A Soil CO2 Sensing Wireless Sensor Network Using eZ430-RF2500

Introduction

Carbon dioxide (CO_2) is one of the major greenhouse gases. The increase in atmospheric CO_2 concentration in recent times is attributed to the increase in soil respiration. We design a wireless sensor network (WSN), to measure soil, atmospheric and zero CO_2 concentration, using the eZ430-RF2500 development tool by Texas Instruments to analyse the contribution of soil respiration [1].

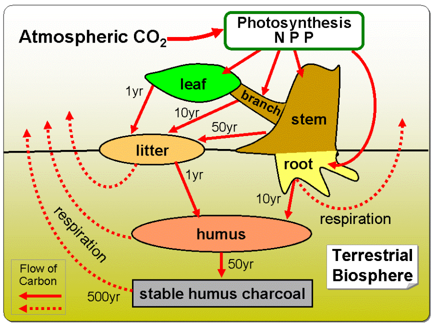

Figure 1: Environmental Carbon flow (http://www.mri-jma.go.jp/Project/1-21/1-21-1/carbon_land_e.gif).

A Wireless Sensor Network

The eZ430-RF2500 is a battery operated module which has a MSP430F2274 microcontroller interfaced with a CC2500 2.4 GHz wireless transceiver (TxRx). As shown in Fig. 2 we form a star network by implementing TI's SimpliciTI protocol with end devices (ED, realizing the sensor functionality) and a access point (AP, doing data collection). The network size is limited by the memory available on the host microcontroller. The network can also be extended further to implement a tree topology as shown in Fig. 2 [2]. Data is then transmitted from ED to AP and sent on to the computer through AP using its UART peripheral.

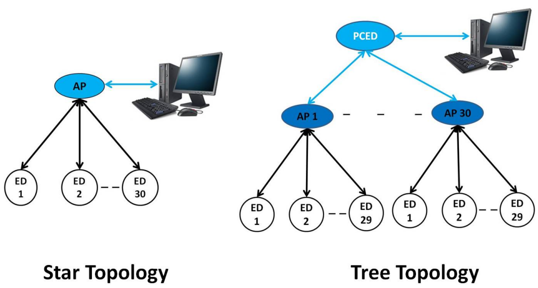

Figure 2: SimpliciTI supported topologies.

Experimental Procedure and Results

The WSN node is shown in Fig. 3. The box with CO_2 sensor is buried under soil and collects data periodically. It sends the data to the microcontroller (ED) using the UART based Modbus protocol.

For each measurement cycle, we begin with the soil CO_2 concentration. Thereafter the pump is turned ON which evacuates the sensor box and pumps in the atmospheric air. The next reading gives the atmospheric CO_2 concentration. Thereafter we turn on both the pump and the valve which pumps out the atmospheric air from the sensor box and also brings the box in contact with a CO_2 absorber. The final measurement gives the zero CO_2 concentration which is used for calibration.

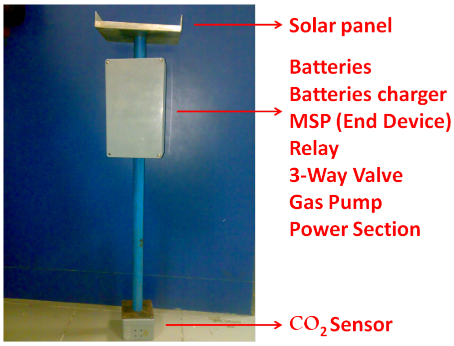

Figure 3: A CO_2 sensing WSN node.

Data was collected from 28.03.12 (day 88) to 08.04.12 (day 98) using CO_2 sensors from SenseAir, Sweden. The scatter plot for soil CO_2 and atmospheric CO_2 concentration at different instances in a day are shown in Fig. 4. The soil and thus the atmospheric CO_2 concentration increases with temperature as is indicated by the spikes at 10 am, 1 pm and 4 pm.

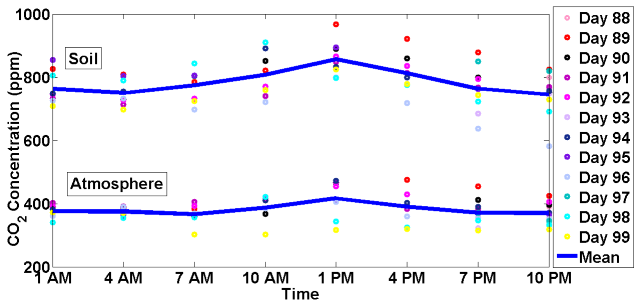

Figure 4: CO_2 variation with time.

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References

[1] B. Bond-Lamberty, A. Thomson, "Temperature-associated increases in the global soil respiration record", Nature Lett., **464**, pp. 579-582, 2010.

[2] V. P. Singh, N. Chandrachoodan, A. Prabhakar, "A Time Synchronized Wireless Sensor Tree Network using SimpliciTI", Intl. J. Comp. Comm. Engg. **2**, pp. 571-575, 2013.

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