Smart Agriculture Monitoring system using IoT and Drones

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Abstract:

Global warming, water shortages, and, most lately, an epidemic, all put strain on current food and agriculture manufacturing systems. The main aim of the research is to study smart agriculture monitoring systems using IoT and Drones. The research is designed to highlight the key characteristics of UAVs as well as artificial intelligence applications in understanding. CNN is utilised in detection and classification of spots on the leaves of plants thus enabling to highlight multiple diseases on the leaf. According to the research, an accuracy of almost 12% has been found as compared to the previous methods which had gained the accuracy of 75%. Sensors are considered to be the backbone of remote sensing that helps to provide all the information related to crops and its environment. This research also resulted in the creation of automated algorithms for producing prescription maps straight from mosaics of UAS pictures, demonstrating the economic and environmental benefits of UAS remote sensing. Therefore, it can be concluded that (UAVs) is known to as Unmanned Aerial Systems (UAS) to more accurately determine such fully advanced, safe, and profitable technologies that will enhance agricultural output profitability in the future.

Keywords: smart agriculture; Internet of Things; IoT and Drones; artificial intelligence; producing quality food; sustainability; IoT and Unmanned Aerial Vehicles

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1. Introduction

Global warming, water shortages, and, most lately, an epidemic, all put strain on current food and agriculture manufacturing systems. These elements are: posing a danger to the country's long-term economic and environmental viability food supply systems, both existing and prospective Scientific and technological advances More than ever, technical advancements are required to ensure security and enough food for the world's rapidly expanding population (Maes 2019). Climate change, limited irrigation water supplies, rising production costs, and an overall decline in the agricultural labour have all posed significant difficulties to agriculture production systems across the world. Furthermore, the most recent concern, the pandemic of COVID-19 presents a danger to world's agriculture and distribution infrastructures. These problems jeopardize the existing and future food supply systems' environmental and economic viability.

While agriculture is continually changing, considerable advancements will be required to keep up with the ongoing effects of climate change. The apparent challenge here is how to sustainably supply enough high-quality food for the world's rapidly rising population. Agricultural research experts have long used cutting-edge technology and explored methods to incorporate it into farming operations (Huang 2018). Dynamic crop simulation models have shown to be effective technology for various agricultural systems and exploring how those components interact. Artificial Intelligence (AI) has lately gotten a lot of interest in agriculture since its capability to use massive data, credit to the use of Unmanned Aircraft Systems (UAS), this information is now more readily available. UAS offers what is to be an opportunity to use advanced analytics to operate agriculture production., hence boosting their robustness and efficiency (Toscano 2019). The purpose of this study is to analyse scientific evidence on the use of sensor technology in agriculture in order to ensure long-term viability. It also plans to examine existing hurdles to UAS adoption, and also future thoughts on UAS incorporation with satellites spatial data for research on a broader basis. The findings of the study determined that prescription maps based on photos captured by piloted aircraft, and effectively employed VRT to administer fungicide during planting to reduce CRR, using the full amount in known infested regions and zero in non-infested areas. The findings also evaluated that the creation of automated algorithms for producing prescription maps straight from mosaics of UAS pictures demonstrate the economic and environmental benefits of UAS remote sensing.

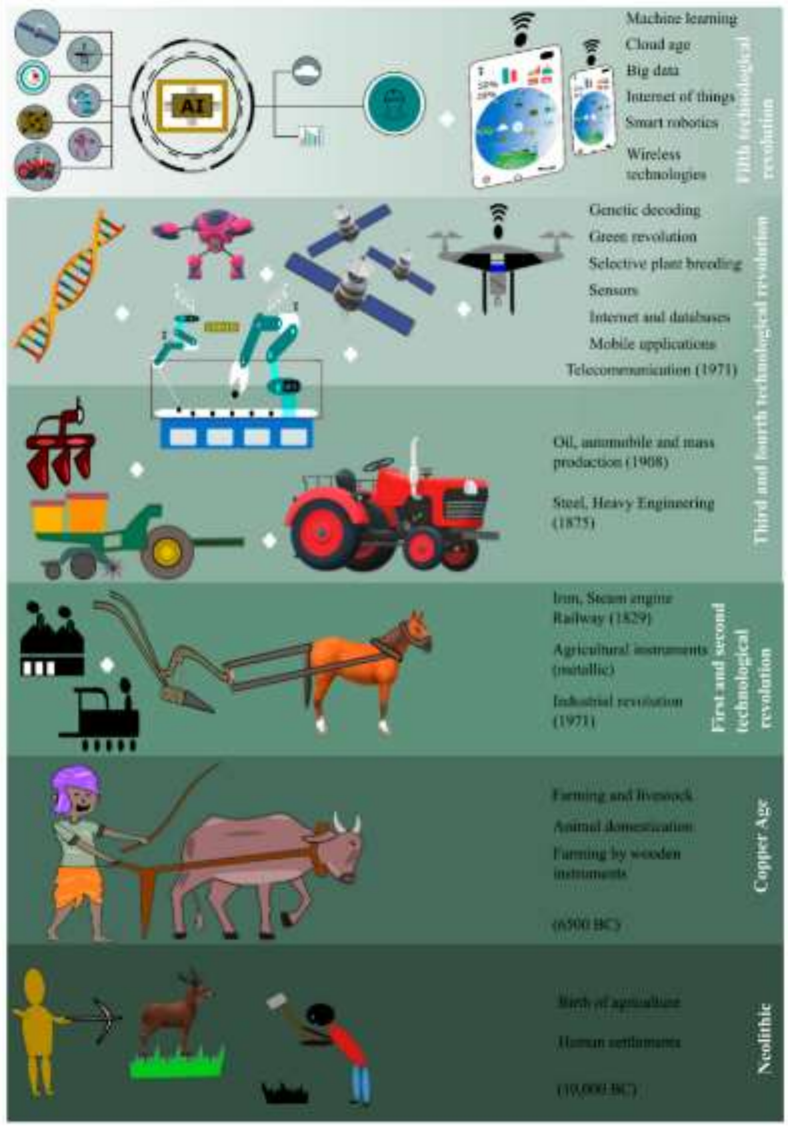
1.1 Aims and objectives:

The main aim of the research is to study smart agriculture monitoring systems using IoT and Drones. Following objectives are specifically structured to fulfil the aim of the study;

1- To explore the revolutions that have been occurred in the agriculture industry.
2- To determine the process of producing quality food for the purpose of fast-growing global population sustainably.
3- To examine the use of IoT and Drones to enable advanced analytics for the management of agriculture systems to enhance the resiliency of production systems.
4- To evaluate the use of IoT and UAV to achieve sustainability in agriculture.

1.2 Significance

It has been studied that constant industrial innovation has made the huge changes in the year 2021, and it has been marked as the era of 5.0 by the European Commission. The agriculture sector has initiated many of the work by the adoption of digitalized and automation systems. Although the agriculture had initiated in the Copper Age but with the time, it has brought industrial revolutions such as robotics, machines, telecommunication systems and many more (Martos et al. 2021). Further with the revolutions of artificial intelligence and cloud computing, it has brought a lot of changes. It is largely applied to agriculture remote sensing (RS). The below figure represents below all of the revolutions which has been adopted in the agriculture sector.



The above picture shows the complete illustration of the complete industrial revolutions related to the agriculture which has been done with the time. Different technologies which have been revolutionized in each era are mentioned.

Further the world population is continuously increasing, climate is continuously getting changed and therefore the sustainable goals are also changing. This has made the significant improvement in agriculture sector by making it efficient and sustainable. As per the organization of food and agriculture, agriculture production in the present era must be enhanced by 70% by 2050 keeping in context the higher requirement for quality and environmentally friendly food (Ennouri and Kallel, 2019). Unmanned aerial vehicles (UAVs) are small unmanned planes. The control station, also known as the interface, and the networking devices between the control station and the Drone are two related features that are essential for the aircraft's safe and efficient operation. Drones are highly effective in detecting land level concerns, which may then be communicated to farmers for rectification. Therefore, presently, it occupies the main position in agriculture and soil studies. Most of the terms have been simultaneously used in this context such as precision farming, digital farming and smart agriculture.

According to Shanmugapriya et al (2019), technology has pervaded many facets of our lives as a result of rapid technological advancements and a decline in human capacity. Agriculture and water management are two areas where man's ability may be realised to its greatest capacity. To keep prices low in a few industries, the company employs a variety of sensors and electrical equipment. To save money and increase the abilities of agricultural professionals, UAVs (unmanned aerial vehicles) can be used for surveillance, pesticide and pesticide application, and bioprocessing fault detection. In this application, both single or multi-UAV systems will work well.

1.3 Rationale:

Agricultural surveillance using IoT and drones may dramatically improve farm produce yields while lowering the cost of visiting the grounds or shooting from an aircraft. Drones are frequently used to scan fields and assess the chemical composition of the soil, the status of the field, crop spraying, and irrigation. Increased yield and more efficient use of land, water, and fertiliser will benefit farmers. Furthermore, the continued need for food safety issues is considered as a driving force behind the use of remote sensing technology in farms. Moreover, the restriction of free movement in the period of COVID-19 has been studied to restricts the agriculture growth which has further make it a necessity to integrate the AI technology of UAV to monitor the better economical, and profitable industry (Khanal et al. 2020). Hence this research is significant to conduct and therefore conducted in detail to study its relevance in agriculture to attain sustainability.

Furthermore, as a consequence, the research is designed to highlight the key characteristics of UAVs as well as artificial intelligence applications in understanding. Agriculture is experiencing its technological breakthrough, as it has in previous decades, as a result of the integration of Information and Communications Technologies (ICT) with traditional farming. Big Data

Analytics (BDA) and Machine Learning (ML), Remote Sensing, the Internet of Things (IoT), and Unmanned Aerial Vehicles (UAVs) are examples of technologies advancement and are beneficial and may help agricultural systems innovate (Khanal et al. 2020). Environmental conditions, development status, irrigation water, soil status, pest and fertiliser management, weed management, and the greenhouse gases are all examples of agricultural limitations that can be seen in smart farming to increase lower costs, crop yields, and improve process inputs.

2. Literature review

2.1 Unmanned aircraft systems (UAS)

According Liu (2020) unmanned vehicles (UV) has been a substantial increase in interest in the subject. The number of UV references in published papers has increased from 551 in 2013 to 1609 in 2018, spatial data, images, electronics, earth sciences, environmental studies, geology, animals, and farming have all seen significant growth. Dong (2018) states that specifically, researchers focused on improving underlying assets precision and information source validation initially. Because of the potential high-throughput benefits, researchers have looked at utilizing UAS data to analyze plant phenotypic characteristics at the field level. Investigators used UAS to, detect effects of drought, track plant pathogens, chart pests, and forecast organic matter and production (Deng 2018). Moreover, it is shown that high resolution images and data may be used to monitor agricultural factors including crop yield, vegetation indices, and canopy cover as well as to select genotypes and forecast crop production.

The deployment of numerous sensing devices is typically costly and time-consuming. It's also tough to keep livestock in the farm since they frequently disrupt tasks such as ploughing, planting, harvesting and spraying. Plants are influenced by soil chemical properties, moisture levels, and biological and chemical factors, and management techniques, to integrate genetics and their surrounding environments. Crops can indeed be utilised as organic sensors in the field that can be studied by equipment onboard UAS (Sishodia 2020). Traditional crop data collection methods are prone to subjectivity and often fail to capture infield differences owing to small sampling sizes. UAS fitted with sensor system can monitor the temporal evolution of crop development reliably, swiftly, and cost-effectively for this objective. Such moderate methods also enable the capture of high-resolution time and spatial information that was before unattainable utilising standard aerial and satellites spatial data technologies.

Even though some breeding programs have begun to use UAS, considerable long-term problems in data collecting, until farmers can fully embrace new tools, they must first master processing of data and analysis (Dharmaraj 2018). Once sensitive information flows through the software development process, it becomes clear that the consistency and quality of raw data are crucial to the forecasting model's effectiveness. One way to achieve this is to develop uniform data collecting, processing, and interpretation methodologies (Liu 2021).

2.2 Unmanned aircraft systems (UAS) in agriculture

Jung (2018) states that Crop profiling with UAS is simple, rapid, and precise. However, because to battery and flight duration limitations, substantial geographical coverage by UAS is presently not possible. Furthermore, despite the fact that UAS has low operational costs, data processing costs climb exponentially as the volume of data increases to cover larger regions. Hatfield (2020) argues that substantial quantity of research suggesting the attractiveness of satellite data for precision agricultural applications, in addition to UAS-based remote sensing technology. To monitor vegetation and predict yields, researchers used freely accessible satellite data with coarser geographical and temporal resolution (Martos 2021). However, little attention has been paid to how they may be adapted for vast agricultural applications. Although some commercial satellites deliver higher geographical resolution data, chronological cover regularity and economic viability are typically concerns. Because precision agricultural applications need data at a much smaller scale, adopting techniques across sizes is a big problem. Machine Learning (ML) advancements have created a once-in-a-lifetime Possibility of developing precise, huge forecasting and instructional systems. Roslim (2021) emphasized the significance of large data in machine learning algorithm development, particularly for highly intricate issues that we are unable to model mathematical models that are easy to understand.

The UAV technologies created are unique in that they rely heavily on sensor and microcontroller technology, ground control station communication systems, and UAS intelligence in order to overcome the absence of a pilot and it provide unmanned vehicle flight and autonomous behaviour (Bhuvaneshwari 2021). Furthermore, the automation system, is utilised for machine control, is a critical issue in UAS. This system is divided into two sections. On the one hand, Machine control systems, which are most often autopilot systems, are used to control flights with a wide range of characteristics. Included in such systems are GPS waypoint routing with altitude and airspeed, completely integrated inter gyroscopes and acetometers, GPS systems, pressure indicators and metres, pressure airspeed sensors, and other components. Each of these devices are put on hardware-based circuit boards.

These are totally self-contained, have automatic take-off and landing capabilities and fail-safe orders coded into the flight control system to accommodate altitude loss, GPS signal loss, and modem communication failure (Chen 2019). When the autopilot detects a problem, it sends out a land order, which causes the UAS to fly back to its starting location. The UAS may also be operated manually via wireless connection using a variety of control systems' All of these sensors are installed on circuit boards that are made of hardware. On the other hand, control mechanisms for computer communication are present (Chen 2019). The Ground Control Software on the UAS serves as an interface between the UAS and the PC. Beside this, it enables for the construction of flight routes and pre-flight simulation using a computer-UAS online flight communication system, the choosing of flight records and their transmission to other systems, the tracking of the flight path, and the analysis of aircraft systems Finally, after the flight is done, a log file containing all of the flight information is provided.

According to Gonzalez (2018), Agriculture could not be excluded from the technological breakthroughs that are occurring in every scientific field in the globe, Moreover, guaranteeing food and water resources for a rapidly expanding global population is a concern that may be addressed via the use of information technology. Unmanned aircraft (UAVs) are representative of these precision agricultural technical advances (UAVs). Initially, they were used for chemical spraying, but they are a solution to vision problems created by overcast conditions or lack of access to a field of tall crops such as corn. In terms of image resolution, Zheng (2019) argues that they have a major advantage over satellite and airborne sensors. Precision agriculture with UAVs has several benefits, including greater production, increased efficiency, higher profitability, fewer environmental effects, and the availability of quantitative data from enormous farms.

Maddikunta (2021) contemplates that those concerns have been raised about the use of UAVs in agriculture. Questions about their usefulness in terms of the photographs collected, the incapacity of UAVs to fly in a variety of weather situations, such as rain, which degrades image quality, or strong wind, and ultimately the cost of data elaboration. When a drone cost as much as a 120kW tractor in 2005, it is now financially feasible for a farm manager to acquire one. The purchase price, however, is not the major issues as it is reported the cost of image processing software is employed for creating maps is far higher concern. As the cost of acquiring and operating unmanned aerial vehicles (UAVs) in agriculture decreases, interest in the area is fast growing.

Unmanned aircraft systems (UAS), are frequently used for military purposes, but owing to higher access and shrinking of sensors, GPS, and other associated hardware, civilian applications are rapidly developing (Skevas 2020). Unmanned aircraft have been used to collect satellite data in vineyard, crops, forests, and rangelands for natural catastrophes disaster prevention, wildlife monitoring, and vegetation assessments. Its capability to swiftly and frequently deploy a UAS at low altitudes allows the transfer of very high-definition remote sensing technology that can illustrate variations in terrain dynamics and movements. The utility of unmanned aerial systems (UAS) for rangeland mapping and monitoring is being investigated. Raj (2020) asserts that Unmanned aerial systems (UAS) are being researched for rangeland mapping and monitoring. UAS photography is being utilised at the JER to adapt field sampling methodologies to extremely high-resolution data and to calculate parameters for hydrologic models, assist in the assessment of disturbance studies and facilitate recurrent data processing for a phenology pilot project, and archaeological investigations will benefit from high-resolution data. Fraser (2019) state that when it comes to distant sensing, UAS are most analogous to piloted aircraft employed to capture digital aerial photographs. Using UAS to achieve these goals has both advantages and disadvantages. UAS offer a lot of potential for remote sensing of rangelands because of their low flying heights, high-quality photography, and lower image acquisition costs per image. Current roadblocks include initial UAS purchase pricing, FAA limits for flying a UAS in national airspace, crew training requirements, and a paucity of elevated, inexpensive sensors.

In agriculture, UAS research has mostly concentrated on remote sensing applications, with the most progress made in crop-plant characterisation, although study has also been performed in livestock, forests, and freshwater and marine resources (Barbedo 2018). UAS have significantly increased return intervals and precision in comparison to remote sensing methods such as satellites, they are restricted in their capacity to cover huge areas acreages. Under some circumstances, however, the employment of UAS is permissible, even for bigger missions. One of UAS's most enduring benefits is its responsiveness. Islam, (2021) supports this notion as he states that Cloud occlusion remains a difficulty to dependable picture data gathering, particularly in humid places, despite the fact that newer satellite systems provide near daily re-visit possibilities. According to data, the likelihood of getting a single image free of cloud cover with earlier satellite systems like Landsat is around 80%. However, the requirement for successive photos, which is common in agriculture for crop growth monitoring, lowered the chance of success to 60% during the vital summer months (Lambert 2018). Thus, for urgent agronomic stressors, it is critical to have the extra flexibility that UAS can give, operating when cloud deck openings permit and collecting data over numerous hours rather than a single window of time when the satellite passes overhead. When clouds are overhead, UAS can still gather data, however the quality of the data is often degraded.

2.3 Internet of Things (IoT) in agriculture

According to Gluhak et al. (2011), the Internet of Things (IoT) is an ecosystem wherein objects, animals, or people are given separate identities that enable them to communicate data over the Internet without needing human-human or human-computer communication. Moreover, as per the study of Juniper Research (2015), and over 13.4 billion gadgets were linked to the internet as part of IoT in 2015, with an anticipated rise of 185 % to 38.5 billion gadgets by 2020. The Iot has applications in practically every facet of contemporary society (Vermesan et al, 2017). (Vermesan et al, 2017). The important industries include smart health care, smart cities, smart industry, autonomous cars, smart farming, smart homes,precision agriculture, and others as reported by Xing et al. (2021).

The Internet of Things (IoT) has immense potential and is one of the most crucial areas for internet service expansion in the future. The majority of countries and significant IT corporations are willing to examine IoT difficulties. Although according to the study of Jazayeri et al. (2015) the majority of the work is focused on solution standardisation, new IoT applications are being researched and produced. In 2016, European Commission, addresses IoT concerns of Europe's Digital Agenda.

According to the European research and innovation framework HORIZON 2020, about 140 billion EUR would be spent in IoT-related technologies between 2016 and 2017. (European Commission, 2015). In addition, the European Commission established the Alliance for Iot. Innovation (AIOTI) in March 2015. This alliance's objective is to create enhance cooperation on innovation and standardisation of IoT practises between the European Commission, IoT-involved organisations, and businesses (European Commission, 2016).

According to Chopra et al. (2020), the internet enables devices with integrated sensors to connect and interact. Included among the devices that can be remotely watched and managed in real time are pumps, sheds, tractors, weather sensors, and computers. In addition, pump, tractors, sheds, weather stations, and computers may be watched and handled remotely and in real time.

Devices that are now labelled as IoT have been depleted in agriculture for many years. In most cases, proprietary systems are used to integrate gadgets into agricultural machinery, and their use is therefore firmly linked to the machine maker. Several efforts concentrating on open solutions to overcome compatibility issues with proprietary devices are expected to make significant progress in this sector in the near future (Stočes et al. 2016).

2.4 Applications of IoT and UAV in Smart Agriculture through system model

The Internet of Things and unmanned aerial vehicles can be employed in a range of smart agriculture applications. Using a system perspective, this section examines many IoT and UAV utilization in smart agriculture.

Smart crop monitoring: Crop monitoring states the right sensing of various restrictions of a farm. Automatic observation is among the initial characteristics of smart agriculture. Advantageously positioned sensors may spontaneously detect and transmit data to a gateway for supplemental examination and controlling. Sensors are used to regulate crop restrictions including leaf area index, colour, plant height, shape, size of leaves etc (Rao et al. 2018). In addition, IoT and UAV may also be used to manage soil moisture and agricultural water limits like pH, as well as meteorological parameters including wind speed, wind direction, rainfall, radiation, air pressure, temperature, relative humidity, and so on. Furthermore, distance sensing is quite good at detecting presence. Furthermore, according to Balaji et al. (2018), because of the simplicity of sensors, lower altitude UAVs can connect remote sensors and so manage crops quickly and cost-effectively. As a result, high-resolution recordings are acquired by removing a variety of aberrant situations, such as weather.

Smart pest management: Detection, assessment, and treatment are commonly the three components of pest management. Image processing is used in the sophisticated infection and pest appreciation approaches, using raw photos created via the crop zone employing UAVs or remote sensing satellites as per the study of Heeb et al. (2019). Moreover, remote sensor protection frequently covers a large area, allowing for increased output at a lower cost. At each angle of the crop series, however, UAV IOT sensors are capable of completing additional duties in data gathering, such as environment sampling, plant health, and pest circumstances. IoT-based computerised traps, for example, can gather, count, and portray insect types while simultaneously uploading data to the Cloud for lengthy research, something remote sensing cannot accomplish (Ayaz et al, 2019).

Smart irrigation: According to Darshna et al. (2015), agricultural UAVs with cameras are capable of providing good perspectives into particular trouble spots in the field. Farmers may utilise the cameras to regulate low soil moisture areas, dry crops, and waterlogged zones, as well as acquire a better knowledge of the overall health of their crops. With traditional farming, such exact watching was either impossible, insufficient, or prohibitively costly due to the need to hire specialists to carry out the task and provide appropriate results. For the time being, however, UAVs help farmers provide extra benefits by allowing them to organise their own operations.

The below figure represents the challenges which occurs in the smart agriculture system;

A lot of studies which has helped to identify the role of digitally controlled farm plants such as the UAVs is used to monetize and predict in agriculture for keeping the health conditions of the crop. Hence the UAVs helps to show a good solution to automate the process of spraying the pesticides and to reduce the various health issues or problems of the farmers as well. Many of the studies have examined the feasibility of using the IoT technology systems for the purpose of controlling water irrigation and monitoring of crops. One of the studies highlights the usage of mobile application to implement the automated water irrigation system. The application is capable to acquire and process the multiple images of the soil which are around the root area of the plants for the purpose of finding the sensor-less the quantity of water. The below figure represents the mechanism used in the study (Karar et al. 2021);

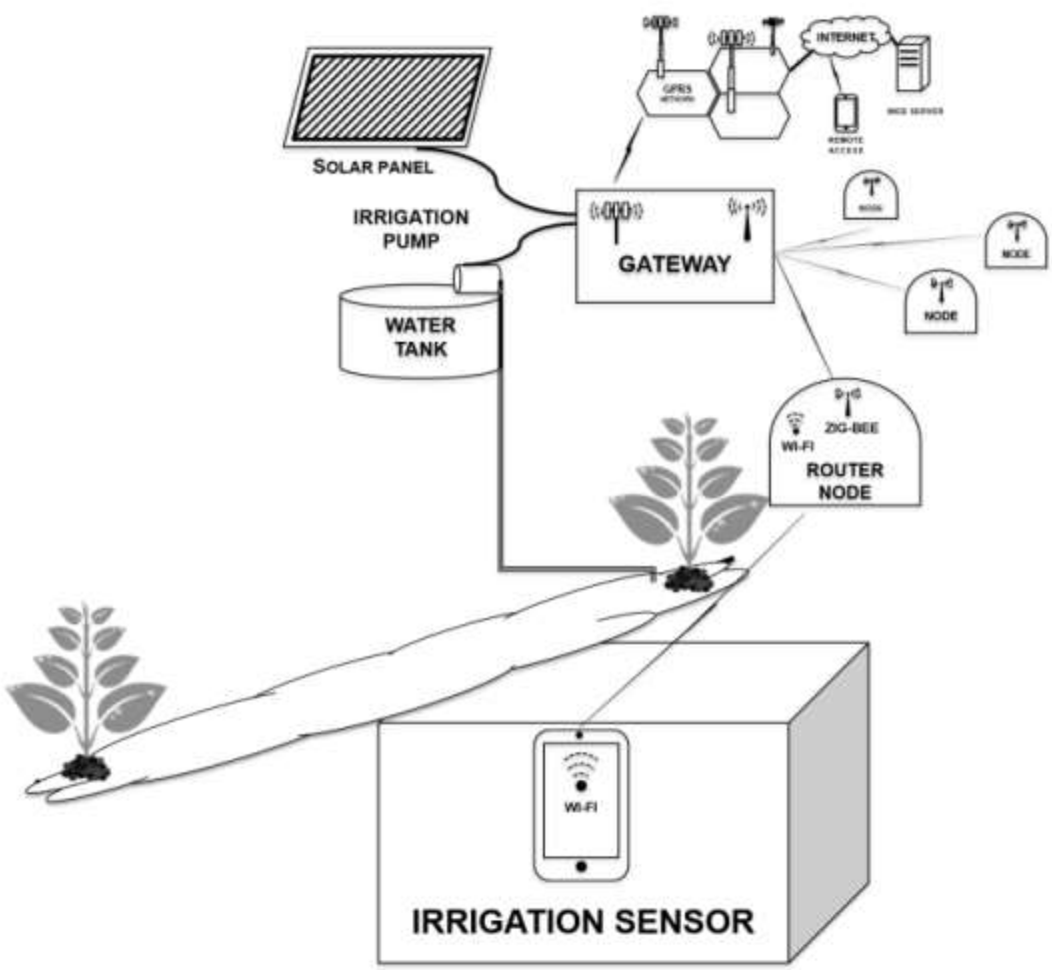


Figure 1(Smart irrigation sensor)

3. Materials and the methods:

In the present era of computing, technological advancements are recorded to reach at the peak. Artificial intelligence has greatly been used in the agriculture field and it has also been used in other industries as well. It has been studied that machine learning is the subset of artificial intelligence. The Internet of Things and Unmanned Aerial Vehicles are two prominent agricultural techniques that are ushering in a new era of precision farming. Drones are becoming more popular in agriculture. Although, there are a lot of limitations of AI tools that can be applied to agriculture UAVs having remote sensing by the constructing of training databases (Chuvieco, 2019). Moreover, in precision agriculture, remote sensing along with utilization of unmanned aerial vehicles is regarded as game-changer. In agriculture, drones are most commonly used as a remote sensing platform for identifying plant stress. Picture classification is the most important field of deep learning application in this context, since it provides diagnostic conclusions such as healthy or unhealthy depending on input (one or two images).

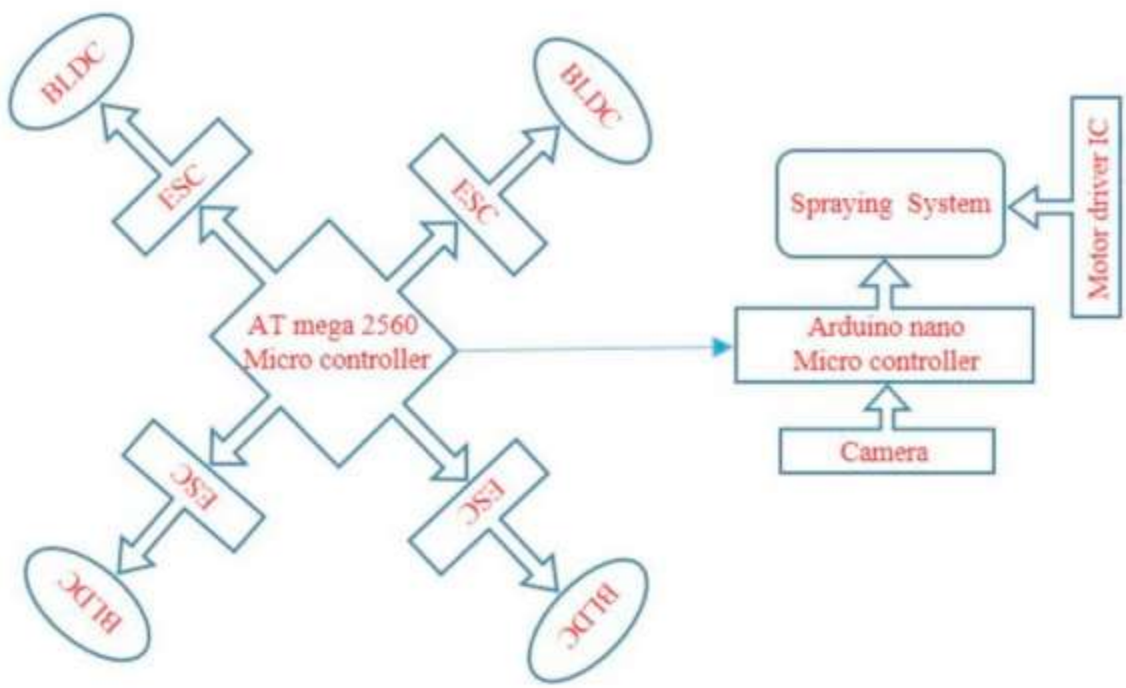


Figure 2(UAV Model)

For instance, a CNN was utilised in detection and classification of spots on the leaves of plants thus enabling to highlight multiple diseases on the leaf. According to the research, an accuracy of almost 12% has been found as compared to the previous methods which had gained the accuracy of 75% (Martos et al. 2021). Similar applications have been found related to stress (biotic and abiotic) classification with the help of AI principles. Since the remote sensing gives the real-time information, so it plays an important role in DSS development which ultimately helps to support the agricultural sustainability. Remote sensing helps to give the temporal and spatial attributes of a crop that can be utilised to enhance the decision making. For instance, the DSS can be used to design a site-specific herbicide map that can predict the weed species or various invasive plants (Zhou et al. 2019). These advancements in technology can be used in the 5th industrial revolution and has the potential to fight against the climate change. This can be done by minimizing the fertilizers usage and hence minimize the input costs.

Moreover, the UAVs helps to observe the crop with the different indices. The data which is coming from the multispectral camera with the help of telemetry is analyse by the NDVI. The below equation helps to calculate the NDVI.

$$NDVI = (R_{INR} - R_{RED}) / (R_{INR} + R_{RED})$$

In this equation, the R_{INR} shows the reflectance of the near infrared band and the R_{RED} shows the reflectance of the red band.

Materials:

Different components are used in the proposed agriculture system. It involves the one Arduino microcontroller board, Quad copter frame kit, 4 brushless motors with an inclusion of ESC, transmitter and receiver used for radio frequency and a rechargeable LIPO battery. Schematic diagram is shown below which illustrates the connected wiring components of UAV.

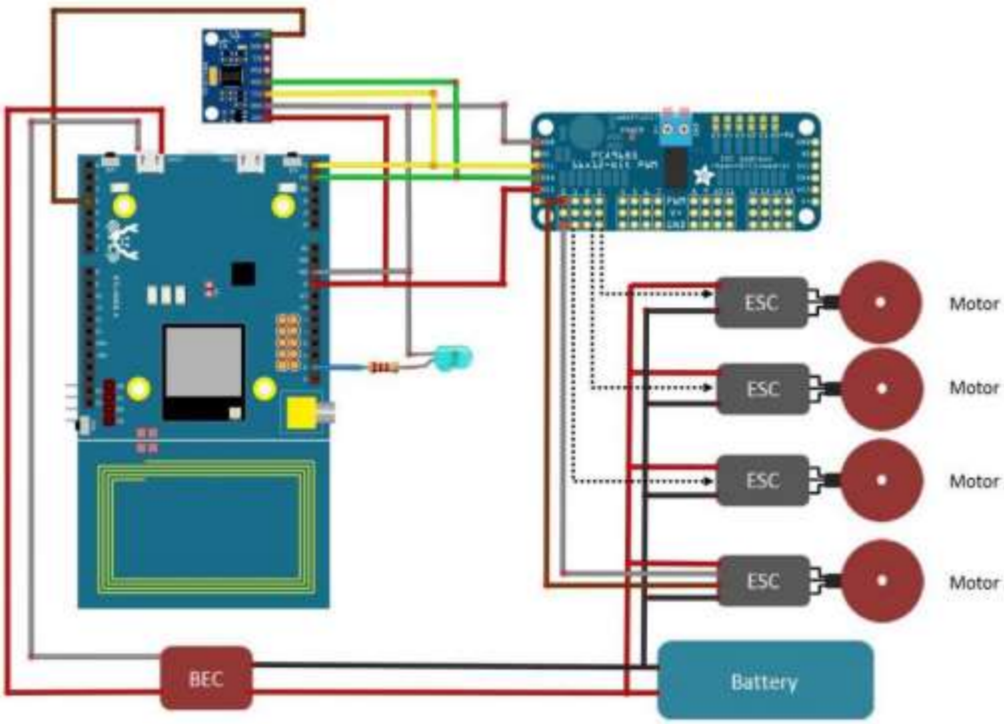


Figure 3(schematic diagram of wiring components)

In order to implement the practical irrigation embedded system which is specifically IoT based, the components of hardware and software which are specifically used to measure the data of environment that is required and send them through the drone to the server. The server is cloud hosted for the purpose of dealing the functional status of the water pumps in an automated manner. The hardware and the software components used in the study are;

1- Arduino UNO microcontroller board
2- DHT22 temperature sensors
3- Soil moisture sensor
4- Wi-Fi module
5- Water pump

The UNO board helps to connect all the sensors used for reading the temperature and humidity and soil moisture sensor via the various input ports which ranges in 5.0 Vdc. The soil moisture is measured by the below mentioned formula;

$$Soil\ moisture(\%) = \frac{weight\ of\ water\ contained\ in\ the\ soil}{weight\ of\ dry\ soil\ samples}$$

In each and every region of the farm, the module of Wi-Fi is utilized for the purpose of giving wireless communication between UNO board and the server of cloud. It is done to control the operations of the water pumps automatically. The below figure represents the schematic figure of the system which is proposed in the current study;

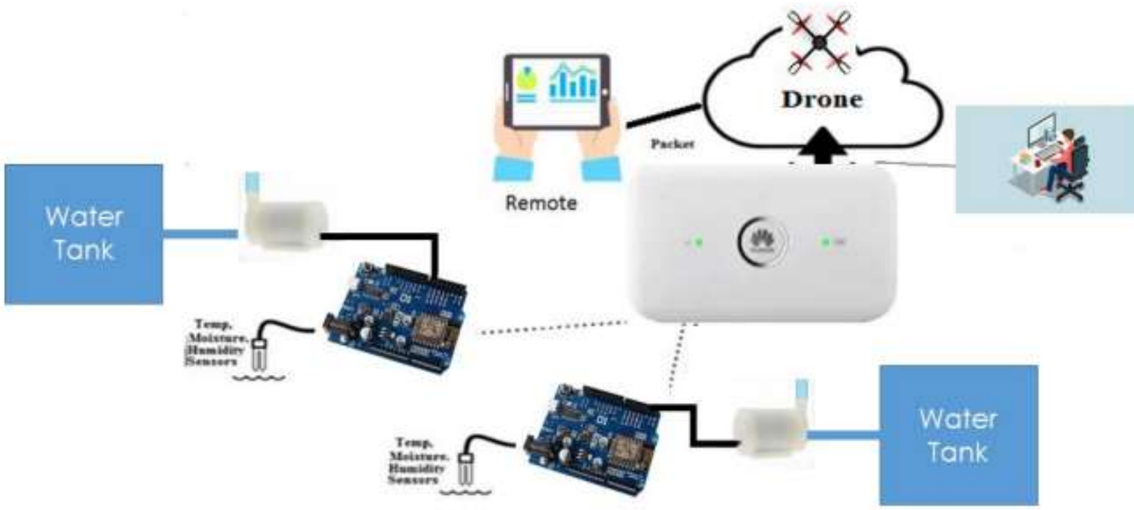


Figure 4(schematic diagram of smart irrigation system)

The system is comprised of various components of the proposed agriculture irrigation which are IoT based. This shows that the drone is flying and thus gathering the data from two of the regions in the farm. There are three readings related to the environmental data, such as the temperature, humidity and soil moisture. This data is acquired by the number of electronic sensors for each and every farm. The data is sent to the drone which is then transmitted to the cloud.

3.1 Sensors

Sensors are considered to be the backbone of remote sensing that helps to provide all the information related to not only the crops but also of the environment. It has been studied that quality of the plants is greatly dependent on various factors such as light, humidity, temperature and CO_2. All of the mentioned factors can be directly measured with the help of sensors. Sensors may have a narrow band or a hyper brand. Agriculture remote sensing is regarded as a beneficial method or technology that allows for the distant observation of crops on a wide scale. (Jung et al.

2021). Typically, it consists of a sensor installed on a platform that may be a satellite, UGV, or robot. The sensor then captures the electromagnetic or reflected radiation from various plants. These are then analyzed to provide useful information and goods. This data and information contain agricultural system characteristics and spatial and temporal disparities. It has been studied that the functional traits refer to the biochemical, morphological, and structural physiognomies which helps to regulate the performance of plants or fitness. The traits that are obtained greatly varies from one to another, or one location to another. Further this can be categorized in different terms on the basis of natures. Remote sensing gives an efficient and effective association between the radiance and traits for the purpose of extracting the valuable information. In the study given by (Berger et al. 2020), approaches of data retrieve in an agriculture from remote sensing can be categorized on the basis of three principles and are mentioned below;

1) Empirical methods

    Make a direct association between the measured signal of remote sensing and biophysical variables.

2) Mechanistic techniques

    Model inversion on the basis of Maxwell' equations, optical geometry and RDT.

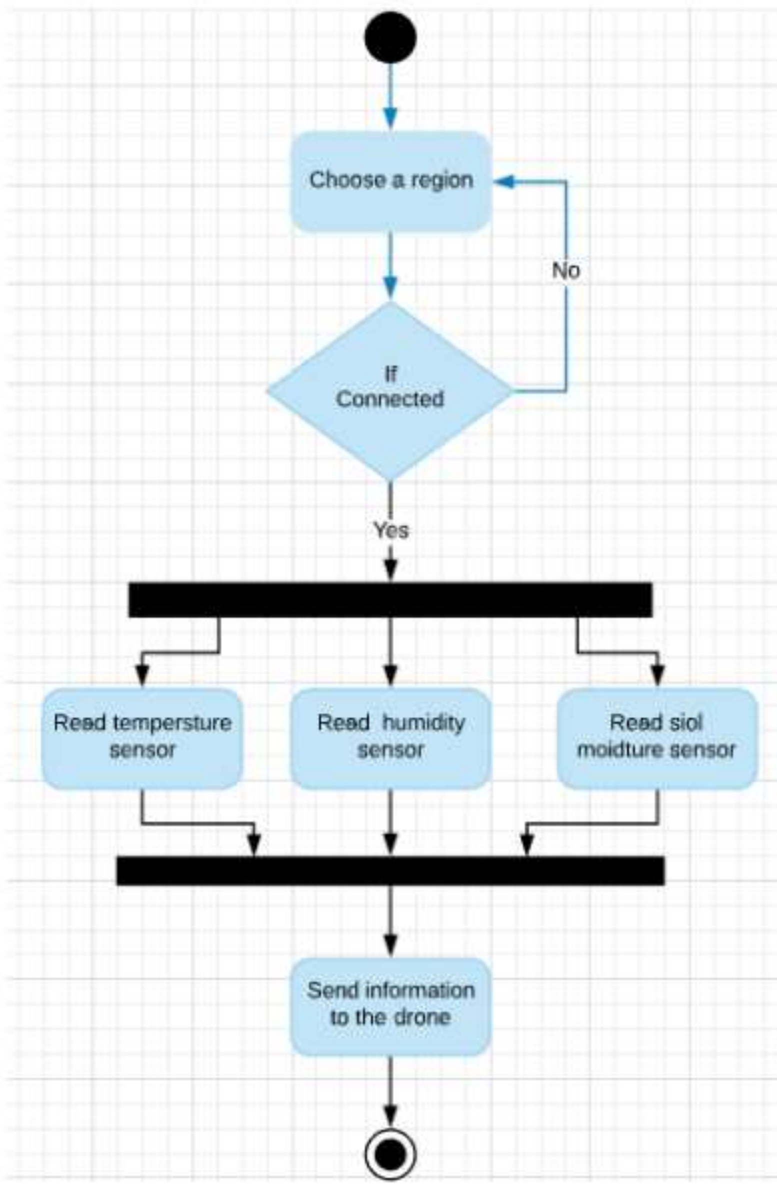
3) Contextual techniques

    It includes the processing of spatial and temporal features of images that are captured with the help of segmentation techniques.

There is another way through which the information treatment can be done with the help of remote sensing technique and this implies the preparation of vegetation indexes. In the most common manner, vegetation indexes can be measured using the remote sensing technique which includes the NDVI for the monitoring of crops, SAVI for enhancing the sensitivity of NDVI and many more. Usually, the sensors are utilised in remote sensing for the monitoring of crops and detects the bands of electromagnetic waves and depends on some of the particular objectives such as the NIR band, RE (Red edge band) and thermal infrared band (Huang et al. 2018). The information' amplitude which is attained from the remote sensing refers to support the sustainable agriculture which are capable of feeding the large population. There are various benefits of the remote sensing technology which includes the identification of phenotypically varieties, prediction of crop production, agriculture, improvement in crop management, services of ecosystem which is associated to soil or water resources, monitoring of land and crop (Vanghele et al. 2021).

3.2 Activity diagram:

The activity diagram of the proposed irrigation system which is IoT based is shown below;



This diagram shows that the drone is configured initially with the help of IP address to have wireless connection with each and every Arduino UNO board in all the areas of the farm. Once the drone has completely covers the farm, it then gathers the respective temperature data, humidity and moisture of the soil. This data is sent to the cloud for taking the required action to operate the water irrigation pumps.

4. Results and Analysis

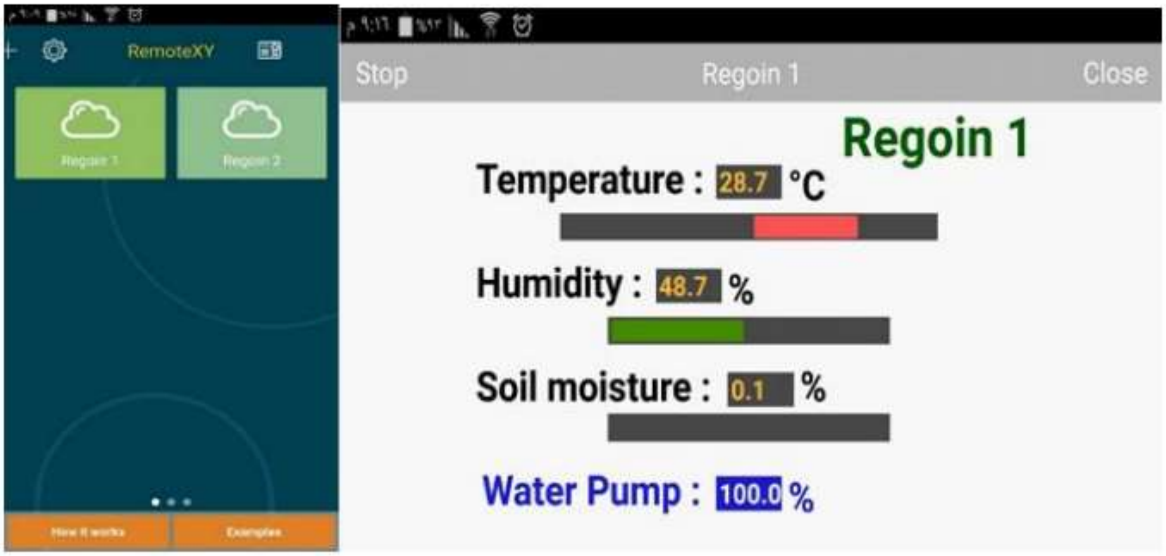
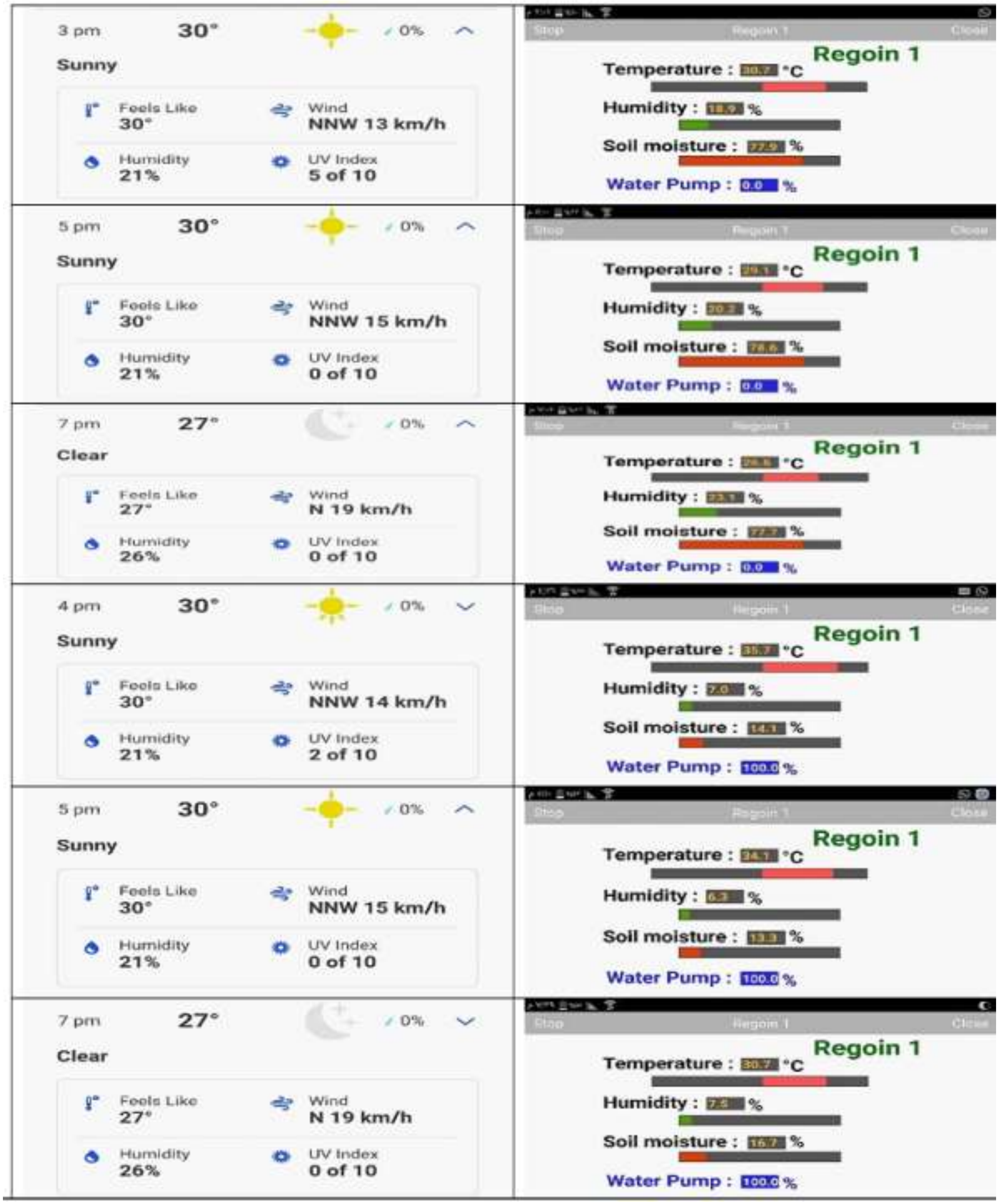


Figure 5(UI of the developed IoT based system)

The above figure represents developed UI which is android based of the smart irrigation system utilizing the Arduino RemoteXY. In the current study, two regions are defined known as region 1 and 2. The farmer can choose any of the agriculture region and then shows the respective environmental data. The values of temperature, humidity and the soil moisture are monitored per different regions in the system of IoT. The latency of the quantity of water irrigation is determined to be 0.5 sec. This is due to the wireless delay transmission which is measured from the sensors.



The above figure represents that the environmental readings from the sensor have been tested, an evaluated. It is also compared to the news of the real weather for the data of temperature and humidity in two countries or regions which includes the Riyadh and Saudi Arabia.

4.1 Analysis:

Farmers and service providers are currently constrained in their use of UAS remote sensing. While UAS technology has progressed, on-farm approaches remain generally application-specific, necessitating translation and calibration between crops and climates, as well as altering light conditions, soil conditions, crop moisture levels, and other factors (Varela, 2018). Differences in sensors and payloads compound the dilemma. The efficacy and specificity of stress detection with UAS photos, as well as the economic sustainability of UAS remote sensing as a tool, require more research. It's vital to have clear standards for using UAS and techniques for making management choices based on UAS remote sensing. These systems, protocols, and methodologies should, in theory, be unaffected by external circumstances such as geography and season. One field-crop management option that might benefit from UAS remote sensing is peanut disease. Leaf withering is a sign of both drought stress and white mild soil-borne disease in the Virginia-Carolina peanut area both stresses can diminish yield, although the pattern of withering is distinct. Withering is more consistent under drought stress from heat and lack of moisture, but wilting is more localized with disease.

Differentiating between the stresses that induce wilting and yield decrease in peanut crops in the region is presently being researched. The capacity to determine the reason of wilting might be utilised to initiate corrective activities (e.g., watering in response to drought stress) as well as to prevent wasting resources (Bhusal, 2018). Virginia Tech researchers are employing UAS remote sensing to evaluate crop water status and wilting distribution, similar to previous work in Texas that used remotely sensed canopy temperature to activate irrigation. When used in this way, UAS can be a useful tool for ensuring efficient water usage, as evidenced by comparable study in Georgia. This type of study is essential. Cotton root rot (CRR) disease is another example of a disease. Flutriafol fungicide has been applied uniformly to CRR-infested fields on cotton farms with CRR predominance over the past decade. The illness, however, only affects 10 to 75 percent of a field and is not evenly spread over the field, but it does occur at the same field positions every year. Remotely detected past CRR incidence sites can be utilised to apply fungicide more accurately in later years. As a result, variable-rate technology (VRT) may be utilised to modify the fungicide treatment rate automatically, lowering costs by eliminating superfluous applications.

Boursianis (2020) produced prescription maps based on photos captured by piloted aircraft, and effectively employed VRT to administer fungicide during planting to reduce CRR, using the full amount in known infested regions and zero in non-infested areas. More recently, a research team led by Texas A&M University and the USDA-ARS successfully established ways to produce similar prescription maps using UAS remote sensing. In a related study, Yinka-Banjo, 2019 used the high resolution of UAS photos to refine the process, allowing it to spray fungicide at levels similar to those of a single plant. This research also resulted in the creation of automated algorithms for producing prescription maps straight from mosaics of UAS pictures, demonstrating the economic and environmental benefits of UAS remote sensing.

5. Conclusion

Agriculture research has centred on establishing long-term crop management solutions for decades. To satisfy present and future demands, we must enhance the productivity and sustainability of agricultural systems moving ahead. While food and agricultural production systems have advanced recently, technology advances provide a unique chance to solve future concerns. Even though the invention is still at beginning, pioneering researchers are combining UAS-based systems with space-based remotely sensed data, artificial intelligence, and crop simulation models to create large-scale digital agricultural applications. Creating multidisciplinary teams capable of addressing a range of problems in the biomedical, ecological, and computer engineering fields currently needs a substantial commitment of time and resources. Protracted initiatives must also be undertaken to create standardized data collection, storage, and analysis procedures. It is impossible to overstate the significance of raw data integrity as a vital component of the development of data-driven digital agriculture.

Moreover, real colour photos may be used to determine crop variation maps for an entire field. Given their cheap cost of operation, the findings are positive for the evolution of unmanned aerial vehicles (UAVs) as a device for location smart farming in small fields. To deliver a trustworthy end result to farmers, it is proposed that innovations in platform design are necessary, and that the farmer must participate in picture collecting, interpretation, and analysis if he wants to get accurate feedback and assistance in farm management decision making. Not only must data analysis be able to identify that agricultural output varies, and that it must be able to explain why this variance exists. The next stage for the agriculture industry is to ensure safe transition from UAVs just generating data to UAVs providing information to the agricultural sector. If unmanned aerial vehicles (UAVs) have become integral part of agricultural business, researchers must be able to collect high-precision data that may assist farmers in improving their operations. According to industry forecasts, business will rise over the next two to three years, and UAVs will be completely incorporated into agriculture within five years. By 2025, agricultural UAVs are anticipated to be economical, autonomous, and an integral component of agriculture industry. Unmanned Aerial Vehicles (UAVs) will ultimately be renamed Unmanned Aerial Systems (UAS) to better identify such fully evolved, safe, and lucrative technologies that boost the future profitability of agricultural produce.

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