Smart Secured Real Time Agriculture Monitoring System

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Abstract - **Embedded systems in Agriculture play a vital role in unifying the work involved and improve conservations. Designing a smart as well as a cost efficient and more user friendly system will be idealistic challenge. The following system that has been proposed is designed with those ideal constraints in mind. It consists of a Raspberry pi3 as a gateway that links the sensor networks with the cloud. To improve security an MQTT protocol is used for cloud connectivity. The communication between the sensor networks is managed by NRF24L01. The Sensor network is a separate entity that can used like a plug and play device and is built by a micro controller with a LCD display and an interfaced GPS. Multicasting is also possible between sensor networks and the gateway. The processed data from the sensor networks is sent through NRF24L01 to the gateway. The gateway further processes and encapsulates the data and through MQTT the data gets stored on the cloud. This cloud data can be accessed through computer or mobile device.**

Keywords - IoT, MQTT, cloud connectivity, raspberry pi, arduino

I. INTRODUCTION

Agriculture is the backbone of Indian Economy. Because Without Agriculture Living is Impossible since agriculture producers the main source of food for us. The farmer has to toil himself day in and out to produce the crop which brings him little revenue , so he has to try some other option for his sustenance, also today the availability of labor for carrying out agriculture activities is less, therefore the automation the automation in agriculture process is needed.[1]

Secondly, in agriculture field survey recognized as an important issue that the successors of a farmers is decreasing continuously. In order to maintain the high level of agriculture technology, it is indispensable to use effectively the empirical knowledge which skilled Agricultural Engineer has.[4]

In order to solve this problem, we develop a data sharing system about knowledge for agriculture technology. typically in these developing countries uneducated farmers tends to use more water than required by manual techniques hence wasting them. So that it is necessary to educate that farmers using technology using technology soil moisture sensors are typically needed in such situations to indicate to the farmer when it is needed to irrigate the field and when not needed.

The increasing complexity of embedded software calls for a new efficient design approach. A natural choice is to use well-established component based design; however its adoption to design of embedded software has been slow and riddled with difficulties. [6]

II. RELATED WORK

This section reviews relevant previous work in smart agriculture system.

A. Smart Agriculture System

Smart farming is the logical advancement of precision farming. The focus of precision farming was mainly on technological invention to allow for site-specific farming. Moreover, smart farm is about empowering today's farmers with the decision tools and automation measurement technologies that seamlessly integrate products, knowledge and services for better productivity, quality and profit Technological advances in these areas gather increasing momentum and this means that maintaining an overview of latest developments becomes more and more of a challenge . The most important things of smart farming are environmental measurements and water management. The reason is that the environmental and water management affects plant growth. In addition, environmental measurements using wireless sensor network and water management technology are much simpler, cheaper and lower running costs Researchers had developed and used various devices for detecting and collecting soil conditions . They had installed the sensor devices and transmission equipments in appropriate area. These sensor devices have used in wireless sensor network (WSN)[5]. A case in point is some researcher had studied the reflected of ultrasonic wave signals monitor a soil moisture and groundwater levels to predict the occurrence of landslides and slope. First, they installed an ultrasonic transducer inside steel pipe and take steel pipe buried in the ground then they calculated reflection of the wave period to measure the moisture content of the soil and the water level. That may cause the landslide when heavy rains. Therefore, the study of the measurement and surveillance environment in agriculture has performed extensive research and continuous with the

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technology to help for detecting the amount of light, humidity and temperature using wireless sensor networks to collect and process on a computer server and report to farmer through mobile device like PDA or cell phone . The environments have various factor relate to plant growth such as temperature, moisture in the air, soil moisture (the water leakage outflow speed of groundwater) and soil PH. Automated Irrigation system has reported factors to farmer through mobile SMS, website or voice mail alert . The part of device to transmit data is often used as a TinyOS or microcontroller (MCU) and ZigBee (XBee), NRF24L01, Bluetooth for radio transmission to send data signals from source to destination . The most of system are powered by solar cells and batteries .[1]

III. SYSTEM ARCHITECTURE

This work aims to address a variety of distinct scenarios, such as agriculture, greenhouses, polyhouses[2]. The proposed architecture (see Figure 1) must be modular to be adapted to each scenario requirements.
It can be divided into three main component such as sensor network, gateway (raspberry pi) and cloud connectivity

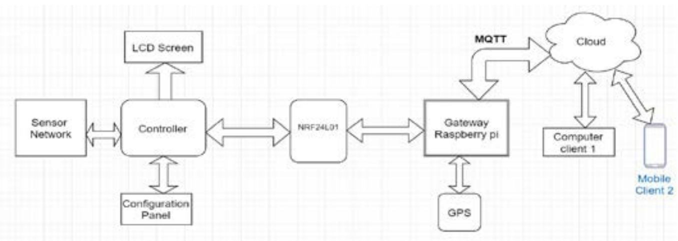

Figure-1 Proposed Architecture

The communications between these nodes are done by wireless communication protocol i.e by using NRF24L01.
All the sensor data from sensor node are transferred to gateway(raspberry pi) by using NRF24L01 and from gateway to cloud connectivity we are using MQTT protocol for secured communication between cloud and gateway.
GPS module – to show location of the device because it is a plug and play type modular system.
All the data we need to store and analyze for the future reference to produce good quality of fruits or crops in the farm.

A. Sensor Node

The hardware used for implementing End Devices is sensors like DHT11 Temperature and Humidity sensor and soil moisture sensor.
LCD screen, configuration board (keypad) - to select sensor to read data .
To transfer sensing data from sensor node to raspberry pi(gateway) we also interface NRF24L01 with controller.
To control all these above hardware and sensor we are using ATmega328P controller shown in figure-2

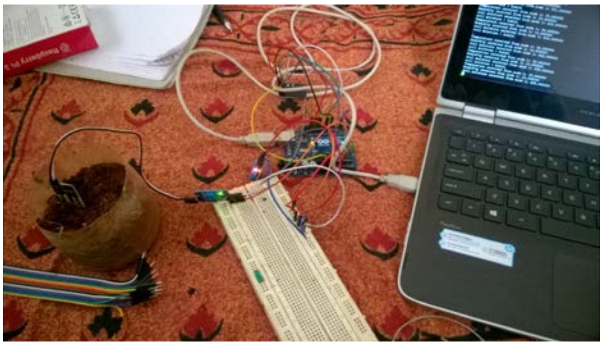

Figure -2 Sensor node (sensors and NRF24 with arduino)

B . Gateway (Raspberry Pi)

All the data from sensor node we need to store on gateway, here we are using Raspberry pi 3 model B as a gateway shown in figure – 3

Figure - 3 Raspberry pi 3 model B with NRF24L01

Here we are interfaced nrf24l01 with raspberry pi to receive sensor data from sensor node shown in figure -3 but for that we need to install RF24 libraries on raspberry pi 3

<u>STEPS TO INSTALL RF24 LIBRARIES AT RASPBERRY PI</u>

1. wget http://tmrh20.github.io/RF24Installer/RPi/install.sh
2. chmod +x install.sh
3. ./install.sh

After that by using make file and program (rf24receiver.cpp) file we have to perform following commands to receive sensing data from sensor node via RF24 network

1. Sudo make
2. Sudo ./rf24receiver

After above command execution you will see some a printout of some radio details, followed by a dot every 2 seconds while the Pi patiently waits for data until the arduino start sending.

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C. Protocol

MQTT- MESSAGE QUEUING TELEMETRY TRANSPORT PROTOCOL

MQTT (formerly MQ Telemetry Transport) is a publish-subscribe based "light weight" messaging protocol for use on top of the TCP/IP protocol. It is designed for connections with remote locations where a "small code footprint" is required or the network bandwidth is limited.
The design principles are to minimise network bandwidth and device resource requirements whilst also attempting to ensure reliability and some degree of assurance of delivery.
The Publish-Subscribe messaging pattern requires a message broker. The broker is responsible for distributing messages to interested clients based on the topic of a message. Every message is published to an address, known as a topic. Clients may subscribe to multiple topics. Every client subscribed to a topic receives every message published to the topic.

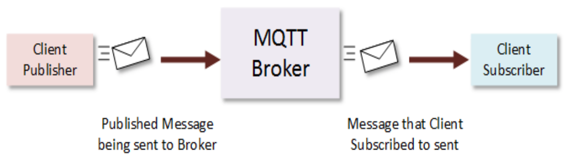

Figure - 4 MQTT Architecture

D. Cloud Connectivity

We have basic C file to read sensor value, by using shell scripting we can read sensor data and send that data on cloud platform. For that we need to create .sh files to read , send , data to cloud

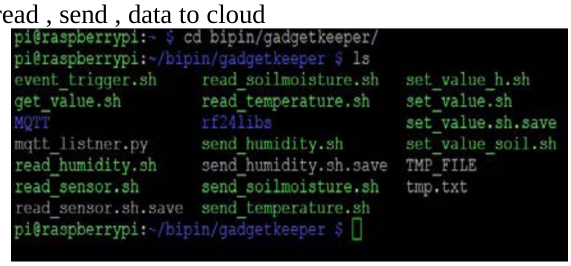

Figure - 5 All shell Scripting files

Above figure - 5 shows all the shell scripting files that we need to create to send data on cloud.
In all these files we need to provide rf24receiver path in scripting, from that we are able to read sensor data which is coming from sensor node.
To run all these scripts following command has to used

- e.g Sudo ./read_soilmoisture.sh

like above we can apply command on other files also by using respective name of file.
To upload data on cloud we need API key for that we are uses gadgetkeeper cloud platform to update data on cloud by using MQTT protocol.
For that we need to specify all API key, thing ID, and property ID of our account on gadgetkeeper in set_value.sh scripting properly & that set_value.sh path we have to specify in send_soilmoisture.sh scripting properly.
We can apply all these steps to other parameters like temperature and humidity.

For run all these send file we have to apply following command on command window of raspberry pi

- e.g sudo ./send_soilmoisture.sh

like above we can apply command on other files also by using respective name of file and we will get following output

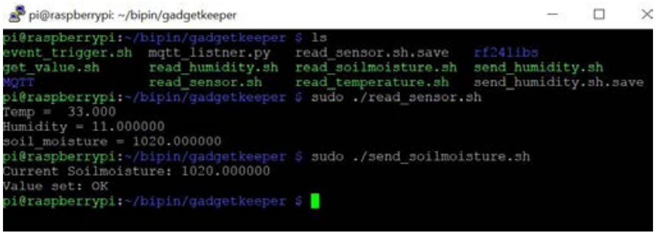

Figure - 6 send script output

By using MQTT protocol we can send data on cloud with security by giving same topic name and TLS layer security
For that we have to install MQTT client on raspberry pi

STEP TO INSTALL MQTT CLIENT ON RASPBERRY PI

For MQTT client we are using mosquitto client libraries, Download the mosquitto from this site or simply use the following command.

http://mosquitto.org/download/
-sudo wget http://mosquitto.org/files/source/mosquitto-1.0.2.tar.gz

- Follow these commands to install mosquito
  - sudo apt-get install libwrap0-dev
  - tar zxf mosquitto-1.0.2.tar.gz
  - cd mosquitto-1.0.2/
  - make
  - sudo make install
  - sudo ldconfig
  - sudo make clean
  - sudo iptables -A INPUT -p tcp -m tcp --dport 1883 -j ACCEPT

Next step is to prepare the MQTT client script to communicate with gadgetkeeper MQTT server, Following Python script can be used to do it.

- sudo nano mqtt_listner.py

in that python script we need to specify thing ID , broker name-“api.gadgetkeeper.com” and also need to specify read_sensor path in the script.
command to run python script

- sudo python mqtt_listner.py

IV. EXPERIMENTAL RESULT

A. At Raspberry Side

At raspberry we will get sensor data received by nrf24l01 from sensor network And at raspberry pi we will distinguish soil sensor data in dry soil , humid soil

Figure -7 Output at raspberry pi

Following figure shows humid soil sensor readings

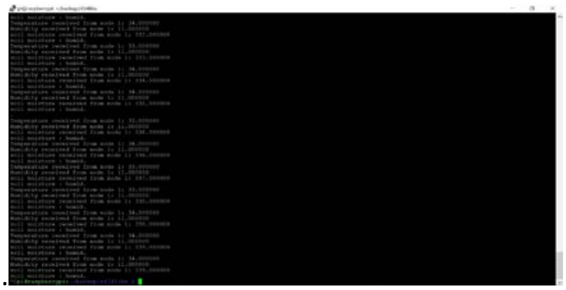

Figure -8 humid soil output at raspberry pi

B. At Cloud

By using shell scripting we will able to upload data on cloud platform, as we explain earlier steps we need to follow to upload data on cloud.Here we are using gadgetkeeper as cloud platform.
By using API and MQTT protocol we are able to upload sensor data on gadgetkeeper.
In this case we are using gadgetkeeper broker (api.gadgetkeeper.com) and we need to install mosquitto client on raspberry pi to send data on cloud.
Following picture shows uploaded sensor data on gadgetkeeper cloud platform

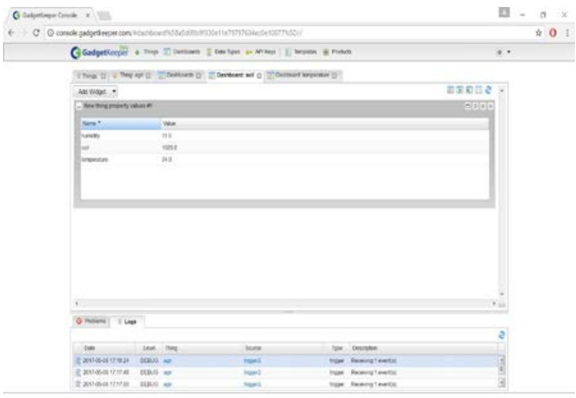

Figure -9 updated sensor data on cloud

V. CONCLUSION AND FUTURE WORK

The development of a system for smart agriculture can greatly benefit from the knowledge of the soil and water dynamics.
Besides the soil moisture monitoring, to assess the plants water needs for its proper and healthy development, it was also important to assess the possibility of natural resources' usage optimization.
Experimental tests on a real case scenario at a farm allowed the identification of some limitations, mainly related to energy consumption.
Ongoing developments address the storage of historical information on the cloud concerning an agriculture field. The availability of a large amount of valuable data on the cloud enables the creation of intelligent services with very high potential, such as data correlation between different cultures and/or fields, plant disease estimation through the application of machine learning techniques, or determination of the most appropriate land cultivation according to soil conditions.
In this paper we are able to send data on cloud by using MQTT protocol as raspberry pi acts as a gateway, which would get data from sensor node. Also we will able to add Transport Layer Security through MQTT protocol.
In advancement, we can able to add more security as video surveillance on farm and we will able to provide ideal climate & water to the crop or fruits trees by analyzing pervious stored data on cloud as per the respective crops and fruit trees.

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