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Design and Implementation of a Wireless Sensor Network on Precision Agriculture

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Abstract: The main purpose of the project is to present a complete irrigation solution for the farmer based on wireless sensors network. The challenge is to create an automated agriculture system which can control the parameters such as temperature, soil moisture, relative humidity of an agriculture field and send these parameters in a cloud where farmer can access the field data whenever he wants and take required precaution that favors the crop in order to give a good yield.

In this paper we mainly deal with wireless sensor nodes with low power having less in multihop network communication between the nodes. Each node consists of a TelosB mote and adequate sensors. Soil nodes are used to sense the level of moisture and temperature in soil. The data collected on the field is sent to the base station, from there it is sent over local area network through the TCP/IP protocol.

Index Terms: TinyOS, NesC, TelosB, S1087, SHT11.

1. INTRODUCTION

Now-a-days most of the agriculture lands in India are turn into real estate lands which is because of difficulties they face in farming and the loss to profit ratio is quite high So in this we process the different agriculture technologies which can increase the productivity of the crop. The need of precision agriculture is to match agricultural inputs and work through the localized conditions within a field and to improve the accuracy of their applications with the present technology. Our project model is done in near SRM university agriculture fields. In this project we will calculate the temperature, soil moisture, relative humidity parameters and these parameters are uploaded in cloud.

Many of the farm fields in India are less fertile farm lands so in order to increase the level of fertility and providence of periodic requirements for plants is one of the solution. Lets a example of some crops. But different plants have different needs for example tomato plant need 16 Celsius of temperature for effective growth of crop and lemon need 11 Celsius of temperature [2] in order to generalize the technology and to produce an effective form of wireless technology to meet the needs of crop. There are other problems such as preserving the energy with this technology and communication difficulties are overcome by TelosB mote [1]. which uses low power consumption which gives life up to 6 months with battery for communication we can using the CC2420 module is used whose range is around 60 meters in indoor and 120 meters in outdoor. Project is based on outdoor we can produce effective results when compared to other low power technology and we are using a standalone system to produce the results.

Mainly in this paper we are not using any wired components in our model we mainly focus on the mote to mote communication. In this project we use the TinyOS[4] application and NesC[5] programming language which occupy the less amount of RAM in mote which reduce the overload and mainly concentrate on radio channel communication through which we can maintain power consumption many of the projects use motes which produce the power around 5 mA in Active mode in mica *z* mote and other cross bow motes. In our project we used the TelosB [1] mote which produce a power of around 1.8 mA in Active mode and 5.1 µA in Sleep mode and we are using the mesh topology which consumes less power compared to star topology.

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2. REQUIREMENTS OF SYSTEM

In this paper we mainly deal with software for programming and hardware part to implement the idea of the project where agriculture solutions are made easy.

3. SOFTWARE REQUIREMENTS

Thepreferred Operating system that we use in this application is Ubuntu 12.0.4. which supports TinyOS application using NesC coding.

TinyOS is an open source, BSD-licensed operating system designed for low-power wireless sensor networks. The different application areas involved: sensor networks, ubiquitous computing, body area networks (BAN), smart buildings and smart meters.

We use Eclipse keplar ide [6] to provide the environment that is required for TinyOS to process the code and gives a user friendly in finding functions and make easier to find the errors in the program.

Programming TinyOS can be challenging because it requires using a new language, NesC. On one hand, NesC appears similar to C. Implementing a new system or protocol doesn't involve climbing asteep learning curve. Instead, the problem begins when trying to incorporate new codes with existing ones. The place where NesC differs from C is in linking model. The complexity isn't inwriting software components, but through combining a set of components and turn them into a working application.

4. HARDWARE SPECIFICATIONS

As our project deals with Precision agriculture we required sensing network and communication network we use TelosB mote and other sensor parameters [3] that are required are soil moisture sensor and soil sensor.

A. *TelosB:* We used a TelosB mote, which is an ultra-low power wireless module for application monitoring, environment-friendly product and rapid application development. It constitutes MSP430F1611 microcontroller features 10 kB of random access memory, with 48 kB of flash memory and 128 Bytes of information storage. It uses single pair of AA batteries Wireless communication is produced by the Chipcon CC2420 radio module [1]. This circuit combines low power and efficient operation which stand as a support for IEEE 802.15.4. It operates in 2.4 GHz. It also has an integrated onboard antenna with 50 meters range indoor and 125 meters range at outdoor. The TelosB works properly within −40 to 123.8°C which is suitable for extreme weather conditions. In which TelosB mote will be connected to the farmer's computer. It will collect data from other nodes plugged in the field.

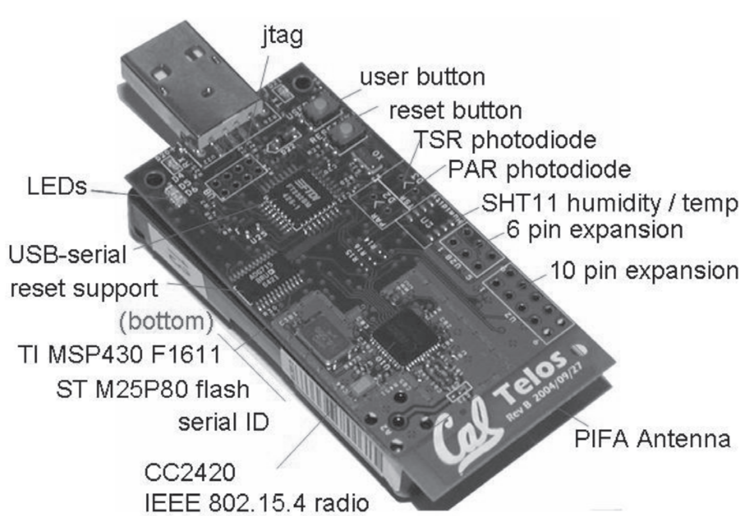

Figure 1: Peripherals of TelosB mote

- It contains two Onboard sensors which can detect light density, humidity and temperature of the surroundings.

B. *Temperature monitoring:* Sensirion SHT11 Sensor Module [7] When it comes to precision temperature and temperature measurement, Sensirion has simplified the process of their SHT1x sensor series. Through which a two-wire serial interface, both temperature and humidity which can be read with excellent response in time and accuracy. Parallax system has simplified the use of the SHT11 by mounting it in a user-friendly 8-pin DIP module. The module involves a data-line pull-up with a series limiter making it possible to connect directly to the BASIC or Javelin Stamp. The input voltage required for this is Input Voltage = 2.5 – 3.5 Volts which is given by the batteries the Equation 1coverts the raw data of sensor to the degrees centigrade in this equation X = required temperature and T = raw temperature value of the environment that we test.

$$X = -39.6 + 0.01 * T \quad (1)$$

C. *Light monitoring:* We use on-board S1087[8] is a ceramic package photodiode that gives low dark current. Ceramic package used is light-impervious, so no stray light can reach through the photosensitive area either from the side or backside.in the following Equation 2, A = light intensity, and Z = raw data that sense from sensor.

$$A = 2.5 * (Z/4096.0) * 6250.0 \quad (2)$$

5. IMPLEMENTATION AND RESULTS

The sensing of required temperature and light is performed using the TinyOS software where we can program it and produce the required output of the sensor with a serial communicator software we have to calibrate the sensor so that we can get the required out put that we want as well as we need to check through the graph where we align points in an orderly manner. Thus how we can produce the light and temperature values in Celsius and lux as their base values.

A. *Sensing temperature:* Here we connected all TelosB motes in a adhoc network where all the nodes communicate with each other and produce result of an areas temperature and light which are present in Equation 1 using this we convert the raw data into the required temperature centigrade. The range of input temperature must be around 2.5 Volts to 3.5 Volts.

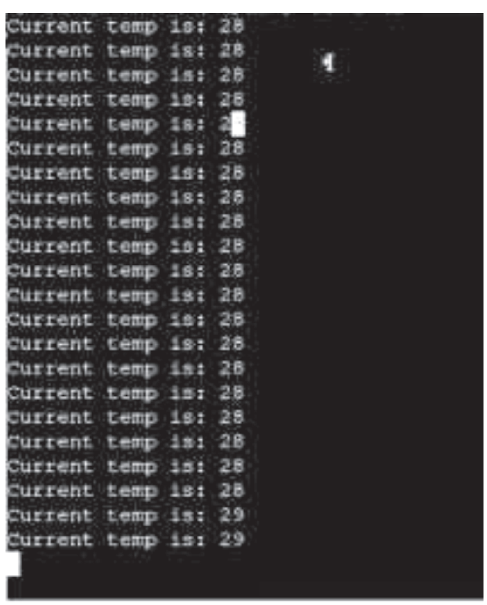

Figure 2: Sensing temperature values from field

B. *Sensing light intensity:* We use TelosB mote for sensing of light and use the Equation 1 to get the intensity of light from the raw data that was produced by the mote. Which is Displayed in Farmer's computer.

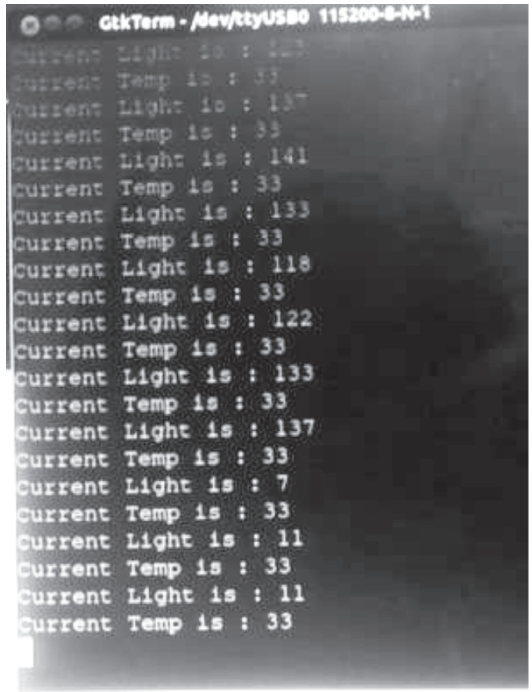

Figure 2: Sensing temperature and luminosity values from field

C. *Block Diagram:* Thus the sensed data of all motes are send to the cloud server using Thingspeak[9] web server where all that can be seen in your mobile phone by login into your account with free access through which we can adjust the water level that are suitable for the cropwe can process the conditions as per our requirements. By using this technology, the farmer can see the sensor data reading any ware he can in his laptop or as well as outside the field with this there is no need of continuous monitoring of the crop is required and can detect the changes easily with necessary requirements.

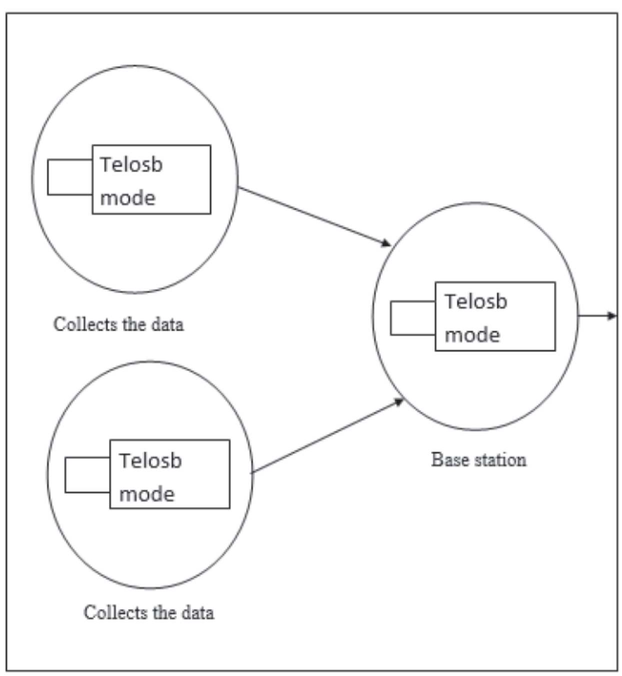

Figure 3: Wireless Sensor Network that collect the data in field

In the Figure 3 completely shows the implementation of TelosB mote in field where we get the sensing data via TelosB mote and that collected data is transmitted via CC2420 radio to the base station where we get the particular areas temperature into the base station using this data we can know the condition of the field in a particular area and we can take necessary precaution for the growth of crop. By using this data, we can control the environmental condition such as humidity, temperature and luminosity by using the green house technics [10]. We can also use this data for feedback purpose to improve the condition until the required conditions are met by the crop. In future we can also add soil sensor and PH sensor where we can access overall development of the crop and give a productive harvesting in a stipulated time and in a confined area [11] with high rate of efficiency. This wireless network is connected to the further process as shown in Figure 4 where we can access the sensor reading from anywhere we want using the following process.

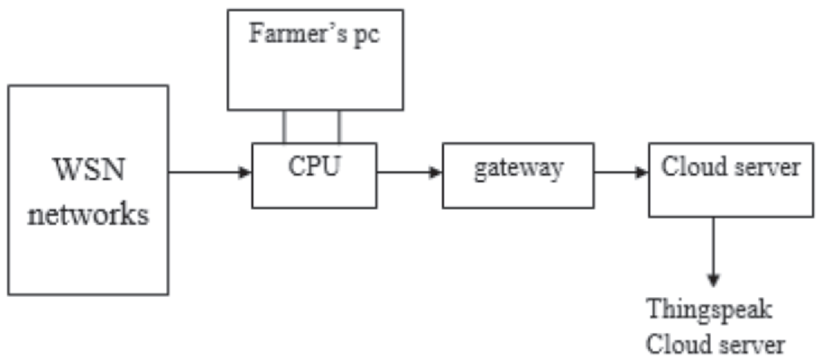

Figure 4: Uploading collected data to Thingspeak Server

As we can see the wireless sensor network that is described in Figure 3 is connected to the farmer's pc [3] through which we can see the processed data in the sensors is displayed over here and this data is send via the gateway through the internet using a server we will connect to cloud. From cloud we will connect it to the Thingspeak [9] server where it process the data and upload it and we can see the sensing by just simply using IP address where we get the login id in that registered IP address that registered equipment may be phone or laptop from which by simply connecting to internet we can see the required data of the crop from anywhere we want.

6. CONCLUSION AND FUTURE WORK

The aim of the project to find a complete agriculture solution based on a WSN has been designed with the appropriate technology and components that satisfy many engineering design constraints such as economic with energy efficient. In this project, we presented the smart solutions for architecture and the implementation of an automated agriculture system based on WSN. Remotely monitored embedded systems for agriculture purposes have become a new necessity for farmers is to save energy, time and money. This system is divided into three nodes; each node is composed from the TelosB mote and adequate sensors. The soil node will be used to sense soil moisture and soil temperature, such as the air temperature, the air humidity, the data from each node are being transmitted to the base station where it will be recorded daily and sent to the farmer's PC just in time to allow him to take the proper action. The application is very simple to use even if the farmer does not have any need of having knowledge about WSN.

Future developments of this project deals with the monitoring and controlling and send the required data through the internet, we plan to use solar panels along with rechargeable batteries in order to make the system with a self-sustainable in terms of energy consumption. Moreover, instead of sending data to farmer's PC, the system of the control will be possible with usage of smart phones, so the system will be more flexible and efficient.

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