IoT IN AGRICULTURE

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Abstract - *The usage of IoT in agriculture is a new concept because IoT sensors can provide information about the agricultural sector and react based on user input. This design is intended to take advantage of the technology that is IoT and smart farming by automation. Internet of Things (IoT) technology is advancing in all areas of ordinary people's lives by making everything smart and intelligent. The IoT is a network of things that form a self-configuring network. With the development different smart farming IoT based products, the aspect of agriculture is changing every day. This not only improves crop yields, but also increases cost effectiveness and reduces losses. The Internet of Things (IoT) transforms agribusiness and enables farmers to address field challenges through a wide range of strategies, including precision and hands-on farming. This design proposes an intelligent IoT-based farming approach that enables farmers to obtain live data such as temperature and soil moisture for effective terrain monitoring, practicing smart farming and overall yield and aims to improve product quality. The technology proposed in this project will be integrated with Arduino technology, breadboards, mixed with a variety of different sensors, and will allow you to access live data feeds online via your mobile phone.*

Key Words: **Smart Agriculture, Internet Of Things (IoT), Arduino, ESP 32 Node MCU, Sensors.**

1. INTRODUCTION

The main idea of the IoT is to connect what is not connected. A world where everything is online and enables new services that improve our lives by communicating with others and people. From self-driving drones to delivering grocery orders to covering your health with sensors on your clothes, the world we live in is in the verge of witnessing major technological transitions.

As the world's population grows exponentially, according to the United Nations Food and Agriculture Organization, by 2050 the world will need to produce 70 percent additional foods, agricultural land will shrink and finite natural resources will diminish. The situation is exacerbated by restricted access to natural resources such as freshwater and agricultural land, as well as slowing yield trends for some staple food crops. Another obstacle to agriculture is the structural changes in the agricultural workforce. Agricultural labor is also declining in most countries. As a result of the diminishing agricultural workforce, the usage of internet connectivity in agriculture have begun to be accepted to reduce the need for human labor.

With the promising adoption of the IoT, most of the connected devices around us have reached almost every aspect of our lives. Also, agriculture, healthcare, education, manufacturing, fitness, home automation, transportation, law and order, the possibilities are endless.

We are going to talk especially about agriculture as a stream where the Internet of Things plays an important role. With centuries of agricultural updates, the IoT is now rethinking the view of agriculture in India. Over the last few decades, agriculture has undergone tremendous changes in how it works, with cutting-edge approaches and operating ultra-smart devices. Agriculture is now innovative, strategic and technology driven and effective with intelligent IoT and automated operations.

2. INTERNET OF THINGS (IoT)

The Internet of things (IoT) describes bodily objects (or groups of such objects) with sensors, processing ability, software, and different technology that join and change information with different gadgets and structures over the Internet or different communications networks. The field has advanced because of the convergence of a couple technologies, along with ubiquitous computing, commodity sensors, an increasing number of effective embedded structures.

Traditional fields of embedded systems, Wi-Fi sensor networks, control systems, automation (along with domestic and constructing automation), independently and collectively allow the Internet of things. In the client market, IoT technology is maximum synonymous with merchandise referring to the idea of the "smart home", along with gadgets and appliances (together with lights fixtures, thermostats, domestic safety structures, cameras, and different domestic appliances) that guide one or greater usual ecosystems, and may be managed through gadgets related to that ecosystem, together with smartphones and smart audio systems. IoT is likewise utilized in healthcare structures. [7]

3. SMART FARMING

Smart farming is a broad term that includes the practice of agriculture and food production utilizing the Internet of Things, big data, and superior analytical technology. Communicating about the IoT generally refers to adding sensing, automation, and analytics technologies to modern agricultural approaches. The IoT solution focuses on helping farmers bridge the supply-demand gap by providing excess yields, profitability and natural safety. The technique of using IoT technology to use resources in the most profitable way, achieve high yields and reduce operating costs is known as precision agriculture. IoT technologies in agriculture include specific devices, wireless connections, software and IT services.

Supply in the global smart agricultural market is expected to triple by 2025 to reach $ 15.3 billion (compared to just over $ 5 billion in 2016).

Smart farming based on IoT technology allows producers and farmers to reduce waste, improve productivity and use resources such as water and electricity in an environmentally friendly way, from fertilizer usage to the number of times agricultural vehicles are moved. IoT Smart Farming Solutions is a system designed to use sensors (light, humidity, temperature, soil moisture, plant health, etc.) to monitor fields and automate irrigation systems. Farmers can monitor the condition of the fields from anywhere. You can also choose between manual and automatic options to take the required action based on this data. For example, if soil moisture is low, farmers can use sensors to initiate irrigation. Smart farming is very efficient compared to traditional approaches. [1][2]

Smart agricultural technology includes:

- Sensors that monitor soil quality, soil moisture, and temperature.
- Communication systems such as NavIC and GPS.
- Data analysis tools for making decisions and making predictions.
- Smart devices such as drones and satellites to collect image data to improve tracking from above.

4. APPLICATIONS OF IoT IN AGRICULTURE [8][9]

- **Precision Farming --** Precision Agriculture / Precision Farming is one of the best known applications of IoT in agriculture. It is done to get more control over your farming practices by enabling smart agricultural applications such as livestock monitoring, vehicle tracking, field observation, and inventory monitoring. The goal of precision agriculture is to analyze the data generated by the sensors and react accordingly. Precision agriculture helps farmers use sensors to generate data and analyze this information to make smart and fast decisions. There are many precision agriculture technologies that play an important role in increasing efficiency and effectiveness, such as irrigation management, livestock management and vehicle tracking. With the help of precision agriculture, soil conditions and other related parameters can be analyzed to increase the efficiency of the farm. In addition, you can see the real-time working conditions of the connected device to know the water and nutrient content.

- **Drones --** Agricultural drones are an exceptional example of Internet of Things (IoT) applications in agriculture. Agriculture has become one of the most important industries in which drones can be used. Drones, both ground-based and aerial-based, are being used in agriculture in a variety of ways, including crop health evaluation, irrigation, planting, and soil and field study. Drones have a number of advantages, including ease of use, time savings, crop health imaging, integrated GIS mapping, and the capacity to boost yields. Drone technology will offer the agriculture industry a high-tech makeover by utilizing strategy and planning based on real-time data collecting and analysis. Farmers can use drones to send information about the areas they want to investigate. They have to select an height from which they want to acquire the data. Therefore, from the data obtained by the drone, useful conclusions can be drawn on various factors such as plant counting and yield prediction, plant health indices, plant height measurement, canopy cover mapping, nitrogen content in wheat, drainage mapping, and so on. The drone collects data and images that are thermal, multispectral and visual during the flight and then lands at the same location it took off initially.

- **Livestock Monitoring --** Large farm owners can use wireless IoT applications to collect data on cattle location, welfare, and health. This information helps them identify sick animals and allows them to be separated from the herd, thereby preventing the spread of the disease. Ranchers can also use IoT-based sensors to track cattle, reducing labor costs.

- **Smart Green House --** Greenhouse farming is a technique for improving the yield of crops, vegetables, fruits, etc. Greenhouses control environmental parameters in two ways; either by manual intervention or by a proportional control mechanism. However, because manual intervention has disadvantages such as loss of output, loss of strength and labor cost, these methods are less effective. A smart greenhouse through an embedded IoT system not only intelligently monitors but also controls the climate. Thus eliminating any need for human intervention. Various sensors that measure environmental parameters based on plant needs are used to control the environment in smart greenhouses. A cloud server is then created for remote access to the system as it connects using IoT. Inside the greenhouse, a cloud server helps to process data and apply control action. This design provides optimal and cost-effective solutions for farmers with minimal and almost zero manual intervention. Greenhouse status and water consumption can be monitored through these sensors by sending SMS alerts to farmers through an online portal. The IoT system's sensors in the greenhouse provide information on temperature, pressure, humidity, and light levels.

- **Monitor Climate Conditions --** Climate plays a very important role in agriculture and the lack of understanding about the climate will greatly reduce the quantity and quality of agricultural production. But IoT solutions allows us to know the weather conditions in real time. Sensors are placed all over the agricultural land. They collect environmental data that is used to select suitable crops that can grow and sustain themselves in specific climates. The entire IoT ecosystem is made up of sensors that are capable of real-time sensing of weather conditions like humidity, precipitation, temperature, and more precisely. Sensors are available to detect all these parameters and configure them accordingly to meet our smart farming needs. These sensors monitor the state of the crops and the weather conditions around them. If unusual weather conditions are detected, an alert will be sent. What is eliminated is the need to be physically present during unusual weather conditions, which ultimately increases yields and helps farmers get more out of farming.

- **Remote Sensing --** IoT-based remote sensing uses sensors placed along farms, such as weather stations, to accumulate data that is transmitted to survey tools for analysis. Farmers can monitor crops through analytics and actions can be taken from the information obtained accordingly.

  Crop Assessment: These sensors are placed at different corners of the farm assessing crops to monitor any changes in shape, size, light, humidity and temperature. Any deviations detected by the sensors are evaluated and the farmer notified. As a result, remote sensing helps prevent the spread of diseases as well as monitor the progress of crops.

  Weather conditions: The data collected by sensors in case of detecting temperature, humidity, wet precipitation and dew helps to conclude the weather pattern in the farms to proceed with the cultivation of crops.

  Soil Quality: Soil quality testing helps to determine the nutritional value and arid areas of the farm, the drainage capacity or acidity of the soil, helps to adjust the water level needed for irrigation, and selects plants favorable for cultivation.

- **Computer Imaging --** This form of photography mainly involves the use of sensor cameras placed at different corners of the farm to create images through digital image processing.

  Quality control: Image processing combined with machine learning uses images from a database to compare them with cropped images to draw conclusions about size, shape, color, and growth rate, depending on that adjust the quality.

  Sorting : Computer images can help sort and classify products based on color, shape, and size.

  Irrigation Monitoring: Timed irrigation helps to map irrigated soil. It helps in deciding whether to harvest the crop before the harvesting season.

- **Smart Irrigation On Agriculture Land --** In smart irrigation, automatic irrigation systems or smart pumps are used. Soil moisture sensor is used in different areas to get soil moisture in agricultural land. Based on the results of the soil moisture sensor, the smart pump or smart sprinkler is turned on/off.

5. PROBLEM STATEMENT

5.1 Aim

The aim of our project is to built a **Smart Irrigation System** , a subpart of **Smart Farming**. It will collect the temperature , humidity , soil moisture and water level readings and will switch on and off the pump if necessary.

5.2 Apparatus

1. ESP32 node MCU
2. Breadboard
3. Jumper wires
4. Temperature humidity sensor
5. Soil moisture sensor

6. Water level sensor
7. 6 volt D.C. motor pump
8. 1channel relay module
9. Smart phone with installed Blynk app

6. CIRCUIT DIAGRAM

6.1 Block Diagram

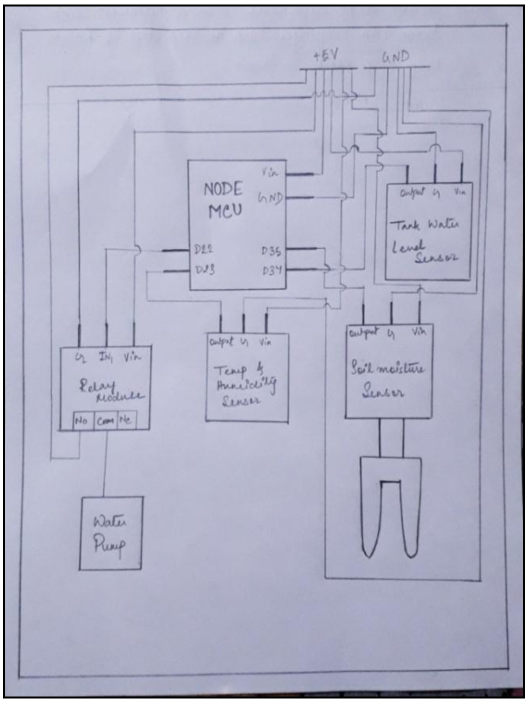

Fig -1: Block Diagram [3][4]

6.2 Actual Circuit Diagram

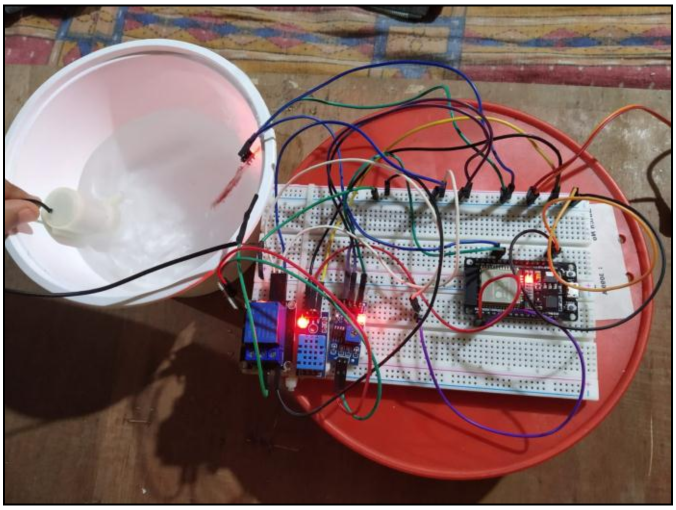

Fig -2: Actual Circuit Diagram [3][4]

7. METHODOLOGY

7.1 Working Principle

The title of the project is "SMART IRRIGATION SYSTEM USING ESP32 NODE MCU". ESP32 NODE MCU microcontroller is the heart of the project. We can refer to Fig. 1 and Fig. 2 to understand the working along with the components. The temperature humidity sensor (DHT11) is used here to collect the temperature and humidity of the surroundings. Soil moisture sensor collects the moisture level of the soil and water level sensor senses the water level of the reservoir. All these sensors collect the data from the surroundings and convert them into electrical signal to feed the data to the system as input. Then the data is sent to the ESP32 NODE MCU .

ESP32 NODE MCU will connect to the internet using WIFI network and will send the data to the Blynk server using the authentication code and password provided in the code, which is uploaded into the node MCU. Then the readings collected by the node MCU is visible in the Blynk app[5] in our smart phone and we are able to monitor the reading of the sensors as well as the pump status.

For building the code Arduino IDE is used [6]. The code is written in such a way, that whenever the soil moisture level falls below 30 and water level of the reservoir is above 50 then the pump will be on and it will water the plants and soil for 10seconds. After that it will be off. The code written in the Arduino IDE is uploaded in NODE MCU using USB cable, so that ESP32 works according the written code.

7.2 Arduino Code

```
#include <WiFi.h>

#include <WiFiClient.h>

#include <DHT.h>

#include <BlynkSimpleEsp32.h>

#define DHPIN 23

#define DHTYPE DHT11

const int relay = 22;

const int waterLevelSensor = 34;

const int SoilSensor = 35;

int waterLevel;

int moistureLevel;

DHT dht(DHPIN,DHTYPE);
```

```
BlynkTimer timer;
char auth[] = "hi6YLbSvQIRkiTenQVTdqLOnRiu0aYqj";
char ssid[] = "barnali";
char pass[] = "barnalisikdar50";
void SendSensorDH()
{
 float humidity = dht.readHumidity();
 float temperature = dht.readTemperature();
 Blynk.virtualWrite(V5,humidity);
 Blynk.virtualWrite(V4,temperature);
}
void SendSensorWaterSoil()
{
 waterLevel = analogRead(waterLevelSensor);
 Serial.println(waterLevel);
 waterLevel = map(waterLevel,0,2000,0,150);
 moistureLevel = analogRead(SoilSensor);
 int moistureLevel1=4100-moistureLevel;
 moistureLevel = map(moistureLevel1,0,4000,0,100);
 Serial.println(moistureLevel);
 Blynk.virtualWrite(V7,waterLevel);
 Blynk.virtualWrite(V6, moistureLevel);
Blynk.virtualWrite(V0,0);
 if(moistureLevel<30)
 {
 if(waterLevel>50)
 {
 digitalWrite(relay,HIGH);
 Blynk.virtualWrite(V0,1);
 delay(10000);
 Blynk.virtualWrite(V0,0);
 }
 else
 {
 digitalWrite(relay,LOW);
}
}
 else
{
digitalWrite(relay,LOW);
 }
}
void setup()
{
// put your setup code here, to run once:
 pinMode(relay,OUTPUT);
Serial.begin(9600);
Serial.println();
Serial.println();
Serial.print("Connecting to ");
Blynk.begin(auth,ssid,pass);
dht.begin();
timer.setInterval(2000L, SendSensorDH);
timer.setInterval(5000L, SendSensorWaterSoil);
Serial.println();
Serial.println();
Serial.print("Connecting to ");
Serial.println(ssid);
WiFi.begin(ssid, pass);
while (WiFi.status() != WL_CONNECTED)
{
delay(500);
Serial.print(".");
}
```

```
Serial.println("");
Serial.println("WiFi connected.");
Serial.println("IP address: ");
Serial.println(WiFi.localIP());
}
void loop()
{
// put your main code here, to run repeatedly:
Blynk.run();
timer.run();
}
```

8. RESULT ANALYSIS

- As shown in Fig-3, the temperature and humidity sensor is showing its reading . The soil moisture level is zero here so the pimp should work but as the tank water level is also zero the pump is not working and the status is zero .

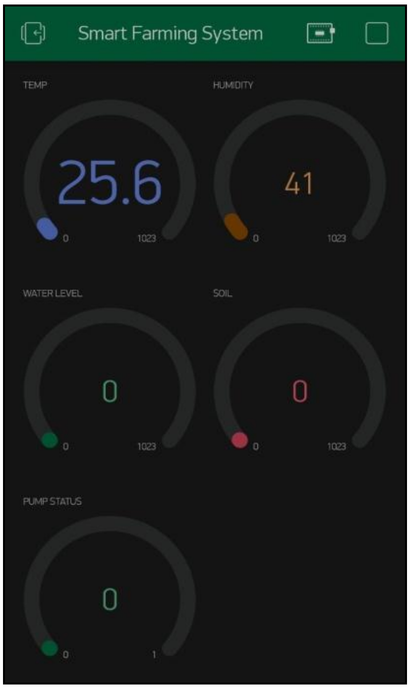

Fig -3: Result 1

- As shown in Fig-4, when the water level sensor is dipped into water the reading is shown as 307 which is more than the threshold value so the pump is turned on and the status change to 1 .

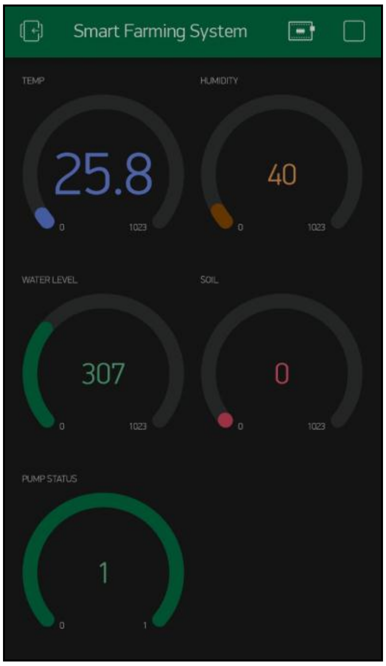

Fig -4: Result 2

- As shown in Fig-5, when the soil moisture sensor is dipped into water the reading is shown as 51 which is more than the threshold value so the pump is turned off and the status change to 0 .

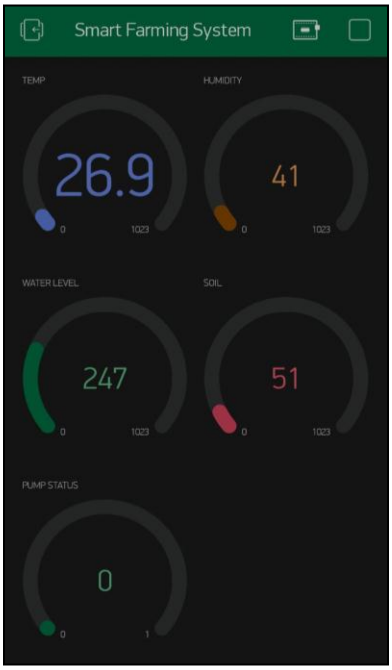

Fig -5: Result 3

9. CONCLUSIONS

Markets grow and collapse, disruptive business models emerge or disappear, but people always have to eat and drink. For this reason, development in areas such as food and agriculture is always a priority, especially given the dynamics seen in today's world. Therefore, the IoT used in agriculture has a very promising future. By using the IoT in the field of agriculture, you can improve your current agricultural scenario by modernizing it to achieve better results, such as increased productivity. IoT creates a virtuous cycle that makes agriculture more efficient, makes food more accessible to consumers, saves farmers time and money, and brings sustainability to the process to the agricultural environment.

Due to the setbacks in all development, the application of IoT in agriculture includes some, such as the costs associated with smart farming, incorrect analysis of weather conditions, or the need for specific skills, especially to run the machines. There are also drawbacks. New developments in all areas can be redesigned to reduce pitfalls, as well as being hampered by some shortcomings. Farmers are beginning to recognize that the IoT is the driving force for increasing cost-effective agricultural production. The range of application of IoT in agriculture is wide, and the disadvantages in the long run are not major obstacles. Future developments in this area will undoubtedly benefit the agricultural sector.

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