Wireless Mesh Networking Using HC-12 for Agriculture

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Abstract: The Internet of things is a widely growing technology. Billions of devices are connected through the internet using various communication modules. So, communication between these devices is of major concern.The internet of things communication can be done in two ways, both wirelessly and wired, but wireless communication has various advantages over wired communication. Further in wireless communication, to improve the performance measure of communication protocol like power consumption, throughput measurement, degree of coverage etc., we are using the Hc-12 transceiver module in the agriculture field. This Hc-12 transceiver has a better coverage area and low power consumption. In this project, we monitor soil temperature and moisture and perform an action if required by the operating motor pump. In this network, we are deploying two slave circuit/node and one master circuit/node. One slave node contains a temperature and moisture sensor, and this node will send data to the master node through the Hc-12 module and second slave node has a motor pump which will get started by receiving a signal from the master node through the Hc-12 module. The master node is used for data transmission over the internet with the help of the Esp32 wifi module. All three nodes are connected and communicate through the wireless Hc-12 transceiver. Here we will take temperature and moisture data of soil, and as per the requirement, we will operate the motor pump accordingly. We can use the Hc-12 transceiver in various agriculture applications, border security, hospitality, health care, remote control, etc.

Keywords: ESP32, HC-12, Humidity, Internet of Things (IoT), Soil Testing, Temperature.

I. INTRODUCTION

Wireless communication is a rapidly growing technology, making it possible to design a wireless network system that can constantly collect, analyze, evaluate and validate our agriculture field to control the factors that influence it. The agriculture field in which farmers operate can affect its activities in many ways depending on many factors such as the amount of temperature, humidity, moisture and light etc., if all these factors are not present in the required amount. They can harm the crop and result in low crop production, which we don't want to happen. Our objective is to develop alternate and low power consumption, wide-range capability and low-cost method in this project. In this project, we are going to perform monitoring of the agriculture field and act accordingly. To achieve our objective, we are using the Hc-12 transceiver module to develop mesh networking in which temperature and moisture sensors

Are connected to the slave node. This slave node is connected to the master node through the Hc-12 module. And this master node is connected to the Esp32 wifi module and monitors the soil's temperature and moisture content. According to the requirement, we are using the pump on the second slave node to operate if required. For example, if the temperature is high and the moisture content is low, we can turn on the motor pump and get to the best temperature and moisture content. By doing this, we can increase food production and helps the farmers to increase the income. This project will help farmers in operating soil content and controlling turn on and off the motor pump. Hc-12 can connect six more nodes to deploy our project in a wide agriculture field [1]. Also, it required low power, which is a big advantage in saving electricity and long-time operation. We can send the data to a web page on mobile or computer so farmers can operate this project from home also, which is time saving and making farmers work easy.

This configuration provides us with a guarantee that each node may have more than one path to the master node so that data will reach safely in any disaster or breaching. This feature is very beneficial in providing security to the network. One damage node can't affect the data transmission. If one node is get affected, then another node is available for data transmission [2]. And in the case of data security, it's very difficult for the hackers to reach the node in which data is getting transmits among the various nodes.

II. LITERATURE REVIEW

2.1 Literature Review: Many colleges, universities, high schools, border security area and agriculture field are converting their entire working area to the digital environment by using various digital technology like IOT,

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ML and AI. For connectivity of all this device, we required a module which makes easy and simple the communication between these devices, so here we are using wireless mesh networking. This solution eliminates the need to bury cables in an old building and across the whole campus. With dozens of well-placed indoor [3] and outdoor nodes, everything will be connected all the time and will help communicate information in the entire working field.

The project's main goal is to design a wireless network of data transmission between the devices, mainly a wireless mesh network in the agriculture field. The project's objective is to ensure secure and reliable data transmission in the agriculture filed using advanced technologies [4]. In this project, we are trying to make data availability at all nodes and system.

A wired network requires huge cable installation and maintenance for its operation. Natural disasters destroy the wired network, which results in the wastage of capital. Also, wireless networks are suitable for long-distance communication over wired networks, for example [5], in the agriculture field. Data security is also not that much better in this wired form of network. The cable is vulnerable to hackers; data breaching is also easy, dangerous for highly important data.

In this project, we have three nodes connected and create a mesh network. Two out of three nodes are slave or sub-nodes used to collect, control information, and sense device and perform an action in the agriculture field. One super-nodes connected with the gateway; super nodes transmit the data to the internet [6]. For data transmission, we are using the Esp32 wifi module.

The sub-nodes collect information from the sensor and transmitting to the super-node, and the super-node will communicate with all sub-nodes and transmit data to the webserver through the ESP32 wifi module [7]. We will monitor the data at the webserver. According to the soil information, we will monitor the motor pump to maintain the soil's temperature and moisture level.

Apart from monitoring the field, we are acting on it. The required components used in this system include HC-12, ESP32, and motor and temperature sensor. Hc-12is a wireless module that is used as a transceiver. The model consists of a single master node and two slave nodes. With one Hc-12transceiver [8], we can connect six more nodes simultaneously.

2.2 ThingSpeak: It is an IoT analysis tool that analyzes live data streaming on the cloud platform. Its service allows you to aggregate, visualize, and analyze live data streams in the cloud. Its response time and execution timing very fast as compare to another IoT cloud-based platform.

III. SYSTEM COMPONENTS

This Security system comprises four basic components: Node MCU, Temperature sensor, Humidity Sensor, Soil Moisture Sensor GPS, and GSM. Each part has its meaningful use with indistinct functionality [9].

3.1. ESP-32: The ESP32 is used for IoT utility and products. Its operating temperature is ranging from –40°C to +125°C. ESP32 is highly-integrated with in-built antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power management modules [10].

Figure 1: ESP-32.

3.2. Temperature sensor (Lm-35): Its sensor Minimum input voltage is 35V and Maximum Input Voltage is -2V, its temperature range 55°C to 150°C, ±0.5°C Accuracy, Low-cost temperature sensor [11].

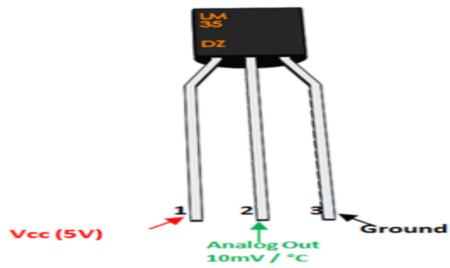

Figure 2. LM-35 Sensor.

3.3 A Humidity Sensor: Its sensor measure moisture and air temperature. In the air, moisture decides to temperature on air with humidity. Some parameters for judgement like accuracy, linearity, reliability, repeatability, and response time [12].

Figure 3. Humidity Sensor.

3.4 Soil Moisture Sensor: The soil moisture sensor is a single sensor used to measure the water content of a soil volume. These sensors measure volumetric water content and are not directly related to other Earth laws such as permittivity, electrical resistance, or otherwise neutron contact, water content input [13].

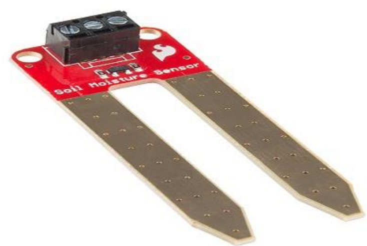

Figure 4. The Soil Moisture Sensor.

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3.5. LDR sensors: Photosensors, also known as light-dependent resistors (LDR), are very simple sensory devices used to indicate the presence or absence of light or to measure light intensity. LDRs have different sensitivity to the length of light used and are non-linear devices [14].

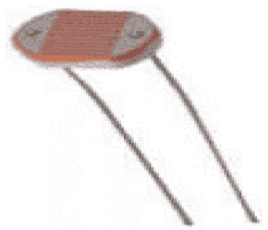

Figure 5. LDR Sensor.

IV. PROPOSED SYSTEM

The proposed system is designed to give a high potential for agriculture, so it used this system temperature sensor, soil sensor, and Humidity sensor for improved agriculture. This proposed work carried two-section transmission and receiver sections below figures 6, 7, and 8 regarding the proposed block diagram for Transmitter, Transmitter Board layout, and Transmitter Schematic Layout. Figure 9,10 and 11 concerning the proposed block diagram for Receiver, Receiver Board layout, and Receiver Schematic Layout.

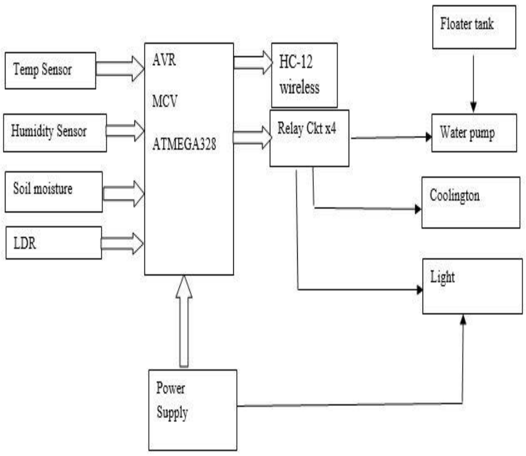

Figure 6: The proposed block diagram for Transmitter.

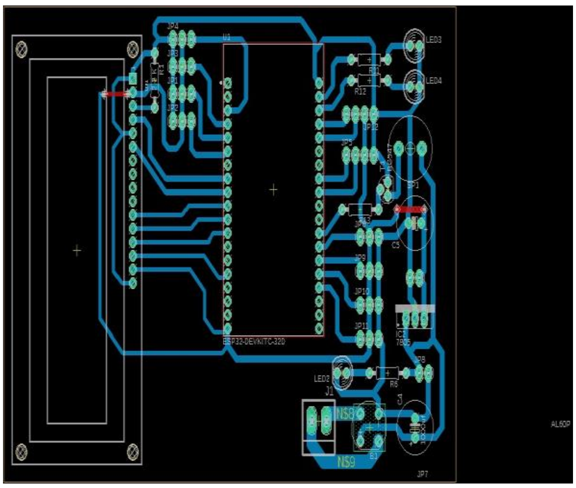

Figure 7: Transmitter Board layout.

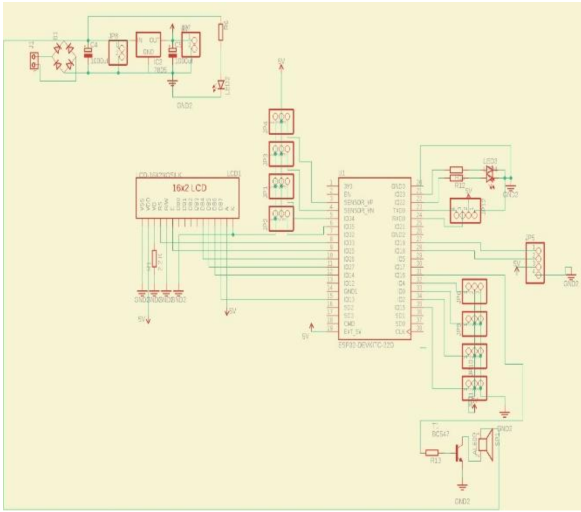

Figure 8: Transmitter Schematic Layout.

Figures 6, 7, and 8 regarding the proposed block diagram for Transmitter, Transmitter Board layout, and Transmitter Schematic Layout

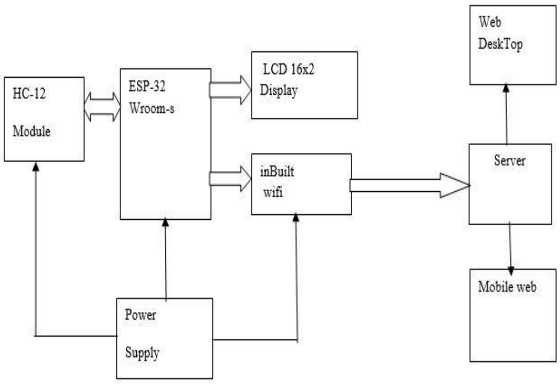

Figure 9: The Proposed Block Diagram for Receiver.

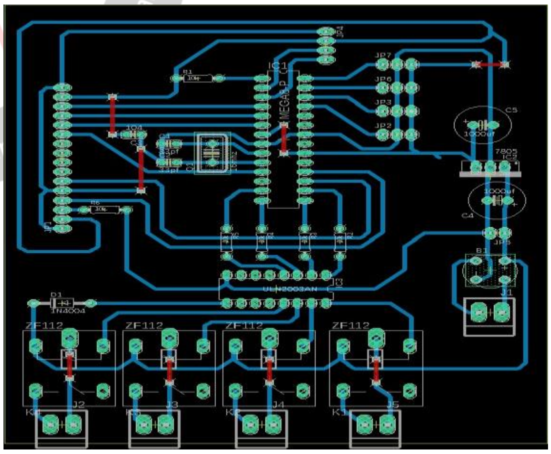

Figure 10: Receiver Board layout.

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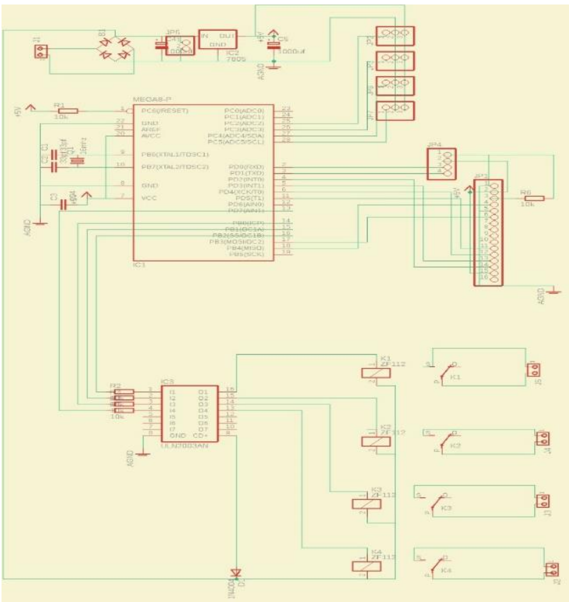

Figure 11: Receiver Schematic Layout.

Figure 9,10 and 11 concerning the proposed block diagram for Receiver, Receiver Board layout, and Receiver Schematic Layout

V. EXPERIMENTAL RESULT

In this phase, explain the result and how to implement our proposed work on hardware. We have to explain the complete experimental result in Figures 12,13,14, and 15 respectively Receiver Experimental Hardware Result, Transmitter Experimental Hardware Result, Real-Time Data Plotting Respect to Data and Temperature, and Real-Time Data Plotting Respect to Data and Soil Moisture.

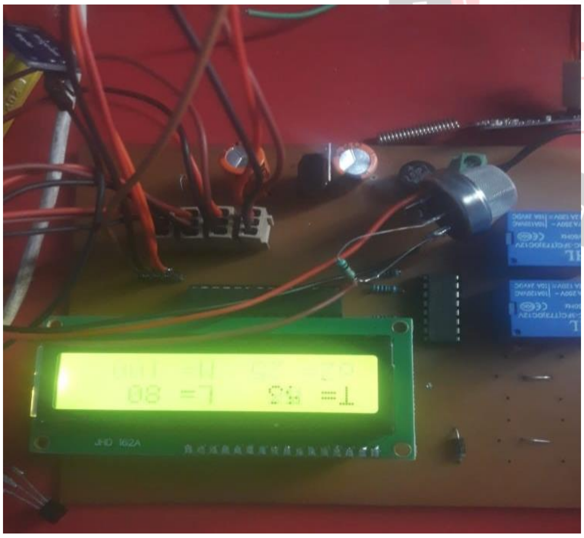

Figure 12: Transmitter Experimental Hardware Result.

In figure 12 explain the transmitter. It has features like 230v AV supply, then converts AC to DC, DC power supply on circuits, after power supply each component activates. In the transmitter processor unit object and calculate each sensor value, the device goes to On and OFF; the whole process operates using the HC-12 device.

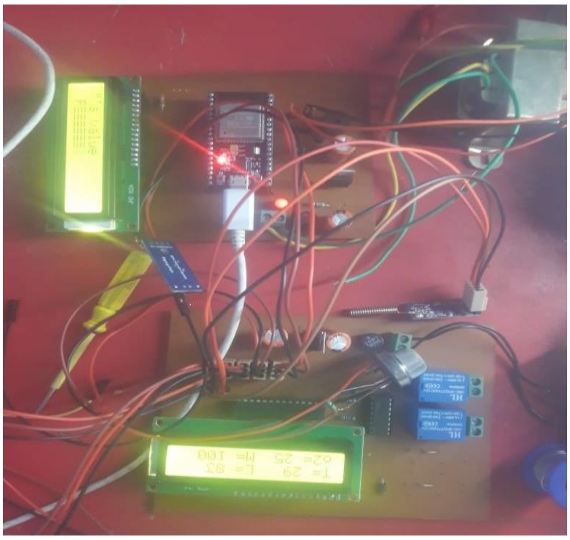

Figure 13: Receiver Experimental Hardware Result.

In figure 13, explain the receiver. It has features like 230v AV supply, then converts AC to DC, DC power supply on circuits, after power supply each component activates. In receiver processor unit receive data from the transmitter unit using the HC-12 module, and ASP-32 operates all instructions as required.

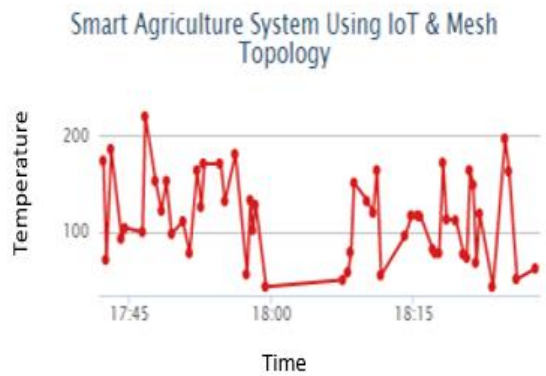

Figure 14. Real-Time Data Plotting Respect to Data and Temperature.

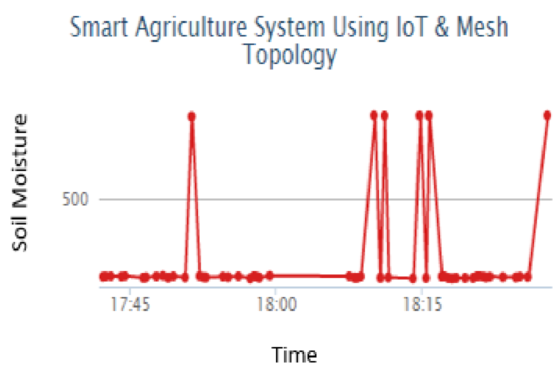

Figure 15. Real-Time Data Plotting Respect to Data and Soil Moisture.

In figure 14 shows Real-Time Data Plotting Respect to Data and Temperature, and figure 15 shows Real-Time Data Plotting Respect to Data and Soil Moisture

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VI. ADVANTAGE, DISADVANTAGE, AND APPLICATION OF OUR WORK

6.1 Advantages

- In a single node malfunction, the packets are automatically inserted to reach the correct location.
- The range of the machine can be extended to many kilometres using the right techniques and technology.
- New locations can be easily added to the network without interfering with existing construction.
- Adding other devices does not interfere with the transfer of data between other devices.

6.2 Disadvantages

- The cost to use is higher than other network sites, making it a less attractive option.
- Building and maintaining a replica is difficult and time-consuming.
- The chance of unwanted connectivity is high, which results in higher costs and lower efficiency.

VII. CONCLUSION AND FUTURE WORK

7.1 Conclusion: Our main objective is to use the project for agriculture purposes, which covers a wide range of area Hc-12 transceiver modules that are more advantageous over Zigbee. It is more beneficial for us to use the Hc-12 transceiver module based on cost-effectiveness and throughput measurement. Explain the result and how to implement our proposed work on hardware. We have to explain the complete experimental result in Figures 12,13,14, and 15 respectively Receiver Experimental Hardware Result, Transmitter Experimental Hardware Result, Real-Time Data Plotting Respect to Data and Temperature, and Real-Time Data Plotting Respect to Data and Soil Moisture.

7.2 Future Work: Carmakers and many telecom companies are working on wireless mesh networking to develop Intelligent Transport Systems (ITS). The public safety authority tightly monitors traffic accidents and dangerous road conditions. According to PC Magazine, a technology alerts a driver when a nearby car deploys its airbags. US military also uses wireless mesh networking in its border security system. Since there is a wide working field, so the wired network is complex to establish, mesh networking is very helpful. Also, it provides security to the data. The wireless mesh network also reduces vulnerability to various cyber-attacks. Mobile Wireless Mesh Networks also operates in-car entertainment features like digital music and movie download. Companies working in the automation system and developing an automated home set-up box can use wireless mesh networks to connect surveillance cameras, climate control, and entertainment systems.

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