IOT Enabled for Smart Farming

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By making everything smart and intelligent, IOT technology has altered every element of the common person's existence. The Internet of Things (IOT) is a network of self-configuring devices. IoT-based Intelligent Smart Farming technologies are quietly but steadily altering the face of agriculture production, not only by improving it but also by making it more cost-effective and reducing waste. The purpose of this research is to provide a revolutionary smart IOT-based agriculture stick that will help farmers acquire real-time data for efficient environmental monitoring, allowing them to engage in smart farming and increase overall yield and product quality. The proposed device has been tested on real-world farm fields and has a data feed accuracy of more than 98 percent. Large-scale Internet of Things platforms can now process a large number of sensor data streams, thanks to recent advancements in the Internet of Things. These Internet of Things frameworks allow smart solutions to collect, process, and analyse data streams in real time, allowing them to provide decision assistance. Existing IoT-based solutions are often domain-specific, delivering stream processing and analytics for a small number of applications. In. Agriculture-IOT can combine many cross-domain data sources into a unified framework, resulting in a complete semantic processing pipeline. for use in intelligent agriculture Agriculture-IOT allows for large-scale data analytics and event detection, as well as seamless interoperability between sensors, services, processes, operations, farmers, and other key stakeholders, such as online data sources and linked open datasets and streams.

Keywords: Sensors, Motor, Wi-Fi module, Arduino UNO, UAV drones, Solar Power Supply, Crop Monitor System, Data Analysis.

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1 Introduction

In the future, the Internet of Things will be the foundation of Smart Computing (IOT). It is critical in the transition from "Traditional Technology" in households to "Next Generation Everywhere Computing" in offices. The 'Internet of Things' is gaining pace in global research,notably in the realm of increased wireless communications. Today, the Internet of Things (IoT) is touching people all over the world and laying the framework for a number of products, including smart health services, smart living, smart education in schools, and automation. It's also used commercially in industries including manufacturing, transportation, agriculture, and corporate management. Figure 1 depicts a variety of fields. (Patel and Jash Doshi [1] say so.) The Internet of Things (IoT) is a powerful, dependable, and cost-effective technology for implementing the concept of a "Smart Village," which aims to empower villages through advanced connectivity via web service, measurement of environmental factors like soil moisture, temperature, and humidity, and real-time monitoring via GSM system.

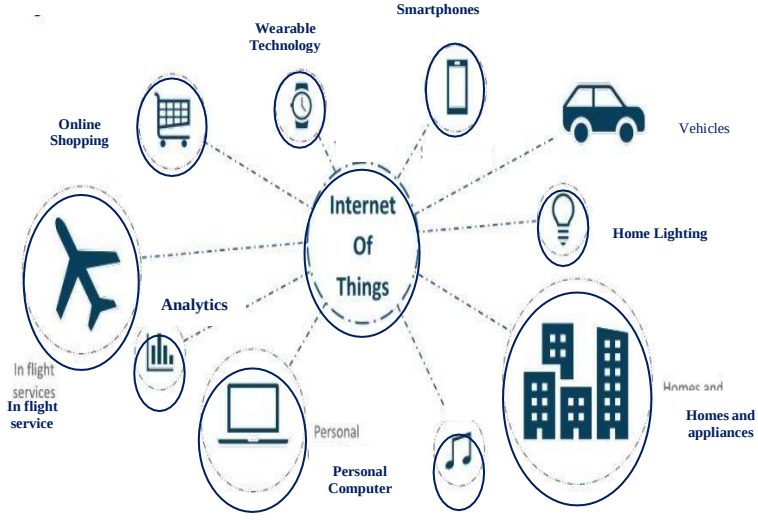


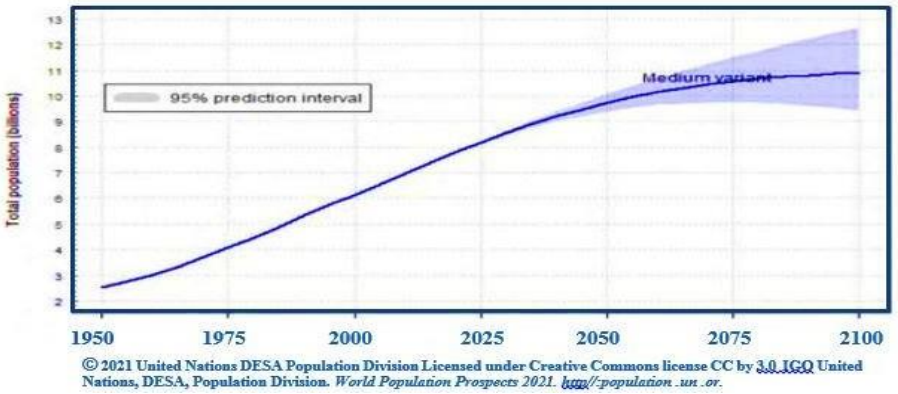
Fig 1. IoT application in ev 9]

Increased agricultural yields will result from the deployment of a Smart Agriculture System, as well as the use of renewable energy sources that are both cost-effective and need less effort. The Internet of Things (IOT) is the primary technology used in this project. It can be described as a combination of the Internet and Things, the two components that were used to name it. Things are genuine physical

elements such as sensors, computer units, communicationequipment, and so on, whereas the Internet represents their connectedness and interrelationship. Using this technology, a farmer will be able to collect data on physical quantities such as soil content, as well as moisture, using a communication network made up of Wi-Fi modules and gateways, data on gas composition, seed health, fertility, and other factors may be collected remotely before being sent to a central analytical system. The farmer may make decisions to improve his crops based on the results of the analysis. India's most popular occupation is farming, which accounts for more than 60% of the country's GDP. Farmers and agricultural producers are given a wide range of information from remote locations about soil and crop behaviour, animal behaviour, machinery condition, and the status of storage tanks to help them make decisions and increase output. Factors like soil moisture, for example, are measured. Because of developments in communications technology and sensors for agriculture, as well as lower production costs, it is now possible to measure temperature and acidity. Smart farming allows farmers to effectively use fertilizers and other resources to improve the quality and quantity of their crops. Their yields Farmers are unable to stay in the field at all times of the day. Farmers may also lack the knowledge and experience required to use various devices to determine the best environmental conditions for their crops.

The problem of food production in the twenty-first century gets more important as the world's population expands. The world's biodiversity is predicted to support between 9.4 and 10.1 billion people by 2050 (Fig 2), increasing the demand for specialised food production areas— specifically for planting and livestock. As a result, smart farming is a new farm management concept that includes tactics and technology at the farm level, enabling for the resolution of food production demand difficulties and staff reductions. As a result, IoT apps allow farmers to analyse data, predict future events, and more. and increase output while lowering costs and conserving resources Open-field farming, controlled environment agriculture (greenhouse), animal breeding, agricultural machinery, grain storage, and other intelligent agriculture applications all employ IOT.

Fig 2. World population projection



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Drinkable and suitable for agriculture water supplies are dwindling as a result of climate change, while natural disasters compound losses in productive areas. The UN Food and Agriculture Organization (FAO) and the World Health Organization (WHO) draw attention to the existing situation and foresee future concerns through their research and publications.

Overview

The purpose of this study is to learn more about how the Internet of Things is used in smart farming by I conducting a systematic review of IOT adoption in smart agriculture and (ii) identifying the most commonly used hardware, platforms, network protocols, and technologies, as well as their applicability to the proposed solutions. This review article assesses the acceptability of (new) IT technologies in the smart agriculture field, such as big data, computer vision, artificial intelligence, and block-chain, and reviews literature until 2021 to provide the reader with a more current view of the smart agricultural research field. This evaluation contributes to the academy's prior studies by providing a comprehensive assessment of the state-of-the-art of IOT in smart farming.

The agriculture industry is affected by Industry 4.0 (as seen in Fig. 3). In recent years, IoT (Internet of Things), AI (Artificial Intelligence), Remote Sensing, and IMP (Remote Sensing and Image Processing) technologies have all been linked to GIS (Geographic Information Systems) and have become widely employed in agriculture. Satellite systems' high-resolution multi-band pictures and unmanned aerial vehicles are being converted to decision support systems, where artificial intelligence can be used to identify agricultural stress causes and recommend immediate solutions,in addition to sensor-collected soil characteristics and meteorological data.

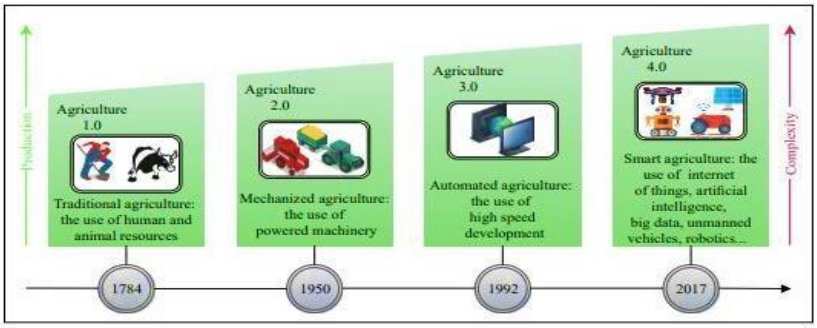


Fig. 3. The four agricultural revolutions

The Internet of Things is critical for resource monitoring in Smart Farming because it connects various and heterogeneous items such as buildings (such as barns), machinery andvehicles (such as milking machines or agricultural tractors), or even living creatures in mixed dairy farms (which produce milk from calves while also farming feed grain for livestock) (e.g., cattle). Edge Computing can also be used to design, develop, and deploy IoT projects and infrastructures. The goal of this project is to develop and deploy sensor systems in the agricultural field, as well as data management utilizing a smartphone and a web application. Hardware, online application, and mobile are the three components application, as shown in Fig. 4.

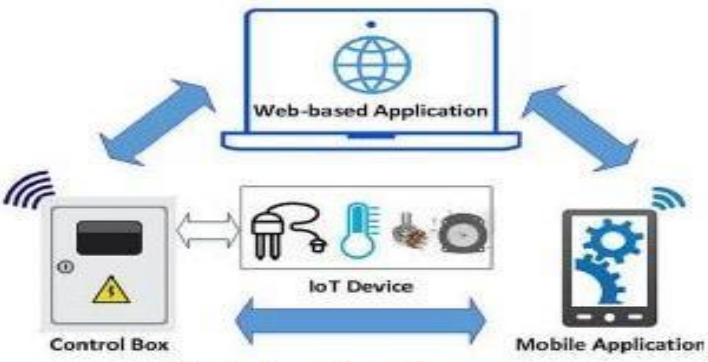


Fig. 4. An overview of the system.

As indicated in Fig. 4, the first component was designed and built as a control box. This is the command. The box will be used to control IoT devices as well as collect data from crops. A control box, a web-based application, and a mobile app are the three components of the proposed system. The control box, as shown in Fig. 4, keeps electronic equipment in a waterproof box. Soil moisture sensors, solenoid valves, DHT22 sensors, and ultrasonic sensors could all be connected to a control box that could be located anywhere on or near the farm. In this study, IoTs are utilised to control the automatic on and off of water sprinklers by detecting the humidity of agricultural soil using soil moisture sensors.

2 Literature Review

It looked at the various types of WSNs (wireless sensor networks) and their application possibilities in agriculture. It discusses the most prevalent agricultural and cultivating applications, as well as WSNs' appropriateness for improved performance and profitability. A single document contains the system architecture, node architecture, and communication technology standards utilised in agricultural applications. The outcomes of this study suggest that the usage of IOT sensors in agriculture to boost production is on the rise. IoT is used in smart farming systems to cover all elements of farming, cutting costs and increasing yield. The absence of infrastructure in many countries is the main barrier to their adoption, with just about 30% of the world's population having access to these technologies. new technologies. In our nation, about 60% of land is suitable for farming, and the majority of people are dependent on agriculture. However, they are often uninterested in new technology, so developing a smart agricultural system in rural areas is a problem.

Current Scenario

- In real time, the farmer should go to the land and check the soil moisture, temperature, and humidity, and then turn on the water motor.
- One farmer may not be able to care for the entire farming region, which necessitates the use of labor for diverse tasks.

3 Proposed Methodology

Fresh vegetable cultivation is challenging in metropolitan areas due to a lack of farming space and

resources. As a result, people in their neighbourhood are unable to access fresh vegetables, and hence are unable to obtain sufficient nutrients for their bodies. The vegetables come from the countryside. Due to higher delivery expenses, the item's price has increased. The cost of vegetables has risen. As a result, this is a significant problem for those who cannot afford such a high price for vegetables. A lot of vegetables go to waste due to the two to three day transit time. Pod farming is a type of agriculture that can assist alleviate this issue. Farm-Pod is a cutting-edge farm! It's a first-of-its-kindvertical aquaponics food production system that's both off the grid and fully automated. The farms are usually constructed from recycled shipping containers that may be stacked and organised to create anything from a single shipping container and garden to a network of shipping container farms. By integrating a range of technologies, the system may scale without the use of redundancy modules. Because of the flexibility, farmers may swiftly adapt to their market and expand their growing capacity without incurring additional costs. Farm pods are miniature, mobile farms made out of repurposed shipping containers. A container farm, a boxcar farm, or a farm in a box is all terms for the same thing. The names farm pod, agricultural box, and agricultural box are all used to describe a farm pod. These farms use vertical farming techniques to grow a wide variety of fresh vegetables in a little space. Vertical farming includes growing fresh vegetables vertically, on shelves or towers, rather than horizontally. Because vertical farming works best with soilless growth methods, farm pods use them. Soilless systems include hydroponics, aeroponics, and aquaponics, as well as aquaponics. These methods all use water to deliver nutrients to their crops instead of soil.

In hydroponics, the nutrient solution, which is made up of water and fertiliser, is used. Individuals in metropolitan regions face challenges in installing this technology. Growing in a windowless container appears to be challenging. Indoor farms, on the other hand, have been successfully cultivating crops for many years under artificial light. Farmers use artificial light instead of sunlight to nurture crops in farm pods. For example, our Pure Greens Container Farms use 5500KWhite LED bulbs that produce 5100 lumens of full spectrum light and are constructed from ISO marine shipping containers. LEDs are more energy efficient, but they are also more expensive. Compared to fluorescent lights, provide a larger amount of light keeping your energy usage in mind can help you save money costs.

Farm pods are a feasible alternative to traditional farming for a variety of reasons. Because they don't use soil, they can't contribute to soil erosion. Soil erosion is a serious problem that is gradually getting worse. If we continue on our current path, we will have lost all of our agriculture by 2074. In addition, agricultural pods save water! Hydroponic farms consume a tenth of the amount of water that traditional farms use. This is because water in hydroponics systems is collected and recirculated throughout the system rather than being wasted through evaporation or runoff. Furthermore, because food can be grown much closer to the customer, it does not have to travel as far as it would if it were grown using traditional methods, saving time and money.

These farms are suitable for persons who want to start a business as well as existing businesses. They're used for a variety of things, including selling at farmers' markets, giving hands-on learning experiences for kids, and providing food for the workplace cafeteria. Some people buy shipping containers with the explicit goal of turning them into farms, while others already have them. You don't need to be an expert to start your own container farm. Our prefabricated farms are immediately usable. If you want to start your own agricultural pod, look no further.

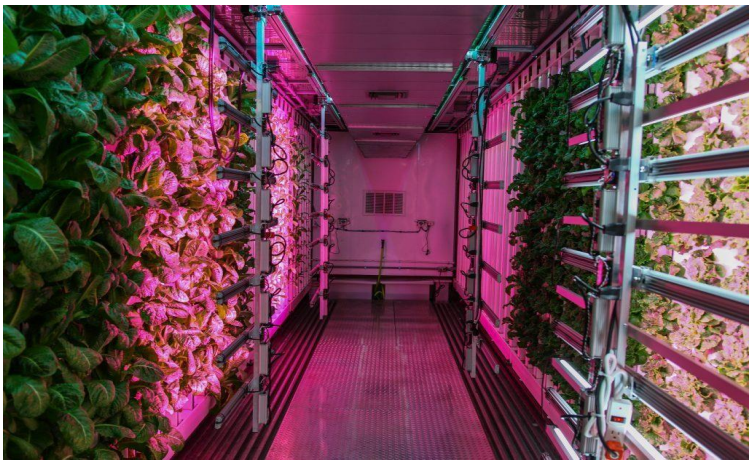


Fig 5. Pod Farming inside a room

4 Proposed Model and Design

An IoT-enabled Arduino-based smart agriculture system that uses a variety of technical ways to control elements including soil moisture, temperature, and humidity. In addition to data and storage management in the IoT, our proposal includes power consumption regulation, with the motor switching on and off automatically using sensors. It can also handle field theft prevention tactics to keep the produce safe. With the use of motors, proper water management is achieved. Seed is flung step by step using a stepper motor in the first stage of cultivation, and the field is maintained and stored using Wi-Fi modules until the crop is harvested. Precision agriculture and the utilisation of solar panels to generate electricity are also covered.

Device needed

i. Arduino UNO: The Arduino UNO is a low-cost, versatile, and simple-to-use open-source programmable micro-controller board that may be used in a range of electrical applications.

ii. Soil moisture sensor: The Soil Moisture Sensor measures the dielectric permittivity of the surrounding medium using capacitance. The electrical connections for the soil's water content are created by the sensor, which generates a voltage proportional to the dielectricpermittivity.

iii. Temprature sensor: Sensors that measure the amount of substances that can flow are called water level sensors. Liquids, slurries, granular material, and powders are examples of such substances. These measurements may be used to figure out how much stuff is in a closed container or how much water is flowing in open channels.

iv. The ESP8266 Wi-Fi Module is a self-contained SOC with an inbuilt TCP/IP protocol stackthat can provide any microcontroller access to your Wi-Fi network. Alternating Current Adapter: An AC adapter, also known as an AC/DC adapter or an AC/DC converter, is a form of external power source that is usually housed in a casing that looks like an AC socket. Plug pack, plug-in adapter, adapter block, domestic mains adapter, line power adapter, wall wart, power brick, and power adapter are some of the other popular names.

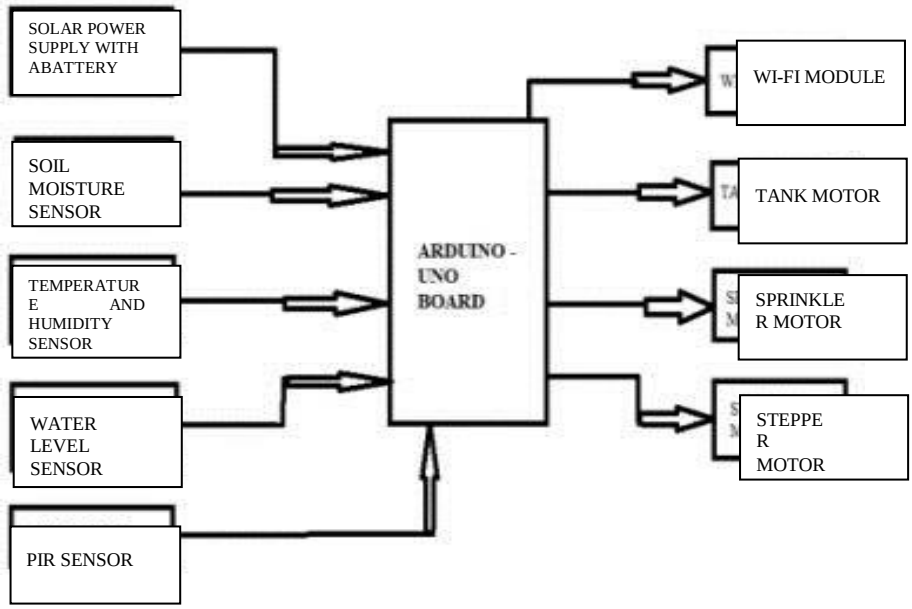
v. Solar power supply: Solar photovoltaic (PV) panels convert sunlight into energy by exciting

electrons in silicon cells with photons from the sun. This electricity can then be used to power your home or business with environmentally friendly energy.

Result on Proposed Model

Fresh veggies are managed by Farm-Pod Fresh vegetables, which use sensors to collect data and deliver it to the application. If the soil moisture is below the edge values, the application can take action such as watering the plants. Such activities are carried out by the application mechanically, without the need for human interaction.

Block Diagram of proposed work



5 Result and Discussion

We go over crucial past research on two separate issues in this section. The first is about Internet of Things (IoT) applications, while the second is on agricultural data analysis with IoT devices. The recent study demonstrated the importance of smart agriculture in terms of enhancing and growingagricultural productivity in order to help close the gap between supply and demand for food. The Internet of Things (IoT) is considered the backbone of smart agriculture technology since it connects all components of smart systems, not just in the agricultural field but also in other applications.

As a result, smart farming has the potential to produce a more productive and sustainableagricultural

production system based on a more precise and resource-efficient manner. New farms will bring humanity's long-held dream closer to reality. It will provide food for our expanding population, which is estimated to reach 9.6 billion by 2050.

Application of IOT

The Internet of Things (IOT) refers to the use of sensors and other devices in the agricultural environment to convert every element and action involved in farming into data. It's an internet-based network system in which smart devices that communicate with one another via sensors can use that data to activate certain actions. When combined with other technologies, IOT is quickly welcomed in many areas due to its real-time, highly sensitive digital information flow and benefits in process and service management. The key elements of IOT are as follows:

(i) WSN: Wireless Sensor Networks have nodes and sensors to accumulate various sorts of data.

(ii) Communication Protocols: It is the most important components that ensures connectivity and exchange of data over the entire system.

(iii) Embedded System: It has both software and hardware to perform pre-defined tasks.

(iv) GIS (Geographical Information Systems): GIS stands for Geographic Information Systems, which are data management systems based on location. With GIS, which incorporates location-based data gathering, administration, and analysis, a large amount of data can be linked together quickly, and maps that show data may give a more in-depth view and insights.

5.2 Agriculture Data Analysis

When IoTs are used, large-scale or big data is generated, which is useful information. As a result, a number of studies have attempted to transform such data into useful knowledge and information. To regulate climate, fertiliser, irrigation, and pests, the system used a wireless sensor network (WSN) to gather and analyse plant-related sensor data. Using WSN data, data mining was used to reveal knowledge. From huge databases on crops obtained via the Internet of Things, data mining was used to extract critical and valuable information. The process of obtaining information from massive amounts of data is referred to as "data mining." This paper divides data mining into five stages:

(i) Data pre-processing: Because the quality of knowledge is predicated on the quality of data, this is a crucial stage in the knowledge discovery process. Data is frequently messy, imprecise, and inconsistent in the real world. Data cleansing, data integration, and data transformation are all partof this process. This study evaluated massive amounts of data from IoT sensors on temperature, humidity, and soil moisture to forecast yields and data.

(ii) Data reduction: This process can reduce the data's representation to a smaller size. The original data's integrity was retained so that mining the reduced data would be more efficient while still producing the same (or nearly identical) analysis findings. Numerosity reduction was used in this study, with nonparametric approaches such as histograms being used to store reduced representations of the data.

(iii) Data modeling/discovery: This procedure derives knowledge from previously generated data. The majority of the time, advanced approaches to data modelling and discovery are used to find patterns in data. Analysis tools include classification, grouping, and association.

(iv) Artificial intelligence (AI): Artificial intelligence is defined in a variety of ways, but the

most common definition is a human-designed simulation system that simulates mental actions. It entails continuously feeding the system with an integrated approach, training the system with diverse ways, providing a kind of reasoning capacity, and improving the output's dependability by using comparison data. Although human intelligence's limitations are unknown, it requires mechanical assistance in the processing of large, complex, and huge amounts of data, and it may use technology and information systems to accomplish its objectives. With these systems, decision-making procedures are constructed and accelerated.

(v) Big Data: Analyzing Massive Amounts of Information Big data is prominent in many economic sectors in today's technology-driven society, but is it now available in agriculture? The growing number of data available for field management needs the implementation of an automated technique for extracting operational data from bulk data. On the other hand, the volume of data now acquired from most business domains is likely not yet at the level considered to be big data.

6 Conclusion

This article looks at a few smart farming use cases, as well as the benefits and uses of integrating IOTin agriculture, which could help farmers increase productivity with less money and manpower. The smart farming system concept might also be utilised to provide fresh vegetables to city people in a smart city. It's possible thanks to a new technique known as pod farming. The study provides an overview of smart farming applications and aids researchers in identifying challenges and open research questions in the field. As a result, it would be good to assess the potential and gaps of sustainable smart farming.

Future Enhancement

According to this smart agricultural revolution, pesticide and fertiliser consumption will drop in the future, but overall efficiency will grow. Food traceability will be improved as a result of IoT technologies, resulting in increased food safety. It will also be beneficial to the environment, thanks to more efficient water use and treatment, as well as input optimization.

We have simply illustrated the notion of pod farming in an urban setting utilizing IOT sensors. This concept will be utilized to improve pod smart farming in India's metro cities in the future.

i. Urban agriculture to produce vegetables in world-class supermarkets such as UAE, Dubai, where fresh vegetables cannot be grown, that are grown in greenhouse conditions and chosen by consumers directly.

ii. As we all know, space agencies such as NASA SpaceX, Blue Origin, and CNSA are working on interplanetary missions to colonise the human civilization on other planets in the future after reaching Mars. We need first and foremost oxizone, and secondly, farming on their land, so we need a lot of high and advanced technology to make farming on the other planet to survive the human steps in interplanetary space.

References

[1] Doshi, J., Patel, T. and Bharti, S. K. (2019). Smart Farming using IOT, a solution for optimally monitoring farming conditions. In *the 3rd International workshop on Recent advances on Internet of Things: Technology and Application Approaches.*

[2] Muangprathuba, J. et al. (2019). IOT and agriculture data analysis for smart farm. *Computers and Electronics in Agriculture*, 156: 467-474.

[3] Kirkaya, A. (2020). Smart Farming- Precision Agriculture Technologies and Practices. *Journal of Scientific Perspective*, 4(2): 123-136.

[4] Verónica Saiz, R. and Francisco Rovira, M. (2020). From Smart Farming towards Agriculture 5.0:A Review on Crop Data Management. *Agronomy*, 10(2): 207.

[5] Roy, P. P. et al. (2020). Multi Purpose Smart Agriculture System. *International Research Journal of Engineering and Technology*, 7(7): 1920-1923.

[6] Kulkarn, H. et al. (2020). IOT based Smart Farming. *Journal of Emerging Technologies and Innovative Research*, 4(4): 29-31.

[7] Sivabalan, K.N., Anandkumar, V. and Balakrishnan, S. (2020). IOT Based Smart Farming for Effective Utilization of Water and Energy. *International Journal of Advanced Science and Technology*, 29(7s), 2496 – 2500.

[8] Duangsuwan, S., Teekapakvisit, C. and Maw, M. M. (2020). Development of Soil Moisture Monitoring by using IOT and UAV-SC for Smart Farming Application. *ASTES Journal,* 5(4): 381-387.

[9] Friha, O. et al. (2021). Internet of Things for the Future of SmartAgriculture: A Comprehensive Survey of Emerging Technologies. *IEEE/CAA Journal of Automatica Sinica*, 8(4): 718-752.

[10] Navarro, E., Costa, N. and Pereira, A. (2020). A Systematic Review of IOT Solutions for Smart Farming. *Sensors,* 20(15): 4231.

[11] Narsimhulu, K. et al. (2020). Smart Village: Solar Based SmartAgriculture with IOT Enabled for Climatic Change. In *IEEE 5th International Conference on Mechatronics System and Robots (ICMSR)*, 102-105.

[12] Almalki, F. A. et al. (2021). A Low-Cost Platform for Environmental Smart Farming Monitoring System Based on IOT and UAVs. *Sustainability,* 13(11): 5908.

[13] Badreddine M. et al. (2020). A study of LoRaWAN protocol performance for IOT applications in smart agriculture. *Computer Communications*, 164: 148-157.

[14] Podder, A. K. et al. (2021). IOT based smart agrotech system for verification of Urban farming parameters. *Microprocessors and Microsystems*, 82: 104025.

[15] Nawandar, N. K. and Satpute, V. R. (2019). IOT based low cost and intelligent module for smart irrigation system. *Computers and Electronics in Agriculture*, 162: 979-990.

[16] Glaroudis, D. et al. (2020). Survey, comparison and research challenges of IOT application protocols for smart farming. *Computer Networks*, 168: 107037.

[17] Alonso, R. S. et al. (2020). An intelligent Edge-IOT platform for monitoring livestock and crops in a dairy farming scenario. *Ad Hoc Networks*, 98: 102047.

[18] Pathak, A. et al. (2019). IOT based Smart System to Support Agricultural Parameters: A Case. *Procedia Computer Science*, 155: 648-653.

[19] Nigussiea, E. et al. (2020). IOT-based Irrigation Management for Smallholder Farmers in Rural Sub-Saharan Africa. *Procedia Computer Science*, 177: 86-93.

[20] Nigussie, E. et al. (2020). IOTArchitecture for Enhancing Rural Societal Services in Sub-Saharan Africa. *Procedia Computer Science*, 177: 338-344.