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IoT based smart farming system

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ABSTRACT

Agriculture has become an important growing sector due to the constantly increasing population throughout the world. In the agricultural sector, enhancing farm quality and farm productivity is a massive task without continual record keeping ensuring a high and quickly expanding food demands. Except for the growing population, climate change is a serious concern in the agriculture sector as well. To deal with such situations smart farming system using the cloud and Internet of Things is the best solution proposed in this research work. Smart farming can be used that may offer a collection of useful data i.e temperature, humidity. The Paperwork represent a smart device for farm field tracking that controls soil, humidity, and temperature. Based on these principles, it takes appropriate action after obtaining the sensor readings without human involvement. Soil temperature and moisture are gathered here, and sensed values are processed for future data processing in the cloud.

Keywords: *IoT, Agriculture Monitoring, Sensors*

1. INTRODUCTION

IoT is a modern communication and computing paradigm in which microcontrollers, sensors and transceivers have been fitted with everyday objects to feel the environmental parameters around them. In addition, the exchange of sensed data with each other or users becomes an essential element of the Web system. By IoT, any object included with a unique identifier in our everyday life is linked so that they can transfer data without human interference over the network. Examples include the Home Control System that uses Wi-Fi or Bluetooth to share data between different home devices.[2]

IoT is a global network of devices for intercommunication. Ubiquitous connectivity, ubiquitous computing and ambient intelligence are combined. "The IoT is a vision where "things" are readable, identifiable, locatable, addressable and/or controllable through the Internet, particularly everyday items, such as all home appliances, furniture, clothing, cars, roads, and smart materials, etc.. IoT refers to the networked interconnection coverage area of everyday tools, devices, artefacts, or computers. Regarding place and time, these items may differ and they may be big or small. The idea is to use a related sensor or RFID or electronic technology like GPS to tag any object.[1,3]

In smart farming the vital job is performed only by IoT systems. Smart agriculture is an evolving phenomenon since IoT sensors are able to provide data about their fields of agriculture. With their low-cost sensors and actors, IoT and Wireless Sensor Networks (WSNs) allow new technologies and development ways for further accurate, feasible farming in the form of smart cultivation. [7,8]

Cloud computing refers to services on the cloud Internet that can be a centralized computer system or a distributed computer system. Parallel or distributed computing refers to the cloud, or both. Clouds may be created over a large centralized or distributed data centre with virtualized or physical resources. [1]

A new form of automation that is based on computing services, virtualize, and service-based architecture is cloud computing. Many information technology (IT) firms, such as Google, Yahoo, Amazon, etc., already provide customers with cloud services. Users might not think about hardware, software, or other external tools in cloud technology. Here they are not aware where the information is located on the cloud storage. Cloud computing offers users with an interface for data sharing. [4]

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means of survival for several people in various regions of the globe.. In India, It seems to be the key essential profession of several other families. For the cultivation of crops such as beans, bajra, wheat, apples, tomatoes, bananas, corn, rice, cotton, jowar, cereals, etc., about 60percent of total of a land are being ploughed and then used.. The IoT model and about the need for automated driving are being taken advantage of by agriculture. Interconnected vehicles can operate the farm of the 21st century: an enormous opportunity are being created mostly by the incorporation of various technologies deliver autonomous activities requires low oversight.[5,6].

During these respect, smart agriculture can thus benefit farmers and ensure that the country's economy is strengthened when viewed on a massive level. A method named precision agriculture, in which almost all the atmospheric impacts necessary for plant to produce were continuously examine. Tracking itself cannot enhance the wellbeing of its plants, and it is also necessary, if possible, to manage these aspects. Furthermore, all of the whole data gets preserved which could be utilized to additionally forecast the preferable product to be cultivated within this particular environment. To create an approach that help the situation, the principles of IoT and cloud might be included.[20]

2. LITERATURE REVIEW

In Li Da Xu et al, the author concentrated primarily mostly on IoT as well as its present research, its key strategies of encouraging (Identification and tracking, communication, service management, networks involved). It sheds light on the industry's major IoT applications, and numerous research developments and challenges are described (standardization, complexity of design, accessibility, integration, etc.[9]

In Zhao Liqiang et al, the author collaborated with IoT for remote field tracking. There's also a picture sensing node that receives the crop images and uses different parameters for the inference, such as temperature, humidity. Low power consumption and reliable operation with an atmosphere of high precision end up making excellent choice for crops management.[10]

In Keerthi. v et al, the author addressed IoT-based greenhouse monitoring schemes. Using different sensors, including temperature, humidity, and soil moisture, multiple parameters are effectively controlled. The coordinator node gathers the data from the harvest every 30 seconds and is processed on a cloud. It allows the user to review the information at any moment.[11]

In Joaquín Gutiérrez, An intelligent irrigation sensor was created by the writer. This paper uses the concept and implementation of automatic irrigation in the field of cultivation. In this procedure, digital images are obtained, using a smartphone, of the surrounding soil and the kernel of the crop. This helps to estimate the water content optically.[12]

In Nikesh Gondchawar et al, The author addressed an agricultural management system based on IOT. A GPS-based robot is being used in this project. This paper presents smart irrigation including specific benefits and sensible decision and smart warehouse management systems.[13].

In Baltej Kaur et al, A system of drip irrigation was created by the author. It is a fully automated technique that helps by actually controlling irrigation water using an Android mobile application to minimize intellectual labour. The irrigation system is managed to track the environmental conditions set of values of the various sensors such as humidity temperature etc. applied in the field.[14]

Krishna, K. L., Silver, O., Malende, W. F., & Anuradha, K., To calculate various environmental parameters, the author suggested a mobile robot fitted with different sensors. To execute the whole operation, it requires Raspberry Pi 2 Model B hardware. Aspects of this new smart cellular robot would perform assignment like detecting dampness in soil, pissing birds, spreading pesticides, going forth and reverse, and changing electric motor ON/OFF. The device is equipped via a camera module, to track the actions at the right life. The suggested wireless devices was tested all over the area and readings were tracked and acceptable results were observed, suggesting that this device is very suitable for smart agricultural practices.[15]

J. Shenoy, Y. Pingle, The author explores potential ways to minimize transport costs for agricultural products and also forecasts crop prices on the basis of past knowledge and current market scenarios. It also provides a solution to reduce intermediaries that typically aim to capture percentage of earnings between buyers as well as suppliers. The whole approach creates a balance among farm workers or even purchasers of farm commodities.[16]

Sandip Khot, M. Gaikwad, The author has the ability to track the intensity of the light all over the field and store data in a database to even further evaluate and examine it. It is extremely easy to use the field variable database to make an optimum decision within the specified time. As just another variable to be regulated by the agricultural sector, the procedure throughout the paper mainly focused on the brightness.[17]

Sheetal V, A Bakshi, Tanvi, By regulating the environmental parameter, i.e. soil ph. and dampness, the author attempts to overcome the issue in the grains due to the uneven distribution of rain. As a central controller, an Arduino is used. This governs the mechanism along with the contact process.[18]

C. Brewster, I. Roussaki, N. Kalatzis, K. Doolin, K. Ellis, The author has summarized technical limitations as well as obstacles that must be addressed during the implementation of a low-scale pilot project based on IoT in the farming. For all phases of agricultural goods, including crop production, manufacturing, distribution, and the retail industry, IT provides a conceptual idea.[19]

3. PROBLEM STATEMENT

The researcher supposes to implement a "IoT Based Smart Farming System" with various sensors, which will help to collect the data and analyse it.

The proposed system collects information about different agricultural parameters (temperature, humidity) using an IoT sensor. These values collected are then sent over the mobile via SMS. Farmers can view all the parameters required for a smart farming system through the webpage

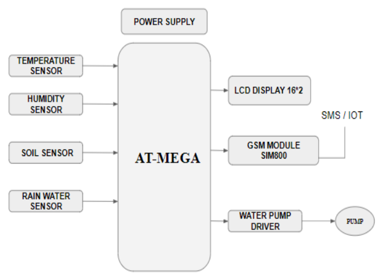
4. PROPOSED WORK

The modern agricultural methods allow the use of sophisticated systems to be implemented for the betterment of job quality and increasing productivity. Such systems can provide a helping hand to the farmers and give them a chance to grow.

The proposed "Smart Farming System" collects information about different agricultural parameters (temperature, humidity, soil moisture detection, rainwater detection, dry run detection, motion detection) using a wireless sensor network. These values collected are then sent over the mobile via SMS. All the values required by farmers for smart farming are viewed on the webpage which is stored in the cloud database. Every system will have a unique ID which will help to identify sensor values for the farmers.

The system also facilitates the controlling of pump motors through IoT and SMS. This facility helps farmers to turn the motor in their farm on or off at any time.

5. SYSTEM ARCHITECTURE



A. Project working

The system is working around the atmega328 microcontroller. The analog sensors convert the physical quantities into the equivalent electrical signals and the digital sensors convert the physical quantities into the electrical signals followed by digitization. The central controller samples the signals from all the sensors and stores them into the local memory. The controller also attempts periodic connections with the server to send the values stored in the memory to the server. Also, the values obtained after sensor scanning are processed further to make the decisions about Pump operations and fencing supply. The LCD is used to display the status of the system as well as sensor values periodically.

The system operates AUTO mode. Depending on the soil moisture, the water pump witches ON in auto mode.

B. Hardware Specification

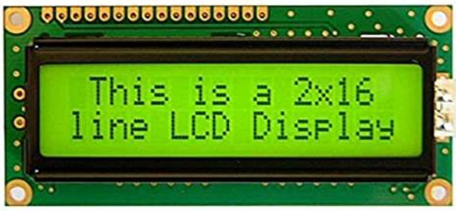
Gsm module: GSM is functioning as the communication device to communicate over the Mobile Network. It is used to send SMS on mobile phones and the data over the Server. The server communication is done via GPRS.

The device connects to the internet via an HTTP connection. It hits the PHP page on the server with the data in parameters. The link is renewed every time according to the data available. The GSM returns the echoed text to the device which is decoded by the Central Controller to get the commands from the server.

PHP file with "GET" Method to send data from the server. The PHP file communicates with the database on the server. It also extracts the data from the database and echoes it back.
The Frontpage is communicating with the database and updates it according to the user commands. It also fetches the data from the database and displays it on screen. It also plots the data for the graph.

ATmega328: In the AVR family, the ATmega328 is a low-power, low-cost and high-performance microcontroller built by Atmel. The ATmega328 is a single 28-pin chip with serial communication.

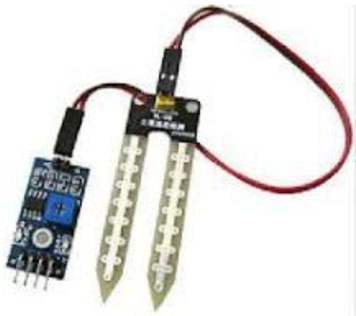
LCD display 16 * 2: This is an electronic display unit used to illustrate parameters and their status in the device. 2 lines and 16 characters per line are represented by the 16x2 LCD.



Relay: Relay is a switch that controls circuits opening and closing electromechanically. Without any human interference, it turns to switch ON or OFF to make or break contact by using signal

C. Sensor Used

1) ***Soil Sensor:*** This sensor measures the conductivity of the soil. The water content and the minerals contribute to the soil conductivity. It measures the voltage drop across the resistance offered by soil.
Sensory Threshold: 2.5V.



2)DTH11

- ***Temperature Sensor:*** This sensor measures the temperature and its output voltage is proportional to the temperature.
  - Sensor Threshold = 350mV.
- ***Humidity Sensor:*** This sensor measures the Relative humidity of air and gives the output in digital format.
  - Sensor threshold = Relative humidity of 70%

3) Rainwater sensor

- *This sensor senses if there is any conductivity between its two plates due to rainwater or not.*

Sensory Threshold: Conductivity present or not

D Software Specifications

1. Arduino IDE

An software platform which allows the Arduino board to compile and upload the C program. The Arduino IDE is a software application that allows the Arduino board to compile and upload the C program. It is designed to work with many kinds of microcontrollers. If the code is compiled and published, the required action is carried out. Arduino IDE software performs Microcontroller programming.

2. Application Web

With actual observation as well as measurement of smart farming, graphical interface application was created. It is based on soil moisture, temperature, humidity, motion detection, rainwater detection data. The program enables the user to use any device over the Internet to visualize the data graphically. In addition to graphs, it offers manual water supply, pesticide, and fertilizer control All the records are collected in a server. The web application is PHP-encoded for control and programming. The database implementation in My SQL.

3. My SQL

Using MY SQL database and connection to it made through PHP. It connects to the database in PHP using the mysqli_connect method with the parameters host server, database name, username, password. If all the parameters are correct, the method returns an object of connection that store into a variable. This object is later used for any query to the database. Two queries namely INSERT and SELECT are used. Whenever a hardware device hits the link with data, the PHP file on the server fetches the data and stores it into the local variables. It also fetches the Date and Time at that particular movement and stores it into the local variables. This data is then inserted into the database using an INSERT query. On the display page, the information from the database is extracted using a SELECT query and is displayed in an HTML context.

4. AT commands

The GSM works on the AT commands. The central controller sends "AT" commands along with data to the GSM.
Each "AT" command with data is counted as 1 step and we need 12 steps to connect to the internet and get the data from the internet.

Step 1> "AT" -> Initialization of module
Step 2> "AT" -> Initialization of module
Step3> "ATE0" -> To stop command echoing.
Step4> "AT+CIPMUX=0" -> To configure multiplexer.
Step5>"AT+SAPBR=3,1,"CONTYPE","GPRS"" -> To configure the connection type to GPRS
Step6>"AT+SAPBR=1,1" -> To get the IP address and connect to internet
Step7>"AT+CGATT=1" -> To connect to GPRS
Step8>"AT+HTTPINIT" -> To initialize the http
Step9>"AT+HTTPPARA="CID", 1" -> to initialize connection ID
Step10>"AT+HTTPPARA="URL"," Link with data" -> Link to send data
Step11>"AT+HTTPACTION=0" -> To hit the link
Step12>"AT+HTTPREAD" -> To read the response from the server.

If expected data is received at the end of the 12^{th} step then the Initialization part is not repeated and the step number is resumed from step 10. The parameters in the link are updated as per the status of sensors and retransmitted to the server.

If expected data is not received due to a network issue or server issue, the step number is set to 1 and the whole process is started from the beginning.

5. Mobile SMS

Another set of AT commands is required to send the SMS.
"AT" -> Initialize
"AT+CMGF=1" -> Set the text mode
"AT+CMGS="SMS NUMBER"" -> Set the number to send SMS

This command initiates a context in which the controller sends the SMS text data which is recorded.

The decimal 26 is sent as the character to terminate the context and send the SMS to the number.

6. EXPERIMENT & RESULTS

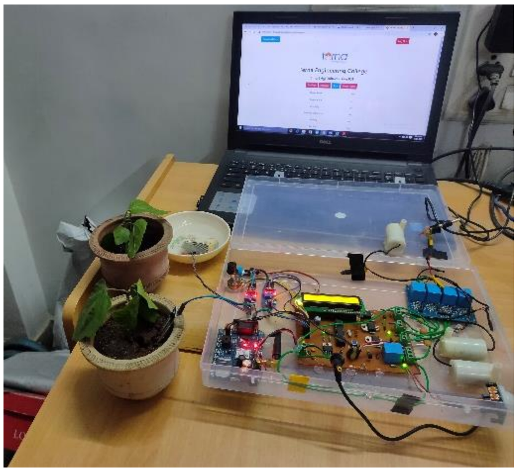


Fig. 1: Experimental setup (interfacing microcontroller, sensors, relay, and motor pump)

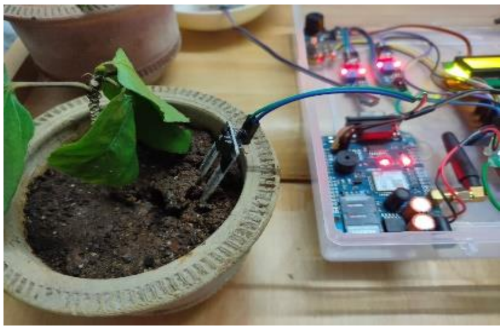


Fig. 2: Soil moisture detection.

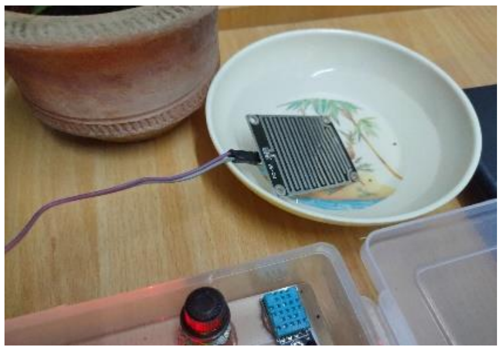


Fig. 3: Rainwater detection.

Fig. 4: Output displayed on LCD (sensors values)

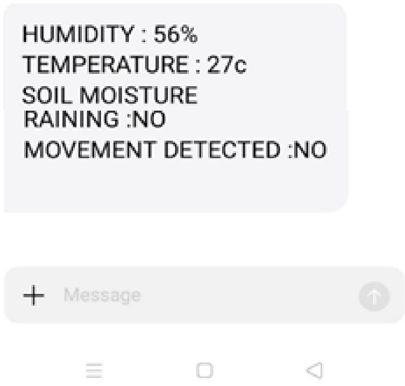


Fig. 5: Output via mobile SMS(sensor values)

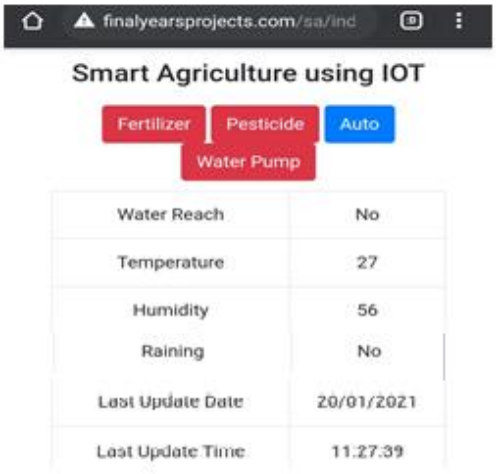


Fig. 6: Output displayed on Website

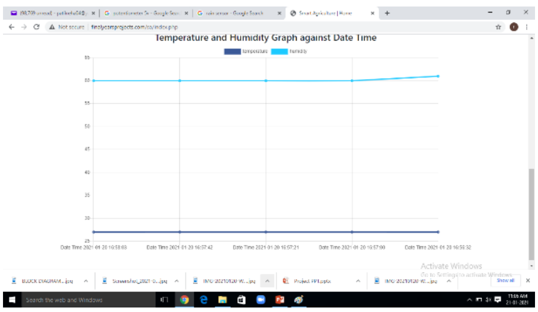
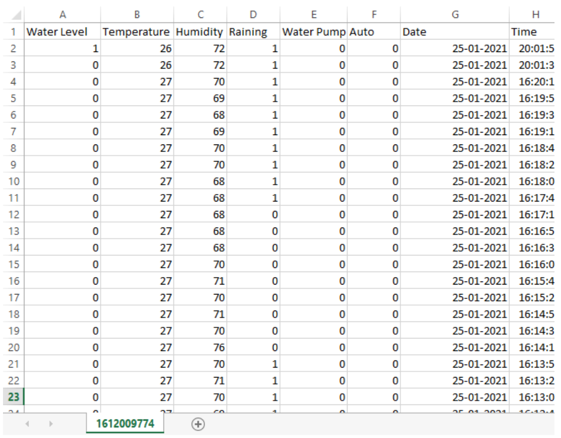


Fig. 7: Monitored data from temperature & humidity sensor.



	A	B	C	D	E	F	G	H
1	Water Level	Temperature	Humidity	Raining	Water Pump	Auto	Date	Time
2	1	26	72	1	0	0	25-01-2021	20:01:5
3	0	26	72	1	0	0	25-01-2021	20:01:3
4	0	27	70	1	0	0	25-01-2021	16:20:1
5	0	27	69	1	0	0	25-01-2021	16:19:5
6	0	27	68	1	0	0	25-01-2021	16:19:3
7	0	27	69	1	0	0	25-01-2021	16:19:1
8	0	27	70	1	0	0	25-01-2021	16:18:4
9	0	27	70	1	0	0	25-01-2021	16:18:2
10	0	27	68	1	0	0	25-01-2021	16:18:0
11	0	27	68	1	0	0	25-01-2021	16:17:4
12	0	27	68	0	0	0	25-01-2021	16:17:1
13	0	27	68	0	0	0	25-01-2021	16:16:5
14	0	27	68	0	0	0	25-01-2021	16:16:3
15	0	27	70	0	0	0	25-01-2021	16:16:0
16	0	27	71	0	0	0	25-01-2021	16:15:4
17	0	27	70	0	0	0	25-01-2021	16:15:2
18	0	27	71	0	0	0	25-01-2021	16:14:5
19	0	27	70	0	0	0	25-01-2021	16:14:3
20	0	27	76	0	0	0	25-01-2021	16:14:1
21	0	27	70	1	0	0	25-01-2021	16:13:5
22	0	27	71	1	0	0	25-01-2021	16:13:2
23	0	27	70	1	0	0	25-01-2021	16:13:0

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Fig. 8: Various sensors reading monitored from the field

After assembling our system, the readings of the sensors have been checked and tested in different situations. The figure above shows interfacing of microcontroller, sensors, relay, and pump as well as readings from sensors and status are displayed on LCD, mobile phone via SMS and on website.

7. CONCLUSION

For live monitoring of agricultural parameters including temperature, humidity, soil humidity, dry run, motion detection, and rainwater detection with both the IoT technology by using cloud, the proposed smart farming system is used. The proper use of water, pesticides, and fertilizers is also managed by it.

Thus, this system provides high efficiency and accuracy in fetching live data of parameters. This will help farm workers in increasing agricultural yields and take efficient care of food production.

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