period and wake-up period. This system can obtain low latency and low power consumption. The source node collects the data in this system and sends it to the sink node. This system includes the ZigBee to share the information to the internet to receive the instruction. All the techniques applied are summarised in Table. 1.

6. Summary

Internet of Things has connected billions of devices and humans in the same connected lane. The Internet of things improves the agricultural system and makes it more intelligent than before. Production has been increased, and the contorting in the agricultural system has also been automated. Except the power supplying IoT is nothing. Power is mandatory to run the IoT devices in agriculture.

In this paper, the agricultural IoT is being elaborated on, and the challenges of agricultural IoT 'power consumption' have been described. There have many proposed techniques by researchers and scientists. Among all the descriptions, the result has been faced out that ZigBee is working so perfectly with the IoT devices to save more power.

Table 1 - Summary of techniques

Authors	**Techniques**
Haider Mahmood	ZigBee, LoRa
Llaria	SigFox
Zhang	Duty Cycle Model
Million	WiPAM, ZigBee
Ouadjaout et al.	DZ50
Nguyen, Thanh and Nguyen, Huynh	C1120 & GPRS
Nesa Sudha et al.	TDMA
Lopez	MAC protocol
Aneeth, Jayabarathi	AODV & DSR

7. Conclusion

IoT in agriculture is one of the best gifts of modern science. To fulfill the food world and demand, productivity must increase. For that, a 24/7 monitoring system is needed. Humans have tiredness, but a system can work as it will be instructed for all times. Power consumption in IoT has been a considerable challenge at this time. This paper presents a comprehensive discussion of the power consumption approaches of famous researchers' books. The techniques and methods have been discussed with their references. This paper suggests a complete idea about IoT's power consumption issues that need more research to find a more suitable algorithm. ZigBee is now working with 83.5% accuracy, which also needs to be increased. The different system also needs to be tried with ZigBee to get good outcomes. Some future work can be done to improve the system to preserve more energy. Agricultural IoT is a remarkable approach. The farmers and growers will be benefited once it is implemented very wisely and perfectly. They will be benefited once the cost is lower than the productivity. Next time a comprehensive investigation will be done on Agricultural robots so that scientists and researchers can see the future of agriculture.

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