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Prototype Development of an Agricultural Environment Monitoring System Using WSN

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Abstract: Agriculture is an essential component of societal well-being. Agricultural production influences, and is influenced by, health, water quality and quantity, ecosystems, biodiversity, the economy, and energy use and supply. We can monitor such parameters using wireless sensor networks. In this paper, we discuss how WSN is used in Agricultural environment monitoring. Also we represent a prototype design of Monitoring system based on WSN and web application for data representation of received data from network.

Keywords: Precision agriculture, Component, WSN, STM32f103c8, ESP8266, sensors, WIR-1186M.

I. INTRODUCTION

For more than farmers have cultivated crops using trial and error, received wisdom and how the soil feels when they run it between their fingers. Nowadays, we're witnessing a new farming revolution triggered by the adoption of staggering new technologies: satellites, high precision positioning systems, smart sensors and range of IT applications combined with high-tech engineering.

A. Precision agriculture is one of the many modern farming practices that make crop cultivation more efficient. Precision farming is about managing variations in the field accurately to grow more food using fewer resources and reducing production costs. Precision farming can make a difference to food production facing the challenge of rising world population and can help farmers to achieve [1].

B. WSN is a network of many tiny low power devices, called motes or nodes. These motes are spatially distributed in areas to be supervised then it relay data to the sink node. The nodes are collaborating together in order to perform measurement of the sensed environment. WSN is receiving significant attention due to their unlimited potential. However, many challenges exist like the deployment of nodes to cover the larger areas, security of data, fidelity and energy efficiency. The power consumption challenge remains a major challenge [3].

All the aspects of the environment – soil, weather, vegetation, water vary from place to place. And all these factors determine crop growth and farming success. These parameters can be monitored and stored using wireless network sensors (WSN).

As wireless sensor networks (WSN) consists of spatially distributed autonomous sensors connected via communications infrastructure to cooperatively monitor record and store physical or environmental condition such as temperature, vibration, pressure or pollutants.as for short range we can use wires sensor network but for long range wireless sensors network is preferred.The wsn is also used to check the humidity before farming as it issuitable or not for cultivating[2].

Here, we propose a prototype of wireless sensor networknode that can monitor as well as store the sensor data and which can be used in any range of field such as garden, green house or farm.

II. PROPOSED SYSTEM

Figure 1 shows the proposed system architecture that includes two types of nodes 1) Master node 2) Slave nodes. Both nodes have similar components 1) Sensors 2) Power supply 3) RF module except master node have Wi-Fi module also.

Here, our node is composed of essentially of microcontroller STM32F103 [4] with WIR-1186M [5] transceiver, battery, sensors like Temperature and humidity, soil moisture also master node consists ESP8266 E12 [6] Wi-Fi module.

The ST Microelectronics has designed new STM32 UltraLow-Power MCU with record breaking performances, STM32F103xx.

This microcontroller has very low power consumption in sleep mode compared to MSP430 [3].

The STM32F103xx medium-density performance line family incorporates the high performance Cortex -M3 32-bit RISC core operating at a 72 MHz frequency, highspeed embedded memories (Flash memory up to 128 Kbytes and SRAM up to 20 Kbytes), and an extensive range of enhanced I/Os and peripherals connected to two APB buses.

All devices offer two 12-bit ADCs, three general purpose 16-bit timers plus one PWM timer, as well as standard and

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advanced communication interfaces up to two I2Cs and SPIs, three USARTs, an USB and a CAN [4].

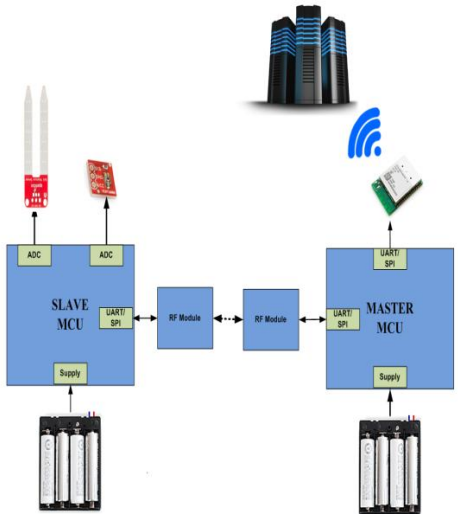

Figure (1) Proposed system

WIR-1186M module integrates SPIRIT1, an extremely low-power sub-GHz transceiver, an MCU for wireless network control and hardware interface, a PCB antenna and matching circuitry. The WIR-1186M modules support a full-mesh communication network with features like data-hopping, listen-before-talk with random back-off algorithm, end-to-end acknowledgement system, node addressing, network addressing, 128-bit AES Encryption and packet CRC [5].

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network.it is capable of either hosting an application of offloading all Wi-Fi networking functions from another application processor.ESP8266 is extremely cost effective module which comes pre-programed with an AT-command set firmware[6].

DHT11 is a basic, ultra low-cost digital temperature and humidity sensor.it uses a capacitive humidity sensor and a thermistor tomeasure the surrounding air , and spits out a digital signal on data pin once every 2 seconds and SEN-13322 is a simple breakout for measuring the moisture in soil and similar materials.

III. DESCRIPTION OF SOFTWARE

Here, we have discussed about the software flow of proposed system as well as network route formation of WSN.We have taken an event based approach to save power consumption by peripheral components, thus all peripherals are initialized one after another instead of being activated on power on of microcontroller. After powering up the node, the entire device will be initialized. The initialization includes the initialization of clocks, I/Os, RTC and transceiver WIR-1186M,it is an initialization of hardware.

Activating sensors: MCU sends commands to sensor to be activated. various sensors can be used as per different environmental applications. The MCU initializes the sensor hardware and take measurements of the sensors in order to measure real parameters. After measuring the data calculations and processing takes place.

Wireless network Formation: Mesh network provides facility to extend range of the network by routing data to nodes that are not in the direct range of gateway. As shown in figure (2), the gateway is center of mesh network with all data to and from network goes through gateway. In our application gateway node is interfaced with master device which also consists ESP8266 [6] Wi-Fi module. By default, all the WIR-1186M modules have unique 32 bit hardware id which helps in differencing them in network and allows very effective routing. Here there is only one gateway node (Master) and rests are configured as router (Slave) nodes.

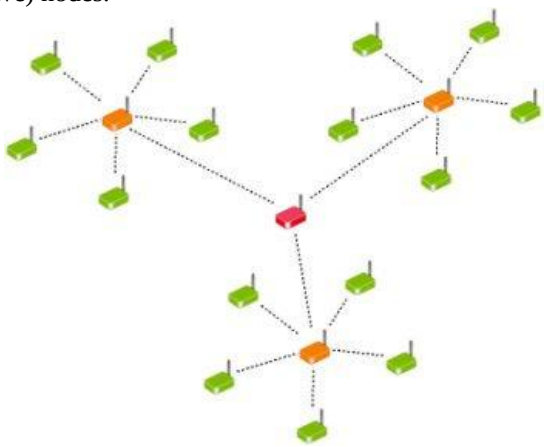

Figure (2) Mesh network topology[5]

A gateway configured node will send out ROUTE REFORM packets every two seconds wirelessly broadcasting its unique ID and the mesh network ID. All routers configured nodes, with the same network ID; in direct RF range of the gateway accepts the gateway as its point of data concentration and in turn sends out ROUTE REFORM packets of its own to all nodes within its wireless range. This allows for dynamic route changing and healing during simultaneous data transfer over the network.After network has been developed, all the slave nodes will send measured sensor data to Gateway (Master) node as shown in figure (3).

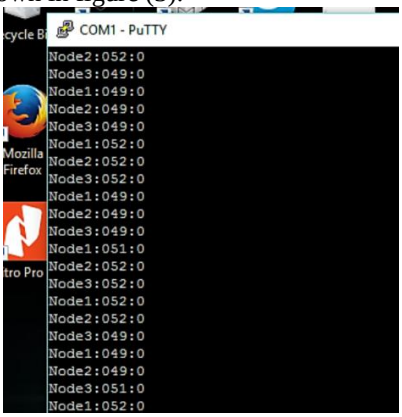

Figure (3) Data received at gateway node

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Data management at Web Server: After successful reception of data from all the slave nodes as shown in figure (3), Master node will initialize ESP8266 Wi-Fi module to send all received data to web server. XAMPP web server package is used to host as local web server and MySQL database for web application. Entries of data sent to web server by master node is shown in figure (4).

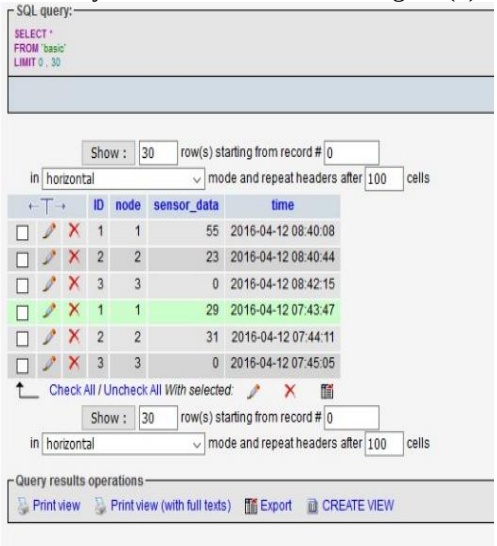

Figure (4) Data Entry in MYSQL Database

At current state of testing all the nodes are configured to be turned on at defined time interval (Hourly) for certain time period (10 minutes) which can be changed as per requirement. In this time period all nodes measures sensor value, send that data to Gateway (Master) node and all slave nodes be in standby mode till all the data transfer in network is completed. Than all data received from node is sent over to web server using Wi-Fi module by Gateway node. This data can be seen and monitored by user via web application.

IV. CONCLUSION

In this paper, we discussed the proposed system for agricultural environment monitoring. This system is based on low power consumption MCU STM32f103xx and SUB-GHz transceiver WIR-1186M and DHT11, SEN-13322 sensors and ESP-8266 E12.This proposed system can be used to monitor any garden, Green house or large farm fields having any range of area.

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