Abstract—Wireless sensor network (WSN) has a wide range of applications. WSN plays major role ad gains attention in recent years. Using WSNs it is able to monitor the environment where the human reach is not possible. WSNs are also gaining importance in agriculture area by controlling the climatic conditions of plant growth in green house. The paper explains about the design and implementation of WSNs for greenhouse to measure and control the climatic conditions of the plant growing environment. The developed system measures and controls the climatic parameters (temperature, humidity of air, sun light and soil moisture) and helps to improve the production in green house. Several numbers of sensors and actuators are installed and they are connected in the green house. Using Global System for Mobile communication (GSM) technology the climatic condition measurement information is sent to farmers mobile through Short Message Service (SMS). The system measures the climatic conditions using the sensors and the variations of the climate is controlled and monitored by using actuators. The proposed system is easy to implement and also cost effective.

Key words: Green house, Sensors, Actuators, SMS, Controlling, Monitoring.

I. INTRODUCTION

Most of the world’s population depends on agriculture for living. For the cultivation of crops balance of climatic conditions of environment also place an important role. The outmoded land tenure system, the lack of an infrastructure for rising productivity and variations in the climatic conditions leads to loss of agricultural productivity. The most important factors for the plant growth are temperature, humidity, light and the level of the carbon dioxide (4). Continuous controlling and monitoring of these climatic conditions it is able to improve the quality and productivity of the plants. Using green house technology and WSNs the climatic conditions are made balanced for agriculture. The proposed system measures the environment variable and makes climatic adjustments of green house and sends information to the farmer mobile through SMS using GSM technology. The system can enable us to improve quality and productivity of plants and to achieve remarkable energy savings and also it is reliable as well as less expensive (2).

In agricultural field human labours are required to monitor the farm and plants. Some plants require 24 hours care and attention from the human labour for the quantity and quality management of the productivity. Due to large farm field and lack of labours the maintenance of the farm is very difficult. This problem leads to fewer yields in the farm. To overcome from this problem cable system was introduced to monitor the green house. The cabled system would make the green house system expensive and vulnerable for the effective measurement of climatic parameters. Hence wireless sensor nodes are used to measure the certain critical points at the green house. The sensor node measures the temperature, humidity, light intensity etc and communicate with the main node. The main node sends information to the agriculturist mobile using GSM technology.

Rapid development in the field of telecommunication and wireless technologies, it is proved that wireless communication has also got more importance in remotely controlling and monitoring of green house. Wireless communication can be used to collect the climatic measurements and to communicate between the centralized control and the actuators located at various points of green house. Compared to cabled system installation of WSNs very easy and fast. The maintenance of WSNs is easy and also less cost effective.

In this system different sensors are used to measure the climatic parameters of green house such as temperature, humidity, l6F877A microcontroller is used as centralized control system. SMS and GSM technology are used to send data from the green house to the farmer’s mobile phone.

II. BLOCK DIAGRAM OF THE SYSTEM

The functional block diagram of the system is shown in Fig 1. The functional block diagram consists of Data acquisition unit to collect the various information from climatic parameters, Control unit for the working of actuators (fan, sprinklers, shutter...), Management unit which contain RS232 interface and microcontroller, and GSM modem which enables remotely controlling and monitoring of the system over the whole coverage of the sensor network used in the green house. The remote functions which are carried by actuators are switching on or off of the fan, opening or closing of the sprinklers and turning on or off of the heating. The system sends SMS to the user to notify any variation detection or confirm the actions of controls.

Fig. 1: Functional Block Diagram of the System

Green house monitoring using wireless sensor networks is a novel approach in automation of the green house. The nodes are placed in several strategic points in the green house for measuring various climatic variations. Nodes containing sensors mounted on them sense the climatic variations and then with the help of control circuitry, transmit the data wirelessly, to a node situated outside the green house. The management node, with the
help of the control circuitry sends the text messages to the agriculturist informing him of the scenario in the green house.

III. WORKING OF REGENERATIVE BRAKING SYSTEM
The green house monitoring system consists of various sensor nodes placed at strategic points of the green house. The sensor node used in the project consists of a battery which is the source of power, temperature sensor (LM 35) for measuring temperature, humidity sensor for measuring humidity, light sensor for measuring luminosity levels and controller PIC16F877A from Microchip for control circuitry. GSM modem to transmit the data to user mobile and LCD to display the temperature, humidity and light intensity. The block diagram in Fig. 2 provides a broad overview of the circuitry used in the wireless sensor node. A detailed description and functioning of hardware is given below.

A. Power Supply
The Power Supply Section is used to provide DC voltages to different sections of circuit. In our project we have designed a power supply to give +5v, 3.3v, +12v and –12v regulated voltages at the output.

B. Temperature Sensor (LM 35)
The temperature is very essential parameter to be monitored as it affects the growth of the plants in the green house to large extent, measuring of temperature and monitor the variations in temperature can be achieved using LM35 temperature sensor.

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature [5]. The LM35’s low output impedance, linear output, and precise inherent calibration make interfacing to control circuitry very easy.

D. Humidity Sensor
Humidity is the presence of water in air. The amount of water vapour in air can affect green house system. Hence humidity sensing is very important. Controlling or monitoring humidity is of paramount importance in industrial and domestic applications (6). Thus humidity sensors are employed to provide an indication of the moisture levels in the environment.

E. Microcontroller
A microcontroller is an entire computer manufactured on a single chip. Microcontrollers are usually dedicated devices embedded within an application. In this project, PIC-16F877A is used as it is the appropriate microcontroller for the given application. PIC is a family of modified Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "Peripheral Interface Controller" [3][7]. Special features of PIC 16F877A are

- 100,000 erase/write cycle Enhanced Flash program memory typical
- 1,000,000 erase/write cycle Data EEPROM memory typical
- Data EEPROM Retention > 40 years
- Self-reprogrammable under software control
- In-Circuit Serial Programming™ (ICSPTM) via two pins
- Single-supply 5V In-Circuit Serial Programming
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving Sleep mode
- Selectable oscillator options
- In-Circuit Debug (ICD) via two pins

The PIC Microcontroller is installed in the control unit. Sensor senses the information and gives the reading in analog signal format. This analog signal can’t be send directly to the GSM modem. But, the PIC Microcontroller consists of in-built 10/8-bit ADC with 10-channel. Using the ADC in 8-bit, ADC will convert the two channel into equivalent reading.

F. LCD Display
When the agriculturist is informed about the conditions in the green house through an SMS, he needs to know the exact values of the parameters which have changed inside the Green house. In order to provide temperature and light intensity levels to the agriculturist, an LCD is used.

The LCD display used in the wireless sensor node consists of two lines, 16 characters per line. The display contains two internal byte-wide registers, one for commands (RS = 0) and second for characters to be displayed (RS = 1).

G. Actuators
An Actuator is a type of motor that is responsible for moving or controlling a mechanism or system. In this project fan, pump, heater are used as actuators. Alarm is used to indicate if any destructions in the system or any malfunctions. These are connected to microcontroller through Darlington amplifier. Darlington amplifier is a compound structure consisting of two bipolar transistors.
connected in such a way that the current amplified by the first transistor is amplified further by the second one.

**H. RS 232 Interface**

Communication defined in the RS-232 standard is an asynchronous serial communication method. The word serial means that the information is sent out bit at a time. Asynchronous tells that the information is not sent in the predefined time slots. Data transfer can start at any given time and it is the task of the receiver to detect when a message starts and ends. The RS-232 standard defines the voltage levels that correspond to logical one and logical zero levels. The most commonly used RS-232 level converter is MAX232 from 5v power supply. It includes two transmitter and two receiver and is capable of full-duplex UART/USART communication.

**I. GSM Modem**

To send the information to user mobile trough text message GSM modem finds the solution. GSM modem acts as a mobile phone which can automatically take actions and send message depending on the conditions by which it is programmed. Fig 3 shows a GSM modem.

![GSM Modem](image1)

**Fig. 3: Gsm Modem**

A GSM modem is a wireless modem that works with a wireless network. A wireless modem acts as a dial-up modem. The major advantage of using GSM modem over dial-up modem is that GSM modem sends and receives data through radio waves where as in dial-up modem these actions are performed through fixed telephone lines. A GSM modem is a special type of modem which accepts SIM card and operates over a subscription to a mobile operator, similar to a GSM mobile phone. It is operated using standard Attention (AT) commands [8]. In addition to standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. An extended AT command provides the following additional facilities.

- Reading, writing and deleting SMS messages
- Sending SMS messages
- Monitoring the signal strength
- Monitoring the charging status and charge level of battery
- Reading, writing and searching phone book entries

GSM modem can communicate over mobile network by interfacing the modem with 8951 microcontroller. The interfacing of modem and microcontroller allows various operations such as send and receives SMS. Thus the GSM modems are most frequently used for sending and receiving SMS as there is no special subscription to an SMS service provider. In this system, GSM modem is used to establish communication between the device and the database. The communication between modem and microcontroller or the modem and the PC is established serially. Since serial data is less prone to errors. Serial communication is established using RS-232 protocol. For further details of AT commands and other applications of GSM refer appendix.

GSM is controlled by the programme which is programmed in the microcontroller. Depending on the conditions of control bits the microcontroller sends commands to GSM to send particular massage through which a common man can understand the information which is to be conveyed.

**IV. SYSTEM FLOW CHARTS**

The system operates according to the flow chart shown below. First the system is initialized with I/O ports, Special Functional Register, timers and counters. Then default directories are stored. Read the analog values of sensor input such as temperature, humidity, and light intensity. The analog value is converted into digital value by ADC. Store the values in SFR and compare with user set value. If the value is grater or less than normal range then the actuator is switched on. Otherwise there will be no changes in the system. The information is send to user mobile by SMS using GSM. Fig 4 shows the functional flow chart for process.

**V. CIRCUIT DIAGRAM**
A. Relay Connection Diagram

VI. CONCLUSION

Green house monitoring using wireless sensor nodes is a novel approach towards greenhouse automation. In the project the conditions in the green house regarding the temperature, humidity and luminosity levels are sent to the agriculturist cell phone in the interval of less than a minute. The exact temperature and luminosity values are displayed in the LCD which is mounted on the wireless sensor node. It is cost effective and much reliable than the cabling method. The nodes can be easily relocated and deployed wherever required without much trouble. This system is more reliable, easy to implement, works effectively and easy to operate. The only maintenance work involved is changing of the battery once in a while.

REFERENCE

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