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LONG RANGE AND SELF POWERED IoT DEVICES FOR AGRICULTURE BASED ON MULTI-HOP TOPOLOGY

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Abstract: *This project presents the prototype design and testing of long-range, secured IOT devices for use in precision agriculture environment. A line-of-sight range of up to 1.8km is achieved with the use of transmissions. However, the coverage area and range can be extended significantly by deploying the devices in multi hop network topology. The custom multi-hop protocol provides energy efficient communication from any device in a wireless sensor network. The sensor data is transmitted to a gateway, which then forwards it to a local server or cloud service, where the data can be analyzed to optimize the production in agriculture.IOT network system can monitor environmental parameters. The proposed network system incorporates multiple sensors to monitor environmental parameters. The sensors on different subjects can communicate with each other and transmit the data to a gateway via RF. the sensor node will provide an effective notification. A smart IOT gateway is implemented to provide data processing, local web server and cloud connection. After the gateway receives the data from sensors, it will forward the data to an IOT cloud for further data storage, processing and visualization.*

Keywords: Temperature sensor, microcontroller, RF module, LCD display,ESP8266MCU, Cayenne app.

I. INTRODUCTION

Internet of things is a system of inter-related computing devices, mechanical and digital machines. The term "Internet of Things" was coined by Kevin Ashton of procter and Gamble in 1999. Long range is a low power wide area network technology. It is based on self spectrum modulation Technique. It uses license free sub-giga hertz radio frequency banks. 868MHz(Europe), 915MHz(Australia and North America) and 923MHz(Asia). Radio frequency module is used to transmit or receive radio signals between two devices. The main aim of this paper is to collect the information in the agricultural fields or in any other environment and transmit through wireless communication. IoT devices for agriculture and aquaponics have been designed and tested based on the nRF52840 with a multi-hop protocol and energy harvesting. The multi-hop protocol is highly efficient with ranges upto 1.8km per hop and a maximum hop by hop delay of 0.6s assuming successful transmission. The data are displayed in LCD as well as in Cayenne app and the temperature is measured by temperature sensor.

II. LITERATURE SURVEY

In the year 2018 a paper "Design and Implementation of long range self-powered wireless IoT devices" was written by Rolf Arne Kjelby, they detect using nRF52840 based on energy harvesting. The test-bed is setup in both star and multi-hop configurations with optimized custom protocols. The average power by which the battery was charged during the test was 941.94μW in an indoor environment. Based on measurements, a line of sight range of 1.8km is obtained using coded transmissions. Sensors of temperature, relative humidity and visible light are integrated into the nodes.

In the year 2018 a paper "Design and prototype implementation of an ultra low power wakeup Audio for wireless IoT devices" was written by Anders froylog. This project focus on reducing the overall power consumption of the battery powered and energy harvesting based devices. The prolonged life time of the devices can reduce the overall costs when deployed in large scale.

In the proposed system we designed the" Long range and self powered IoT devices for agriculture based on Multi-hop topology". This project is useful in agricultural field. This project is based on multi-hop topology and focus on the longer transmission of data without loss in transmission. With the help of ESP8266MCU module the data is send to Cayenne app. Thus, the data can be analyzed to optimize the production in agriculture.

III.BLOCK DIAGRAM

The main platform of this project is Arduino which is based on the platform of Microcontroller. It is an open source and easy programming.

The data from the sensor is collected through RF transmitter and it is transmitted over long distances. The temperature sense the temperature in the agricultural field and soil moisture sensor sense the moisture content of soil.

ESP8266MCU is a low cost Wi-Fi microchip. This is a small module allows microcontroller to connect to a Wi-Fi network and make simple TCP/IP connections using commands. The longer range of transmission is achieved through Multi-hop technology.

Finally, the output is viewed by using Cayenne app which is an online IoT dashboard useful for creating hardware-oriented programming. Thus, the data can be analyzed to optimize the production in agriculture.

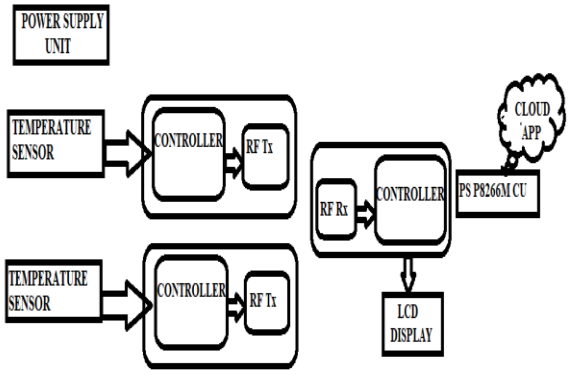

Fig -1: Block diagram of proposed method

1. ATMEGA328microcontroller:

ATMega328 micro controller is a single chip micro controller created by Atmel in the negative family. At mega 8-bit AVR RISC based micro controller combines 32 KB ISP flash memory with read-while write capabilities 1 KB EEPROM, 2 KB SRAM, 23 general purpose input lines, 32general purpose the working registers. The device operates between 1.8to5.5v and maximum frequency 20MHz. Flash memory 32 KB. Number of touch channels16. Maximum input pins 23.SRAM 2 KB.

Fig 1: Arduino

2. Temperature sensor

The temperature sensor is a device to measure the temperature through an electrical signal it requires a thermocouple or RTD (Resistance Temperature Detectors). The thermocouple is prepared by two dissimilar metals which generate the electrical voltage indirectly proportional to change the temperature. The RTD is a variable resistance, it will change the electrical resistance indirectly proportional to changes in the temperature in a precise, and nearly linear manner.

Fig 2: LM35 Temperature Sensor

3. ESP8266MCU

ESP8266 is a low-cost Wi-Fi microchip, with a full TCP/IP stack and microcontroller capability, produced by Espressif Systems in Shanghai, China.

The chip first came to the attention of Western makers in August 2014 with the **ESP-01** module, made by a third-party manufacturer Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at first there was almost no English-language documentation on the chip and the commands it accepted. The very low price and the fact that there were very few external components on the module, which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, the chip, and the software on it, as well as to translate the Chinese documentation.

The **ESP8285** is an ESP8266 with 1 MiB of built-in flash, allowing the building of single-chip devices capable of connecting to Wi-Fi.

The successor to these microcontroller chips is the ESP32, released in 2016.

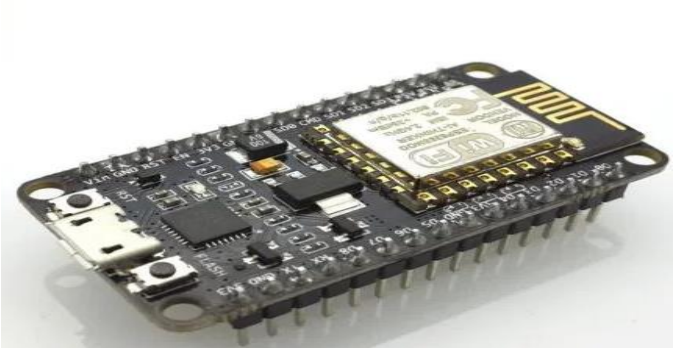

Fig 3: ESP8266MCU

4. LCD DISPLAY

LCD display is a 16*2 alphanumeric display which means that its displays alphabet and numbers. It displays the current status of the cylinder and displays the leakage and the temperature sensor.

Fig 4: LCD Display

5. RF MODULE

RF module (short for **radio-frequency module**) is a (usually) small electronic device used to transmit and/or receive radio signals between two devices. In an embedded system it is often desirable to communicate with another device wirelessly. This wireless communication may be accomplished through optical communication or through radio-frequency (RF) communication. For many applications, the medium of choice is RF since it does not require line of sight. RF communications incorporate a transmitter and a receiver.

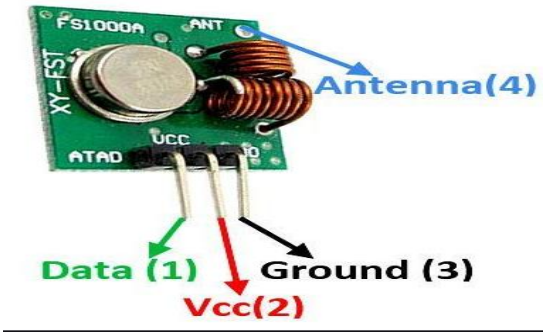

Fig 5.a: Transmitter module

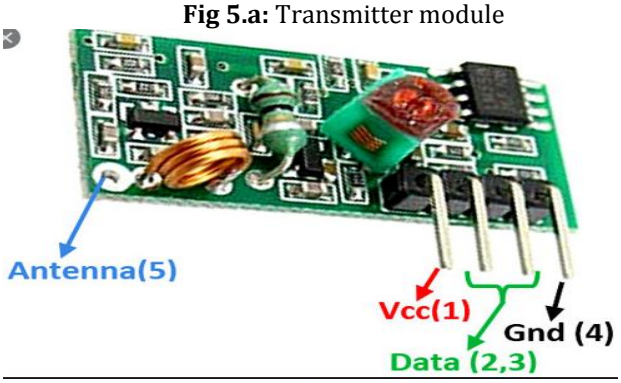

Fig 5.b: Receiver module

6. SOIL MOISTURE SENSOR

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity.

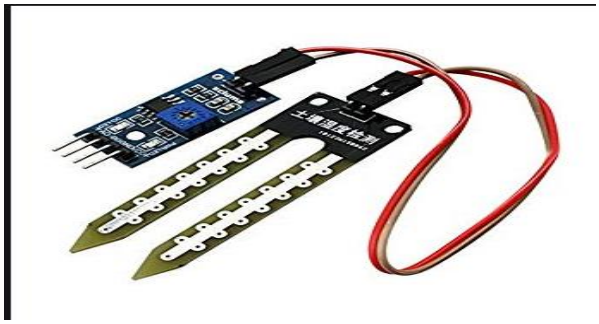

Fig 6: Soil moisture sensor

7. CAYENNE CLOUD

Cayenne is an online IoT dashboard that takes most of the complication out of creating hardware-oriented programing. Originally it worked with just the Raspberry Pi. ... **Cayenne** is a drag-and-drop programming system for the IoT that really does make it much easier.

Fig 7: Cayenne Cloud's application

IV.CONCLUSION

In this paper we implemented the prototype design and testing of long range, secured IoT device for the use in agricultural environment. This system is used in the wireless network field in various application. The temperature of the field is monitored using temperature sensor and displayed in the LCD with the help of ESP8266 module. The data from the controller is send to the cayenne cloud app and the output is displayed in the form of widgets. This project is user friendly and cost is low when compared to other network.

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