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Smarticulture: Novel Farming Technique to Achieve Automation in Farming and Higher Crop Yield with Aid of Artificial Intelligence

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Abstract— Smart agriculture is a new concept, Because IoT sensors can provide information about agriculture fields and then act on it based on user input. This paper proposes a smart agriculture system which include of drone seeding, fertilisers spraying, soil sampling, farm condition monitoring includes temperature, level of water, moisture monitoring and even any movement happens in the field which may ruin the agricultural field ,through the application of IoT drones and sensors for farms and also crop rotation farms. Drone will collect farm data such as pH value, soil humidity from a ground-based sensor that will be pre-plugged in the farm by the farmer. Because of its capacity to connect over a long distance, Zigbee is used to connect the ground sensor and the drone. The acquired data will subsequently be transmitted through LoRa to a gateway, where it will be stored for data storage and analysis in the cloud. We believe that the proposed application will make farming operations more automated and increase crop output rates.

Keywords— IoT, Agriculture, Automation, Zigbee, LoRa, Smart Agriculture, Blockchain, Data Management.

I. INTRODUCTION

The purpose of smart agriculture research is to develop a farm management decision-making assistance system. From crop planting and watering to health and harvesting, smart farming considers it important to handle the concerns of population expansion, climate change, and labour, all of which have received a lot of technological attention. Smart farming is a farming management concept that focuses on increasing the quantity and quality of agricultural products via the use of contemporary technologies. GPS, soil scanning, data management, and Internet of Things technologies are all available to farmers in the twenty-first century.

A system is constructed for monitoring the agricultural field with the help of sensors (light, humidity, temperature, soil moisture, etc.) and automating the irrigation system in IOT-based smart agriculture. In the agricultural environment, IOT (Internet of Things) refers to the use of sensors, cameras, and other devices to convert every aspect and action in farming into data. We need smart agriculture to expand and evolve from where it is now because it will significantly reduce modern agriculture's negative environmental externalities. Smart cities collect and analyse data using Internet of Things (IOT) devices such as connected sensors, lighting, and metres. Cities then use this information to improve infrastructure, utilities, and services, among other things. Farmers find it difficult to understand technical vocabulary and how to use technology, and it is also a costly endeavour.

To provide an effective decision-making system based on a wireless sensor network that manages various agricultural activities and provides important farm information such as Soil moisture, temperature, and humidity content. Due to many unstable climatic conditions, Farmers are subjected to several diversions, which is detrimental to agriculture. Farmers use that mobile application to manage water levels in both automatic and manual modes. It will make farmers feel more at ease. Agriculture takes a lot of time to complete.

In terms of hardware and cost, it should use the bare minimum. This eliminates the need for manual operations in both automatic and manual modes to monitor and maintain agricultural lands. It should be able to detect changes in water levels as well as moisture levels in the soil. Smart farming and precision agriculture entail incorporating sophisticated technologies into existing farming processes in order to improve production efficiency and product quality. They also improve the quality of life for farm workers by lowering the amount of heavy labour and repetitive activities.

II. RELATED WORKS

A method for precision agriculture monitoring has been proposed by Deepak Murugan et al. Using data from the satellite and the drone, it can discern between a sparse and crowded area. This method uses image statistics from a region to assist reduce drone activity. [1]

The popularity of drones in agriculture has been highlighted by Paolo Tripicchio et al. Various ploughing techniques can be recognised using an RGB-D sensor linked to the drone. To distinguish between the ploughing fields, two separate algorithms are applied. [2]

Rodrigo Filev Maia et al. discussed an Internet of Things device that is used to track several agricultural metrics. The gadget measures soil temperature, humidity, and wetness using a network of sensors. The experiment was conducted in Sao Paulo, Brazil. Reference climatic data was gathered to help various crop life and sustainability decisions. [3]

Drones could be used to improve crop quality, according to Marthinus Reinecke et al. Farmers may be able to enhance their output by discovering loopholes ahead of time. Specific cameras connected to drones could detect water shortages and hazardous pests, allowing the crops to be controlled.[4]

Floriano De Rango et al. have recommended using a simulator that is appropriate for agricultural fields. In the presence of dangerous insects in the crops, this simulator would coordinate with the UAV and govern its operation. It would also take into account other factors such as energy and the drones' communication range. [5]

D. Yallappa et al. have proposed the design of a drone that could be useful for spraying crops with required pesticides. Pesticide application costs are reduced as a result of this. Six BLDC motors are supposed to be used in the planned sprayer. The insecticide solution was held in a conical chamber with a capacity of 5L. Four nozzles were employed to pressurise the solution into small droplets using a DC motor and a pump. A transmitter at ground level was used to regulate the entire process. The live spraying procedure was monitored via a camera. [6].

III.PROPOSED SYSTEM

Our proposed method includes two parts, the first of which is the pre-farming stage. Land tillage is done first in the pre-farming stage. Aerial vision could then reveal barren soil. After that, the drone will snap an overhead photo of the farm. This provides an overview to the farmer; based on the processed image, the farmer can determine the true size of the farm and arrange the drone planting route appropriately. Soil sampling is another service that can be provided during the pre-farming stage. They exhibited a prototype for gathering information from soil using aerial images and augmented reality software in this publication [7]. However, their implementation makes use of image processing and augmented reality technology, which we don't require in ours. As a result, we eliminated the AR element from our design and replaced it with IoT functionality.

In phase two, the drone can collect data on the entire farm status through its sensors and ground-based IoT devices, then send it to a cloud service for data storage and analysis. The soil humidity, pH value, farm temperature, and fauna are all included in the data. Drone self-charging module is another service that will be implemented in phase two. A capacitor in the drone detects the battery level in this module, and once the battery percentage falls below a set threshold, the drone can fly to a base station for self-charging. We proposed using Zigbee for communication between the ground sensor and the drone, and LoRa for communication between the drone and the gateway.

A. Soil Sampling

The pH value is a crucial factor in determining which seed to plant and which fertiliser mix to employ. However, considering the scale of the farm, the farmer would be overwhelmed and incur significant costs if he made the option. As a result, soil sampling using a drone is required. A drone will take an aerial image, from which we can extract soil map colour using image processing. The procedure' goal is to divide the large farm into subregions. The farmer can send the soil sample to the laboratory for exact examination once we have the information from the subregion. Figure 1 depicts the soil sample procedure.

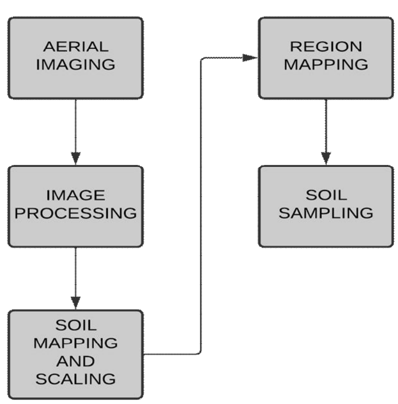

Fig. 1 Soil Sampling Procedure

B. Drone Seeding

Planting a seed in the farm, as stated in the problem description, is another time-consuming task. As a result, drone seeding is required to carry out the action. Our recommended strategy for the drone seeding module is that the drone carries several types of seed, and our farmer may arrange a pre-planned route based on the input from soil sampling using 3D mapping. As a result, the seed will germinate in the proper location. Figures 2 depict the process mapping and image illustration of drone seeding, respectively.

Fig. 2 Drone Seeding Illustration and Process Mapping

C. Farm Monitoring

Our strategy revolves around farm monitoring. This module allows the drone to collect sensor data such as soil humidity and agricultural temperature. The optimal amount of fertiliser and water is determined and given based on the data collected. Finally, it must constantly transmit NDVI photos to the cloud in order to calculate the normalised difference vegetation index (NDVI). The NDVI algorithm is used to determine crop health and growth. When compared to other wavelengths, healthy vegetation (chlorophyll) reflects more near-infrared (NIR) and green light. It does, however, absorb more red and blue light.This is why our eyes see green as the hue of plants [8]. The formula for NDVI is shown in Equation 1.

$$NDVI = (NIR - Red) / (NIR + Red) \text{ ----------Equation (1)}$$

In other words, the higher the NDVI, the better the plant's health. Low NDVI indicates a lack of vegetation. The comparison between the Real Colour Image and the NDVI Image is shown in Figure 3.

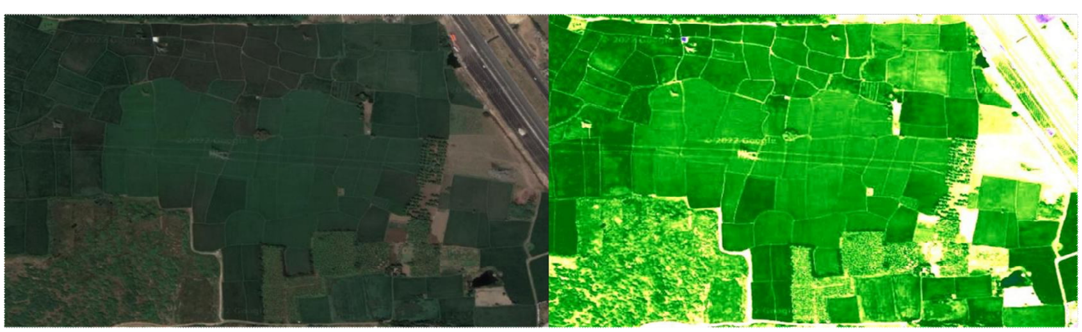

Fig. 3 Real Colour Image and NDVI Image

As a result of the NDVI data, the farmer can determine whether areas require "special treatment" with fertiliser. The amount of fertiliser used to healthy areas might be lowered, while more fertiliser could be applied to less healthy areas. Moisture content is determined using humidity sensors. A humidity sensor would be plugged into the soil in our approach, and it would gather and transmit data to the drone. This module's ultrasonic sensor detects if any birds are near the farm; if they are, the buzzer will "buzz" to chase the bird away. Additionally, the data will be sent to a connected gadget for farmers to be aware of.

D. Fertiliser Spraying

The IoT solution calculates the appropriate fertiliser amount for each farming zone. Software schedules the application of fertiliser and pesticides without the need for human participation. The drone was programmed to spray fertilisers and insecticides along the designated route at a certain time. Drone-aerial spraying has a high efficiency and can cover a considerably larger area than human labour. Farmers can avoid heat stroke and poisoning by employing drones.

E. Drone Charging

There is also a proposal for a self-charging solution. A current sensor in a drone may monitor the drone's battery level; if the battery falls below a certain percentage, the drone will fly to a charging pad to charge. Because the charging panel is outside, the charging pad must be water resistant (IP55). The charge information will be sent to the cloud for storage and analysis. Using an API and a graphical user interface, the user may control and monitor the data (GUI). The user can keep track of the battery's health and be alerted if it needs to be replaced.

IV. DISCUSSIONS

In our proposal, we presented a smart agricultural system, which would allow farmers to boost crop yields. The best way to compare our method to earlier work is to convey it with a scenario.

Consider the following scenario: we have a wheat farm that is now being harvested, and the farmer would like to convert the land to a corn field. They must identify the pH of soil in different sectors of the farm during the pre-farming stage, and then use appropriate fertiliser to deliver necessary nutrients to the soil. Traditionally, these have to be done manually, but with the help of a drone, we can just snap a photo and execute software analysis, substantially reducing the job effort.

Drone sowing will take place after the soil condition has been rectified. According to the findings, walking an 80-acre farm would take 5 hours, but using a drone would save a lot of time and effort. We can quickly gather and centralise data and perform analysis on temperature, humidity, and pH of the farm using an IoT strategy while in the farm monitoring stages. The farm might be sprayed with the right amount of fertiliser and water. Furthermore, using data analysis, farmers can foresee what will happen in the future and plan accordingly.

Self-charging is another fantastic advantage of our technique; the drone's current sensor can detect whether the battery is below the threshold level, and if it is, the drone will automatically fly to a charging station.

V. CONCLUSION

We explored the service and solution that would address the traditional farm issue in this article. The workload and risk for farmers will be reduced during the farming process as a result of the implementation. The installation should result in a higher crop yield rate. Furthermore, we feel it would assist the farmer and society in other ways, as the farmer's knowledge level would be raised indirectly. In the future, researchers may look into incorporating the proposed mechanism into the blockchain. Blockchain can retain a ledger of many different forms of data, such as invoices, purchase orders, and so on. Imagine a system that is capable of capturing current demand and even forecasting future demand as a result of this development.

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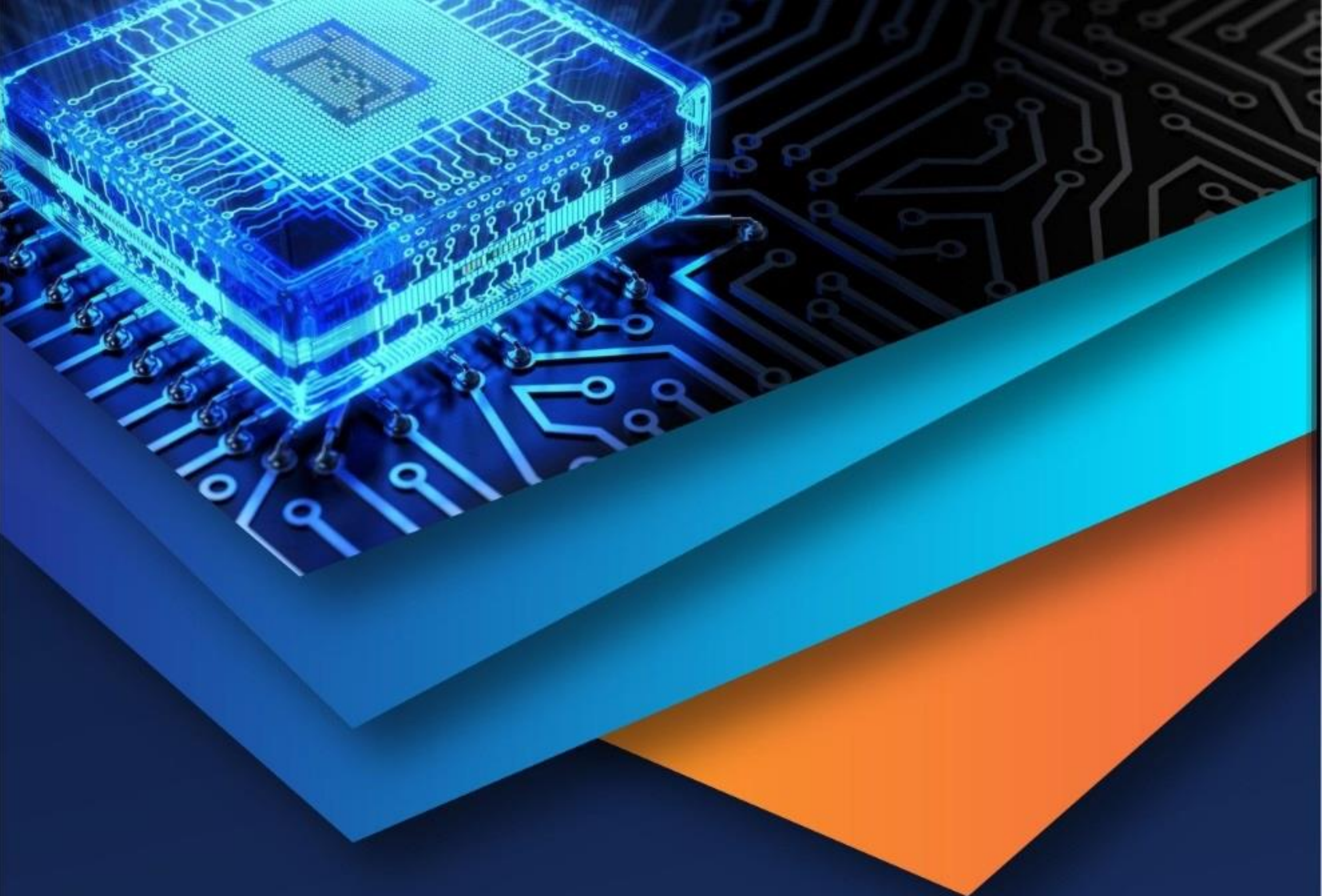

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