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IOT AND ARTIFICIAL INTELLIGENT BASED SMART FARMING SYSTEM USING CLOUD COMPUTING AND WIRELESS SENSOR NETWORK.

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ABSTRACT
In this research, IoT and cloud computing are used to implement SmartFarm AgriTech. It will be challenging to feed such a large population in the future because the world's population is currently 7.9 billion and is expected to reach 12 billion by 2050. Thus, the agriculture sector has to be equipped with the newest technology in order to feed the entire population. Residents in urban cities will be covered with their daily responsibilities, making it extremely challenging to visit the hamlet and periodically check on their agriculture. With cloud computing, IOT, networking, and other technologies, one can simply manage and monitor the crops, weather, water, and spray fertilizers as necessary. Without appropriate farm maintenance, it is difficult to get the desired outcomes. Raspberry Pi and Arduino were used as the primary design components for this SmartFarm AgriTech System. Relay switches, motors, and numerous sensors are all controlled by microcontrollers. To establish a server and APIs for data collection and storage over the Internet or a Local Area Network, Thing Speak and Amazon were utilised (LAN). The data flowing from the Raspberry Pi and Arduino board is also controlled and monitored by a GUI (Graphical User Interface) application that is produced in addition to that.

KEYWORDS*:* Smart Farming System, Cloud Computing, Wireless sensor Network.

INTRODUCTION
The term "smart farming" refers to the management of farms employing IOT, robots, drones, and AI technology to improve product quality and quantity while minimizing the need for additional human work. On a farm, the Internet of Things has not only made it possible to measure and regulate growth variables like irrigation and fertilizer, but it will also revolutionize how we see agriculture more accurately. In this essay, we define a smart farm and examine how the Internet of Things will change agriculture in the future. The management of agricultural operations via the utilization of data gathered from many sources is at the heart of smart farming (historical, geographical, and instrumental).
A system need not necessarily be intelligent just because it is technologically sophisticated. Smart systems stand out due to their ability to store and analyze data. In order to gather data and offer useful insights to manage all farm operations, both before and after harvest, hardware (IoT) is used in smart farming. The information is comprehensive, constantly available, and can be seen from any location in the globe. It includes details on all facets of finances and field operations.
The following are some of the technologies that are accessible to farmers today

- Sensors: control of soil, water, light, humidity, and temperature (ii) Software: tailored software solutions for certain farm types or IoT platforms that are not case-specific
- Connectivity: LoRa, cellular, etc.
- Location: satellite, GPS, etc.
- Robotics: self-driving tractors, manufacturing plants, etc.

- Data analytics, including stand-alone analytics programs and data pipelines for later-stage programs.

RELEVANT WORK

An Intelligent Decision Support System (IDSS) is used in paper [1] to monitor crop healthiness. Several sensors are utilised to collect data from the fields and deliver it accurately and immediately to the Intelligent Decision Support System. The image processing unit of IDSS is used to monitor crop health. It employs a moisture sensor, a rain sensor, and a light sensor to assess crop moisture status. Using cutting-edge technologies like machine learning and the Internet of Things is the aim of the article [2]. In the proposed work, a farmer uploads a picture of a plant with a disease to the developed algorithms, where he may obtain details on the disease and a machine-readable treatment.

By automating processes, Paper [3] aims to utilise emerging technologies like the Internet of Things (IoT) and smart agriculture. By automatically monitoring ambient temperature and moisture values, soil dampness values, and tank water levels from the field, the recommended framework enables farmers to increase both the quality and quantity of their agricultural produce. If employed, the IOT framework can be more useful. On the other hand, they utilize a clever mechanism that shuts and opens green paper in reaction to temperature changes to protect plants from high temperatures.

The goal of Reference [4] is to develop an autonomous crop monitoring system that detects the need for water and reacts appropriately. The technology also removes extra water from the fields during heavy rains to protect the plant yield. The irrigation system has also made use of artificial intelligence. Every so often, the plants will be examined for any illnesses that might endanger the harvests. Any variations in crop quality will also be noted, and the farmer will be informed right away. We'll also be watching for weeds that have sprung up around the crops. In order to transport and analyze data using any IoT platform, such as Kaa IoT, Watson IoT, and Cayenne, they utilized an Arduino Yun with built-in Wi-Fi in paper [5].

They simulate and emulate the design of the whole sensor network employed in this research using the NetSim simulator and emulator software. We received many throughput graphs.

graphs of various parameters, such as packet transfer, collided packets, payload and overhead transmitted, and battery consumption by each sensor for a predetermined period of time after simulating the intended network design with a field size of 50 m, of each link from the sensor node up to the monitoring base station. Designing, constructing, and deploying a ZigBee-based wireless sensor network that connects to a hub and, from there, to a Central Monitoring Station (CMS) through GPRS or GSM technologies is suggested [6]. Also, the system gathers GPS data from the field and transmits it to a central monitoring station.

It is predicted that this technology will help farmers evaluate the state of their soil and take the necessary steps. The farmers are aided by this approach [7] in Using the Internet of Things (IOT) strategy and object detection techniques, monitor the fields and preserve and manage the crops. Based on the soil moisture and temperature, the Raspberry Pi and Relay automatically ON/OFF the DC Pump. A method for intrusion detection is employed to safeguard the crop against theft and animal damage. This is done using object detection technology, which recognizes the type of animal assault and then tells the farmer through SMS and email with a picture so they may take the required precautions to limit further damage.

The study [8] introduces a general smart cloud-based solution to serve a number of scenarios where Internet of Things (IoT)-enabled agriculture fields need to be monitored remotely.

Real-time and historical data are examined by experts and farmers. For audio, video, picture, text, and digital maps that are gathered in vast numbers and variety from many sources, the cloud acts as a central

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digital data repository. Artificial intelligence (AI)-based machine learning algorithms, such as the Support Vector Machine (SVM), one of several classification kinds, are used to successfully classify the data [9]. This paper talks about building a framework for cloud-based monitoring of agricultural resources. We used a simple approach, depending on 4Duino and the required sensors to transfer data. Soil moisture (% volumetric water content), humidity, ambient temperature, dew point, and soil temperature were the variables that were being monitored. The application of cloud computing to agriculture is described. This research proposes a straightforward method for enhancing agricultural resource management through the use of associated parameter monitoring in the cloud. Data Files Type Formatting (DFTF), a load balancing method presented in this study [10], combines SVM with a modified Cat Swarm Optimization (CSO) algorithm. Initially, to categorize data in the cloud from several sources into different formats, such as text, photos, video, and audio, the suggested system employs one to many types of SVM classifiers. After that, the information is passed into CSO, a customized load-balancing algorithm that effectively divides the workload across virtual machines.

CONVENTIONAL FARMING AND SMART FARMING DIFFER FROM EACH OTHER

Below is a discussion of how conventional and smart farming vary from one another:

1) Traditional farming
   i. Errors result from manually preserving field and finance data separately.
   ii. The field is treated with fertilizer and pesticides.
   iii. Geo-tagging and identification of zones are not possible
   iv. There is no way to predict the weather
2) Smart farming
   a) Early diagnosis and application just in the damaged area save money
   b) Each farm is analyzed to determine the best crops and water requirements for optimization
   c) The different zones in farms are detected using camera footage
   d) There are weather forecasting and analysis

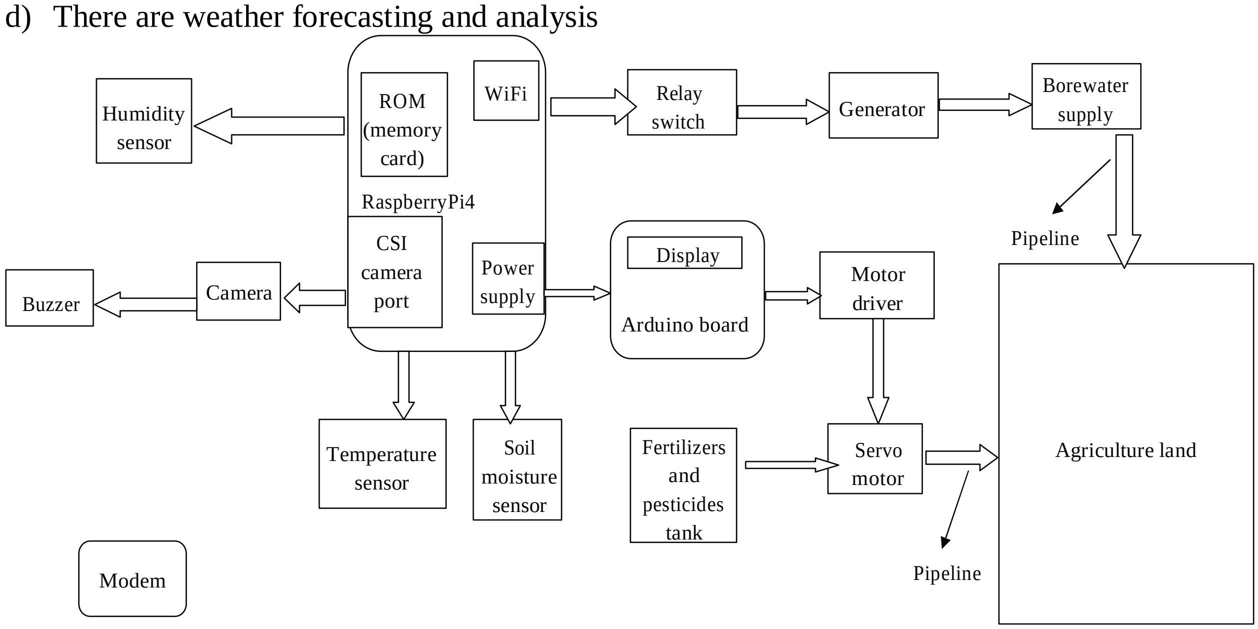

Figure 1: Basic system block diagram.

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Issue Statement

The agriculture sector is now going through a lot of changes and has a lot of issues. Among these include land degradation, environmental and regulatory problems, population growth and increased food consumption, climate change, and sustainability. The disadvantages of farming in the traditional sense include manual field maintenance, which makes it challenging for farmers and regular people to apply pesticides and fertilisers evenly throughout the field. Zone identification, geo tagging, and weather forecasting are not feasible. The Smart Farm Agri Tech system is employed to address this.

METHODOLOGY

The SmartFarm AgriTech system's fundamental technique or concept is depicted in Figure 1.
Figure 2 displays the many tasks that the Smart Farm AgriTech system completes.

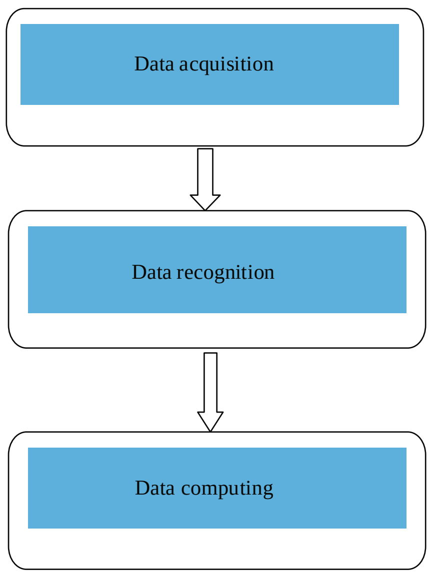

Figure 2: Work flow.

- Sensor Data Acquisition
  In order to read, gather, and store information about environmental variables including temperature, humidity, and moisture, the Raspberry Pi is linked to the DHT11 Humidity Temperature Sensor and the Soil Moisture Sensor as shown in Figure 1.
  Real-time sensor data is concurrently uploaded to the "HTM DATA" dataset and supplied to the SmartFarm AgriTech Application utilizing the HTTP protocol over the Internet or a Local Area Network (LAN) [11–15].
- Animals and Unknown Data Recognition
  As seen in Figure 1, the Raspberry Pi's CSI (Camera Serial Interface) connector is directly linked to the Raspberry Pi High Quality Camera (PiCam). The User's frontal face is learned and saved in the dataset using Python programming language and OpenCV package [16–18]. Tensor flow and Keras modules from Python are used to construct the algorithm for the faces contained in the dataset, and if unknown people or animals are detected, the Buzzer gets an oscillating signal from the Raspberry Pi that generates sound [19–21].

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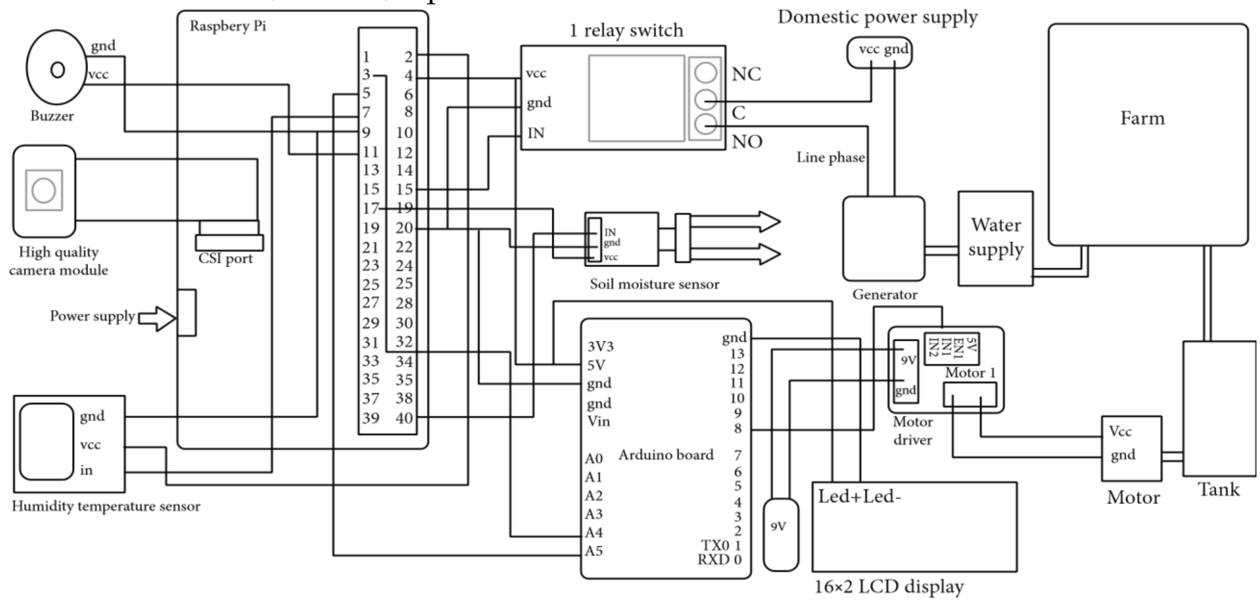


- Cloud Data Computing

Using Figure 1, Relay is a linked electrical switch that is originally configured as Usually Open (the circuit is always open and does not transmit electricity unless a signal is sent from Raspberry Pi to the relay switch). With the assistance of a server or cloud built using AWS (Amazon Web Services), the user controls the relay switch. The relay switch begins transferring energy to the generator as soon as it gets the Raspberry Pi signal via the Amazon cloud computing method. Via a drip irrigation system, water is piped from a generator to farmland [22–24]. Allowing water to drop softly to the plant's root system is a practical way to conserve nutrients and water. . The Fertilizer and Pesticides Tank is operated and the uploaded sensor data is shown using the interface built between the Raspberry Pi and Arduino board. In the Fertilizers and Pesticides Tank, 5–11% of organic natural fertilisers and pesticides (such as Jeevamrutham organic fertiliser) are combined with the appropriate amount of water. By sending a signal to the raspberry pi via the server built using Amazon Web Services (AWS), the user may control the motor driver, which turns the servo motor from 0° to 180° to open the tank holding fertilizer and pesticides for the farm.The user can turn on the tank to spray fertilizer over agricultural land for irrigation once every 7–15 days, depending on the development of the crops and their convenience.

Working System Architecture

The Raspberry Pi, Arduino, Relay, Camera, sensors, buzzer, motor driver, and motor are linked using jumpers and connecting wires in the circuit design for the system, which is seen in Figure 3.

The Raspberry Pi creates a "sensor data" dataset/directory where the humidity, temperature, and moisture measurements from sensors are kept in.csv (comma separated values) files. One data point from each is sent for one minute to the "Sensordatas date.csv" csv file. Similar to that, 1440 measurements for temperature, humidity, and moisture are submitted to a csv file for one day. The code snippet is created to retrieve the maximum and minimum values from the Sensordatas date.csv file and to reset the csv file precisely at 12:00 am or 24:00 [5, 6, 25]. The "humidtempmoist date. csv" file is now uploaded with the maximum and lowest values, and it is saved in the "HTM DATA" dataset.

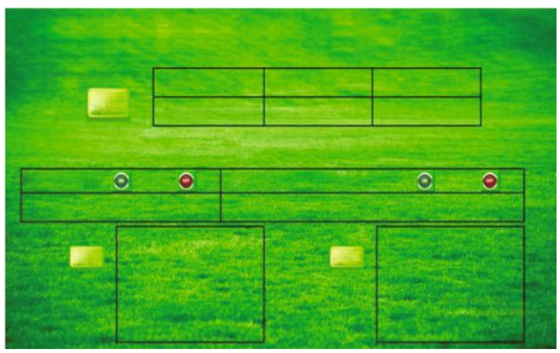
The procedure is repeated every day in order to save the sensors' maximum and minimum data in the "HTM_ DATA" dataset. Figure 4 depicts the basic and user-friendly SmartFarm AgriTech Application, a Graphical User Interface (GUI) programme made with Python 3 and the Tkinter Module. With the aid of the ThingSpeak Application Programming Interface, this application enables the user to examine and analyse the real-time data flowing from the Raspberry Pi (API). The HTTP Request from the GUI application to the Raspberry Pi asking for sensor data is delivered through the ThingSpeak API [26]. After receiving the request from the GUI application, the Raspberry Pi sends the HTTP Response to the AgriTech Application that is supplying the sensor data.

The soil moisture sensor's output lies in the ADC value range of 0 to 1023. The ADC value in the GUI application is used to calculate the percentage of soil moisture using the following formulas:

(i) Data = ðADCvalue/1023Þ

(ii) Moisture% = 100 –ðdata ∗ 100Þ

In accordance with Figure 5, the user is given instructions via a GUI application that instructs them to turn off the water supply whenever the moisture percentage exceeds 51.1241% by pressing the OFF button in the app, and to turn on the water supply for irrigation purposes whenever the moisture percentage is less than 26.6862% [27]. The soil moisture is moderate, ranging between 26.6862% and 51.1241%, and no procedures for water delivery are required.



SmartFarm AgriTech Application

An Amazon firm called Amazon Web Services (AWS) provides cloud computing platforms, APIs, and other services on demand.

ADC values	Moisture %	Instructions:
<500	>51.1241%	Soil is too wet, off the water tank
500-750	26.6862% to 51.1241%	Soil moisture is perfect
>750	<26.6862%	Soil is too dry, on the water tank

Instructions displayed.

One of the services offered by AWS that enables two-way communication between the Smart Farm AgriTech System and AWS cloud is called Amazon Web Services Internet of Things (AWS IoT) [28]. As seen in Figure 6, the MQTT protocol is set up on AWS IOT to connect the Raspberry Pi to the Agritech Application, which controls the motor and relay switch.

A	B	C	D	E

1	02:09:58	27	56	44
03	02:10:57	27	60	4
-06-2021	02:11:32	27	51	43
2	02:12:31	27	53	1
03	02:13:30	27	60	36
-06-2021	02:14:29	27	50	5
3 03-	02:15:28	27	59	51
06-2021	02:16:27	27	53	4
4 03-	02:17:26	27	57	44
06-2021	02:18:25	27	60	4
5 03-	02:19:24	27	60	44
06-2021	02:20:23	27	59	6
6 03-	02:21:22	27	55	30
06-2021	02:22:21	27	54	6
7 03-	02:23:20	27	58	55
06-2021	02:24:19	27	56	1
8 03-	02:25:18	27	58	30
06-2021	902:26:17	27	51	4
03-	02:27:16	27	56	42
06-2021	02:28:15	27	57	6
10 03-	02:29:14	27	56	38
06-2021	02:30:13	27	58	8
11 03-	02:31:12	27	57	59
06-2021				3
12 03-				57
14 06-				6
15 2021				30
16 13				1
17				
18				43
19 03-06-				5
20 2021				46
21				
22 03-06-				8
23 2021				30
03-06-2021				9
03-06-2021				33
03-06-2021				8
03-06-2021				55
03-06-2021				2
03-06-2021				33
03-06-2021				1
03-06-2021				51
03-06-2021				8
				53
				0
				34

6

	A	B	C
1	Temperature	Humidity	Moistu
2	27°C-27°C	56%-60%	re 304-589 ADC

Humidtempmoist_2021-06-03.csv.
Every time a user updates the programme, a sample image for animal recognition is shown in the GUI application's recognition area. Similar to this, the graph part of the app displays a temperature over time graph so that the user may examine the temperature curves.
Humidtempmoist_2021-06-03.csv.

The Findings and Discussion

The example photos for animal and unknown person detection using the Python animal recognition method are shown in Figure 7. The "Sensordatas_ 2021-06-03.csv" file, which contains real-time data of temperature, humidity, and moisture measurements from the sensors, is sampled in Figure 8. The maximum and minimum values from the "Sensordatas 2021-06-03.csv" file are computed and saved in the "humidtempmoist 2021-06-03.csv" file seen in Figure 9. Figure 10 displays an example picture of the SmartFarm AgriTech Application, which was created using the Python Tkinter Module for regulating the water supply and viewing sensor data.

Conclusion

By avoiding over- and under-irrigation, soil erosion, and water waste, smart farming conserves water. As a consequence of customized processes that take into account precise resource application and thus lower production costs, it enables farms to be easily managed, resulting in decreased waste. The key benefit is that the system's action may be altered based on the circumstance (plants, climate, soil, etc.).
As a result, crop productivity is boosted through input optimization and ongoing monitoring.

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