SOLAR POWERED WEATHER STATION AND RAIN DETECTOR

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Abstract

In this paper we have proposed a model which acts as a weather station and a rain detector and is solely solar powered. The model is designed in such a way that it can be used remotely and the readings are displayed on a user friendly LCD display and are displayed as digital numeric values. The weather station includes a remote station for monitoring the weather powered by a solar panel, and a base station to display data. The remote station includes sensors to measure temperature, relative humidity, rain and solar radiation level. The goal in system design is optimizing cost and power.

1. Introduction

With the rapid decrease in the natural resources we are returning to renewable sources of energy for sustenance. Taking this as the motivation for the project we used solar power for powering the proposed model. Features of our system are Low power, Microcontroller based remote monitoring unit which is solar powered, monitors site-specific data such as temperature, humidity, amount of rainfall and solar radiation level.

1.1 Technical Background

The proposed model makes use of the clean and renewable source of energy such as the solar energy as was used in the model proposed by Iem Heng [1] using solar energy to detect lethal and toxic gases in subways and underground tunnels. Here we have used the solar workstation as remote weather monitoring station, monitoring temperature, humidity, solar radiation level and also to detect the amount of rain in that area. The concept for rain detection was used in the model proposed by Jing Xu [2] in which the solar energy is not only used as a source of energy but it also used a solar tracking algorithm to detect rain for the prevention of forest fire and to detect weather condition. However, our model uses the solar energy only as source of energy to activate our remote unit which is restricted to assessing some environmental parameter as compared to former's model's applications. In Benghanem's [3] paper, the development of wireless data acquisition system (WDAS) for weather station monitoring is described. It is based on the Emitter/Receiver architecture and it does not require the physical connection of the monitored systems to the data collection server. Weather prediction facility through PC-based system [4] which monitors site-specific ground data augmented with satellite images were designed and reported.

1.2 Organization of the paper

In Section 2 of the paper we discuss about detailed explanation of each block diagram and the various initial conditions that were taken into consideration. The section 3 of the report we give a detailed description of the hardware and the software used in the project along with algorithms demarcating each step. The section 4 embarks upon the result obtained from the project. The section 5 sheds light on the goals achieved after the completion of the project.

2. Proposed Solution

The main intention of the proposed model was to make a weather station which is powered by renewable sources of energy. Hence we built a solar powered weather station which can capture the various environmental factors and send the reading back to the LCD for monitoring.

The basic block diagram for the proposed system consists of a Transmitter and a Receiver blocks that are connected wirelessly through an air interface hence reducing any further costs for wired connections.

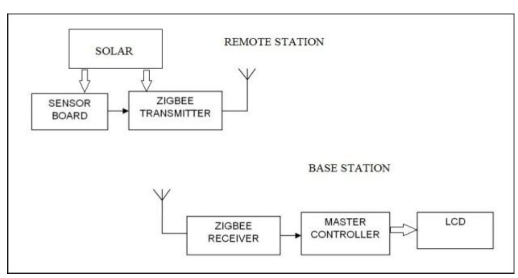

Figure 1 – System level block diagram

Figure 1 shows the system level block diagram of the proposed design.

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In the remote station side there is a solar panel which energizes the sensor board consisting of the sensors and the wireless transmitter module (ZigBee based).

In the base station the wireless receiver module (ZigBee based) receive the transmitted data and sends to the low power microcontroller (MSP 430) which drives the LCD display unit.

The ZigBee module is mainly responsible for the wireless transmission of the signal to the receiver.

3. Implementation

3.1 Hardware Implementation

The hardware basically consists oftwo main blocks as described in the previous section. The remote monitoring station (Figure 2) consists of solar panel, the sensor board, the microcontroller and the ZigBee modules for the sheer purpose of transmission of the acquired data in the proper format.

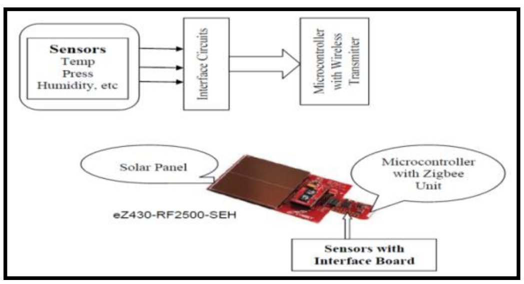

Figure 2 - Remote monitoring unit (Transmitter block)

The sensor board consists of three sensors namely LDR which is actually used for detecting solar radiation level, humidity sensor, temperature sensor and a small circuit designed for rain level detection.The rain detection is done with the help of four rain detectors which are placed inside a graduated container with each level demarcating 20ml at each of the four levels. When the water reaches the different levels in the module it short circuits the sensors and the level is detected. The temperature sensor measures the outside temperature and the result is sent to the receiver. The humidity sensor which is also fitted on the board along with the other sensors help in measuring the relative humidity.The sensor board and the Microcontroller with the ZigBee unit is energized with the help of the solar panel. The sensor board is connected to the microcontroller where the acquired data is processed so that it can be transmitted wirelessly through ZigBee module.

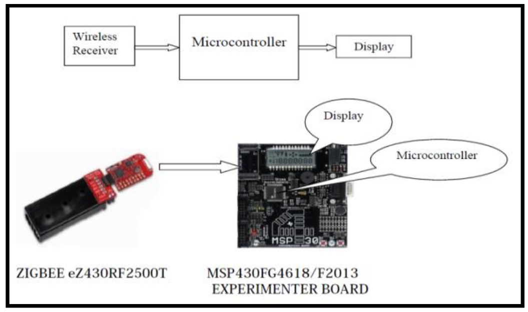

Figure 3 – Base station (Receiver block)

In the receiver block (Figure 3) the base station the main component is the MSP430 experimenter's board with the LCD display. This unit is battery powered. Microcontroller unit with ZigBee module is connected to receive the transmitted data.

The access point (Base station) and End point (remote monitoring station) are coded to do their specified functions whose algorithm is listed in the next section.

3.2 Software Implementation

The coding is done with the help of Code Composer Studio v 5.3.0.00090 IDE. The coding is done for MSP430F2274 uC (present inside the eZ430 - 2500 target board) and for the MSP430FG4618 uC(present inside the experimenter`s board). EZ430- 2500 Target boards are used for both transmission and reception through the ZigBee module. The end point (EP) target board will gather the information such as temperature, humidity and LDR output through inbuilt ADC and using GPIO port 4 board will gather the rain water levels. These values are sent at regular intervals by the CC-2500 module present inside it. The receiver target board is programmed to receive values and these values are given out through the UART (UCA0TXD) out pin which is fed directly to the UART input of the experimenter board. The experimenter board MSP430FG4618 is programmed to get these UART values through UCA0RX UART interrupt. The valuesare updated at regular intervals using the timer interrupt, on the inbuilt board LCD.

We are using TI's Code Composer studio software for the access point coding and IAR embedded workbench for end device coding.

End point Coding:-

- ❖ Firstly initialize the board support package.
- ❖ Then initialize communication port.
- ❖ After waiting for a certain time interval, read the sensor output values from ADC.
- ❖ Acquire the network ID.
- ❖ Send the results through CC-2500.

Access Point Coding:-

- ❖ Firstly initialize the board support package.
- ❖ Then initialize communication port.
- ❖ Initialize network.
- ❖ If a node is present, then the values are to be read on to array.
- ❖ The sensor values are then displayed on the LCD.

4. Result

The designed weather monitoring unit is kept at a remote location for obtaining the various environmental factors including solar intensity, humidity and rain detection. The solar panel is kept at an exposed area. The solar panel energises the sensor unit and the transmitter moduleZIGBEE eZ430RF2500T (figure 4).

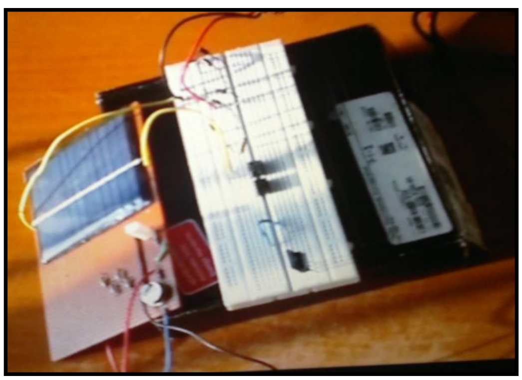

Figure 4 - Transmitter side with our solar panel and the sensor board

Then the data acquired is transmitted in the required format. The values from the transmitter module are transmitted wirelessly to the receiver module (figure 5) ZIGBEEeZ430RF2500T which is connected to the MSP430FG4618/F2013 EXPERIMENTER BOARD.

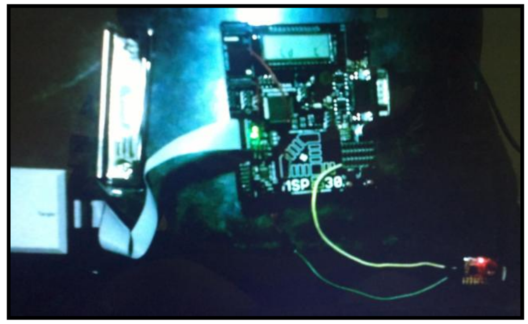

Figure 5 - Receiver side with the ZigBee module and the MSP430 experimenter board

The experimenter board has an LCD screen where the temperature, humidity and solar intensity values are displayed. Ambient temperature is measured and display was calibrated in ^{0}C as shown in figure 6.

Figure 6 – LCD displaying showing the temperature in ^{0} C

Relative humidity level was displayed in percentage as shown in figure 7.

Figure 7 – LCD display showing humidity

Solar intensity level was classified into Low (L), Medium (M) and High (H) as shown in figure 8.

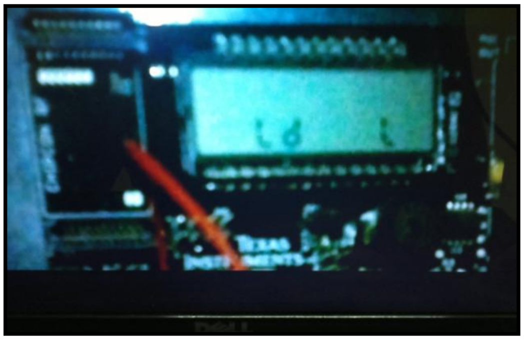

Figure 8 – LCD display showing solar intensity as low

The rain detector gets short circuited when rain falls on the detector present with the other sensors. The amount of rain is then measured seeing the calibrations at different levels at the storage container. The amount of rain water increases, the current increases. To simulate the rain falling we poured water into the detector unit and observed the change in the received and displayed data. The rain level was displayed as number of gradations the water level has reached.

5. Conclusion:

The proposed model was successfully built and tested. The remote station powered by solar cell acquired the sensor data and transmitted successfully. The base receiver station received the data and displayed it one by one as the LCD display had just 160 segments. Wind direction and speed could also be incorporated. Further improvement can be done by incorporating solar tracking unit, as well as some energy storage unit for backing up during cloudy weather. But the trade-off will be the increase in the unit cost. With further intelligence imparted to the system we can even predict the weather using the site-specific ground data acquired.

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