Wireless Indoor Farm Monitoring System Using PSoC1

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***Abstract*—As the growing population continues to grow and urbanize, farmers are opening up indoor facilities to full-fill food supply. Indoor agriculture isn't only urban farming but also it plays the key feature in newly developed urban farming. In this research paper we focus on monitoring the Temperature of soil and air, Humidity of indoor farm, Light intensity and Moisture level in Soil. These parameters play very important role in the growth of the crops. This prototype module provides information to the farmer through wireless Bluetooth module on their Personal Laptop. The PSoC1 microcontroller device process on the data and send result to the Bluetooth module (HC-05). This module sends information wirelessly on the Laptop.**

***IndexTerms*—Agriculture,Indoor Farming, Monitoring System,PSoC1, Wireless System.**

I. INTRODUCTION

Indoor Farming is one of the fastest growing industries in the United States as well as all over the world. The world's population continues to increases, so it is important tobuild secure and consistent food supplies. The amount of available arable land space and water for conventional agriculture support new labour. While traditional agriculture system is tied to areas with sufficient land and water, indoor farming is coupled from such needs and can be located closer to the point of end consumption [9].

In this paper we have deployed a system for thosefamers who want to do indoor farming. This system is useful for those farmers to monitor soil temperature, soil moisture, air temperature, light intensity and humidity.

Now a days Real time embedded application require, not only higher performance but also more flexibility as well as without increasing cost and resources. Here, for air and soil temperature measurement temperature sensor LM35 is used, for soil moisture measurement moisture sensor is used, for light intensity measurement LDR is used and for humidity measurement HIH4031 humidity sensor module is used. A GUI is also designed to make the system user friendly using processing software which provides all the required information selected to the farm in the form of graph and numerical value which helps the user to take decision as per obtained information.

PSoC1microcontroller is actual heart of this system which is designed by the Cypress Semiconductor. PSoC1is an 8–bit microcontroller which can process with analog peripheral and digital peripheral. Traditional MCU- based system component is replaced by PSoC1 (CY8C28433).

II. PROPOSED METHODOLOGY

Transmitter is located at indoor farm for transmission of soil temperature, air temperature, humidity measurement, soil moisture measurement and light intensity measurement. Analog output of LM35, LDR, HIH4031, moisture sensor are interfaced with PSoC1 CY8C28433 and converted to digital using incremental ADC(Analog Digital Converter) ADCINCVR with the programmable system on chip controller PSoC1 CY8C28433 and transmitted via Bluetooth HC-05 using the specific frame.

Receiver is located on the farm or inside the room where indoor farming takes place. Receiver receives the frames and decodes the value of temperature, humidity, light and moisture value and displays it on GUI developed in processing software. In this GUI data is display graphically in the form of percentage.

Block Diagram

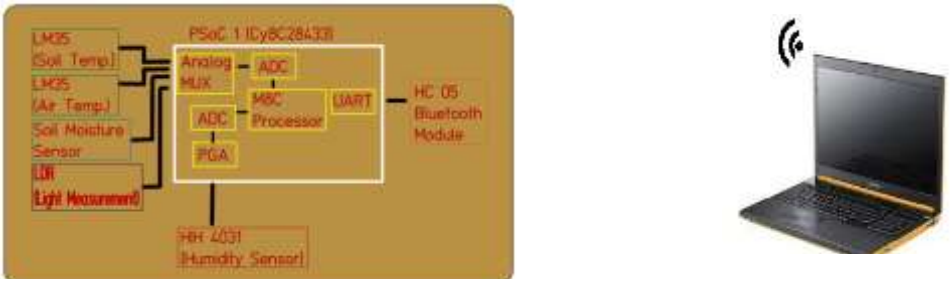

Figure 1 Internal Block Diagram of System

III. HARDWARE IMPLEMENTATION OF PROPOSED SYSTEM

PSOC1 Microcontroller (CY8C28433 Development Board)

The PSoC family consists of many mixed-signal arrays with on-chip controller devices. PSoC stands for Programmable System on Chip. PSoC device includes configurable blocks of analog circuits and digital logic, as well as programmable interconnect. This architecture allows the user to create customized peripheral configurations, to match the requirements of each individual application. Additionally, a fast CPU, Flash program memory, SRAM data memory, and configurable input/ output (IO) are included in a range of pin-outs [1].

These configurable blocks can be programmed as peripherals to perform a wide variety of functions, and then they can be interconnected to perform a specific task. Between these functions there are PGA's, ADC's, DAC's, filters,timers, counters or UART communication.

Figure 2 Development Board of PSoC1 (CY8C28433)

LM35 Temperature Sensor

The LM35 is precision integrated-circuit temperature devices with an output voltage linearly- proportional to the Centigrade temperature. Itsoutput impedance is low and output is linear. The precise inherent calibration of LM35 device makes interfacing to readout or control circuitry especially easy. It is rated for a −40°C to 150°C range [3].

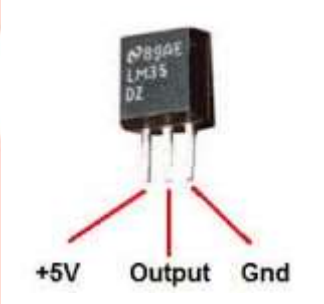

Figure 3 LM35 Sensor

In this system LM35 is used for measurement of air temperature and soil temperature. The output is fed to the analog 4 bit MUX and when the proper channel is selected then the analog value is provided to the 10 bit ADCINCVR and this analog value is converted in the digital value.

Moisture Sensor

This sensor is used to measure the moisture of soil in the percentage range. When the soil is having water shortage, the module output is at high level else the output is at low level. It provides output digitally as well as in the form of analog. By using this sensor, one can automatically water the flower plant, or any other plants [4].

Analog output is more accurate. So that we use analog value for the input of analog MUX and further this value is converted in the digital value and then converted into percentage.

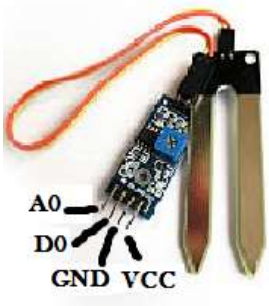

Figure 4 Moisture Sensor

Light Sensor

Typical LDR (Light dependent resistor) is made up of cadmium sulfide (CdS). It is a sensor whose resistance is inversely proportional to the light falling on it. It is known by many names including the photo resistor, photoconductor, photoconductive cell, or simply the photocell.

This sensor effectively measures the amount of light falling on a given unit of area.The SI unit of luminous is lux. A simple way to display a lux meter is to say that it measure the brightness of light falling on the sensor.

The figure 5 given below shows the typical LDR [5].

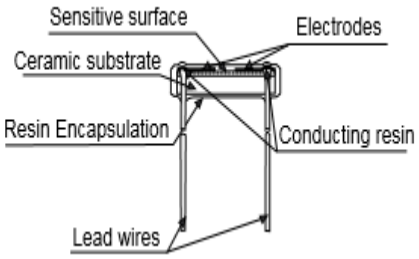

Figure 5 LDR (Light Dependent Resistor)

This sensor is used in the voltage divider format to find the amount of light. The voltage divider converts light in the form of voltage. This voltage is provide to another channel of analog MUX and further converted into LUX or luminous value and displayed on the GUI.

The figure given below shows the wavelength vs. relative sensitivity of LDR.

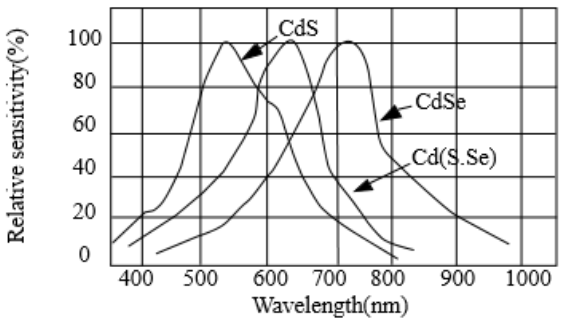

Figure6 Spectral sensitivity characteristic

HIH4031 humidity sensor

Honeywell has expanded HIH Series to include an SMD (Surface Mount Device) product HIH 4031. SMD packaging on tape and reel allows the use of high volume, automated pick and place manufacturing, eliminating lead misalignment to printed circuit board through a hole.

The sensing element's multilayer construction provides excellent resistance to most application hazards such as condensation, dust, dirt, oils and common environmental chemicals [6].

It is analog sensor which generates the output voltage proportional to the relative humidity. This output value is fed to the inputof PSoC device which further converts it in the relative humidity. The ideal graph given below shows the output voltage vs. relative humidity at 25°C and 5V.

Figure 7 HIH4031 Sensor Module

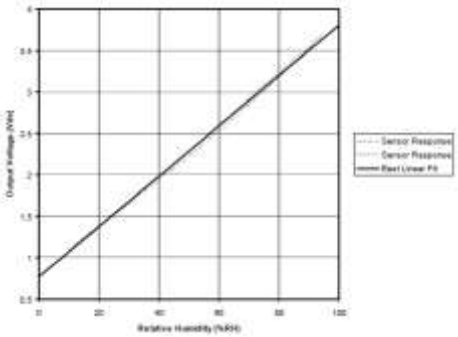

Figure 8 Characteristic of Humidity Sensor

HC-05 Bluetooth module

HC-05 module is an easy to use Bluetooth module, designed for transfer wireless SPP (Serial Port Protocol) serial connection. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation.The working frequency is 2.4GHz radio transceiver and baseband [7].

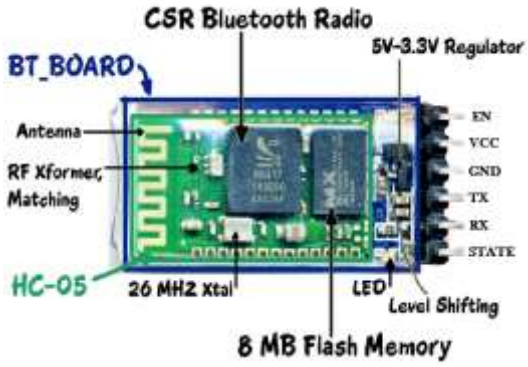

Figure 9 HC-05 Bluetooth Module

IV. SOFTWARE IMPLEMENTATION OF PROPOSED SYSTEM

PSoC Designer 5.0

PSoC Designer 5.0 is the revolutionary Integrated Design Environment (IDE) that can be used to customize PSoC for specific application requirements. IDE using a library of pre-characterized analog and digital peripherals in a drag-and-drop design environment. After that, it customizes our design dynamically generated API libraries of code. Finally, debug and test our designs with the integrated debug environment including in-circuit emulation and standard software debug features [11].

PSoC Designer Application Flow

Step 1: Create a new project in PSoC Designer 5.0
Step 2: Choose a base device CY8C28433 for work.
Step 3: Choose and configure user modules that used in the system.

Configure Global resource-

Global resources are those that are shared by all user modules in a particular configuration. All the proper configuration of the project is given in the Global resources properties shown in the figure 10

Figure 10 Global Resources

User modules-

There are number of User modules available in the PSoC device CY8C28433. The configured resources of our system are shown in figure11

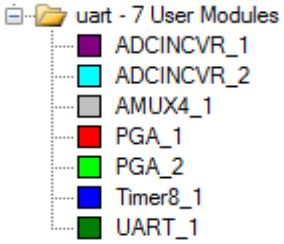

Figure 11 User Module

Integrating ADC (ADCINCVR_1 and ADCINVR_2):

The ADCINCVR is an integrating ADC with an adjustable resolution between 7 to 13 bits. In this system ADCINCVR_1 configure in 10-bit resolution and ADCINCVR_2 configure in 12-bit resolution. Sample rates from 4 to 10,000 sps are achievable depending on the selection of the resolution, DataClock, and CalcTime parameters.

4 to 1 Analog Multiplexer (AMUX4_1):

The AMux4 User Module provides a four input analog signal multiplexer to a Continuous Time (CT) block that can be controlled programmatically by way of an API. One of the four input signals may be selected as the input of the amplifier in the CT block. AMux4 module is used for selecting the proper sensor used in developed system with help of program.

Programmable Gain Amplifier (PGA_1 and PGA_2):

All PSoC Devices have thirty-three user-programmable gain settings with a maximum gain of 48.0. The PGA User Module implements an operational amplifier based non-inverting amplifier with user-programmable gain. In this project PGA_1 and PGA_2 are configure as a buffer for the input of soil temperature, soil moisture, air temperature, light and humidity.

Timer (Timer8_1):

The 8, 16, 24, and 32-bit Timer of User Module provides down counting with programmable period and capture ability. The clock and enabled signals can be selected from any system time base or external source. Once started, the timer operates continuously and reloads its internal value from the period register upon reaching terminal count.

In this project 8-Bit Timer is used to generate clock frequency for baud rate to UART serial communication module.

Universal Asynchronous Receiver Transmitter (UART_1):

The UART User Module is an 8-bit Universal Asynchronous Receiver Transmitter that supports duplex RS-232-compliant, data format serial communications over two wires. Received and transmitted data format includes a start bit, optional parity, and a stop bit. Programmable clocking and selectable interrupt or polling style operation is supported.

Step 4: Connect the user modules to each other, as appropriate, and to the proper pins.

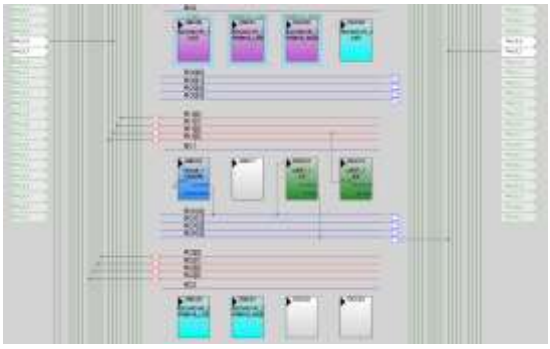

Figure 12 Digital I/O routing

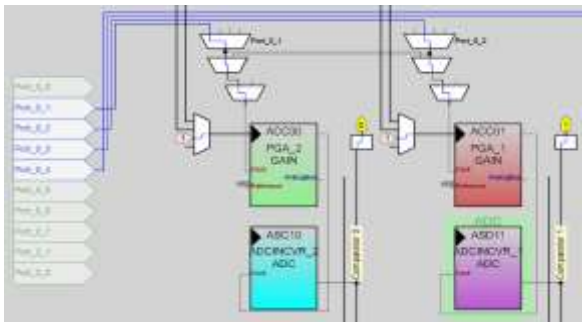

Figure 13 Analog Input configuration

Step 5: Write firmware for project in C or assembly language.

Step 6: Program the PSoC device CY8C28433 and test the program.

Processing 3.2.4

Processing is a flexible software sketchbook and a language for learning how to code within context of the visual arts. It is open source interactive programming language with 2D and 3D integration for GNU/Linux, Mac OS, Windows, Android and ARM [10]. In this software we designed our GUI for indoor monitoring system which is successfully interfaced with PSoC1 (CY8C28433) microcontroller and data is represented in the form of information and graph.

In the beginning software is configured with Bluetooth module. The processing GUI will provide the information of the com ports available on the laptop after execution of software program run. Selects proper com port where Bluetooth module is connected on the laptop.

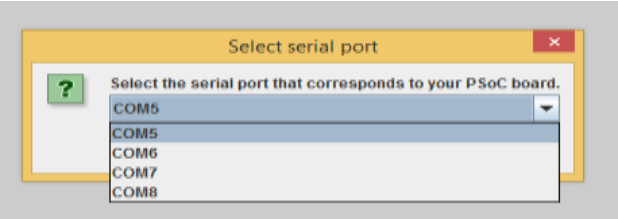

Figure 14 Serial Communication Selection

V. RESULT

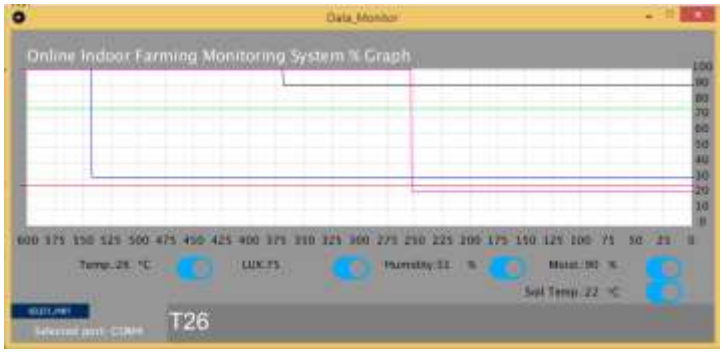

Figure 15 GUI of User

The main application of this system is to monitor indoor farm. It is also implemented in the green house where the continuous monitoring is required. This system can be used by the research student in the field of agriculture for their crop monitoring system where they study the growth of crops.

VI. CONCLUSION

This module is successfully run using PSoC1 Device. This would be boon to Indian farmers who have to depend on weather, soil erosion and rain for their crop yield. The population boom in India would benefit immensely as quality food could be provided.

VII. ACKNOWLEDGMENT

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