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ARM7 Based Monitoring and Control System for Environmental Parameters in Greenhouse

P. Lavanya, A. Rajendra Babu

***Abstract*— The Monitoring and control of greenhouse environment play a significant role in greenhouse production and management. To monitor the greenhouse environment parameters effectively, it is necessary to design a control system. Here controlling process takes place effectively by manual manner. All plants and vegetation require certain conditions for their proper growth. Therefore it is necessary to bring the environmental conditions under control in order to make those conditions as close to the ideal as possible. The work is implemented for monitoring and control of greenhouse parameters with the help of sensors and GSM communication. It overcomes the disadvantages of wired and wireless constraints such as complicated wiring, difficult maintenance and distance, to monitor and control the applications. The application will have embedded system which consists of ARM7 microcontroller, sensors, GSM modem and control devices to monitor the environmental parameters condition namely temperature, gas and light intensity. It is simple useful for farmers. Besides, most people use their cell phones to communicate and send messages. Thus, in our system, with a simple message, all farmers can control their greenhouses from a distance. They can know the status of their greenhouse climate and can control the Devices. The experimental results show that the developed monitoring system has the following features, such as simple structure, high reliability and flexible configuration. It will monitor and control the environmental parameters in every greenhouse.**

***Index Terms*—Greenhouse; GSM; ARM7; Temperature; Fire; LDR; Gas; PIR.**

I. INTRODUCTION

A greenhouse is a structure with walls and roof made chiefly of transparent material, such as glass, in which plants requiring regulated climatic conditions grown. These structures range in size from small sheds to industrial-sized buildings. The greenhouse industry is the fastest growing sector worldwide. The growth of crop in greenhouse depends on temperature, gas, light intensity and other parameters in greenhouse. So it is important to real-timely and properly measure and adjust the temperature, gas, light intensity and other parameters in the greenhouse. With the continued expansion of production scale, the disadvantages of traditional wire monitoring system are more and more prominent, such as complicated arrangement, difficult maintenance and so on. Then the monitoring system is developed, which based on wireless communication technology, does not need cables, adds or reduces configuration at random, possess simple system construction. Moreover, it is characterized by its low power consumption. Therefore, it proves to be simple and of practical significance.

Using GSM it is possible to control and monitor systems from a long Distance. The primary aim of this paper is to propose the concept of Development of a Low-Cost GSM SMS Based monitoring and Control system for Greenhouse using the combination of a ARM Controller. Greenhouse environment parameters monitoring system based on wireless communication technology has been developed to control remotely, which realizes the measurement and control of temperature, gas, light intensity and the other parameters.

II. FUNCTIONAL BLOCK DIAGRAM AND DESCRIPTION

The Functional Block diagram of the entire system is as shown in the Figure 1. The project consists of LPC2148 microcontroller, temperature sensor (LM 35), LDR (light dependant resistor), gas sensor, fire sensor and PIR sensor. All these sensors are connected to LPC2148 microcontroller which is main processing unit of the system. The sensors sense different conditions and provide data to microcontroller for processing. GSM modem is connected to controller through serial interface. It also uses a LCD display to display the data obtained from the sensors. System architecture is composed of ARM based system board.

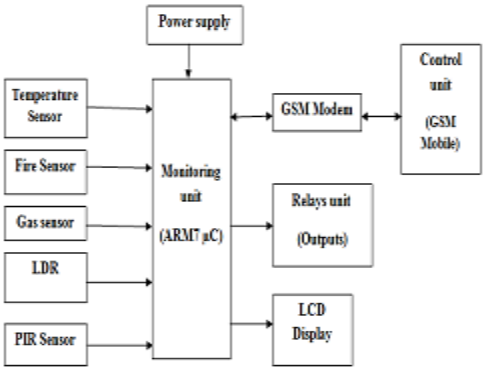

Figure 1. Functional Block Diagram

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***P.Lavanya**, Electronics and Communication Engineering(DECS), Bharath College of Engineering and Technology For Women, Kadapa, India, Phone/ Mobile No7093426678.*

***A.Rajendra babu**, Electronics and Communication Engineering, UBharath College of Engineering and Technology For Women, Kadapa, India.*

Two relays connected to controller and these relays can control by SMS. When sensors gets activated SMS will transmitted to mobile. This system uses regulated 5V 500mA power supply. A 7805 three terminal voltage regulator is used for voltage regulation. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12V step down transformer.

A. ARM 7 LPC2148

The monitoring module will be placed at the greenhouse. This module will consist of a microcontroller which is designed on ARM7 Architecture. The LPC2148 is an ARM7 high-performance 32-bit RISC Microcontroller with Thumb extensions 512KB on-chip Flash ROM with In-System Programming (ISP) and In-Application Programming (IAP) and is chosen because of its low power consumption. It has inbuilt 10 bit ADC, and UART based serial communication and is well suited for application requirement. Level sensitive external interrupt pins make these microcontrollers suitable for control systems. The sensor array will have five sensors namely temperature sensor, fire sensor, gas sensor, LDR sensor and passive infrared sensor. The microcontroller monitors the sensors; these sensors will give an analog output i.e. variable voltage output. To read this information the microcontroller needs to convert this analog signal to digital form. This is done with the help of analog to digital convertor (ADC).

B. Temperature Sensor:

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors, as the user is not required to subtract a large constant voltage from its output to obtain convenient centigrade scaling. If the temperature is high then we will switch on cooler, in this paper we are using fan instead of cooler. Features are as follows.

1. Calibrated directly in ° Celsius (Centigrade)
2. Linear + 10.0 mV/°C scale factor
3. 0.5°C accuracy guaranteable (at +25°C)
4. Rated for full −55° to +150°C range
5. Suitable for remote applications
6. Low cost due to wafer-level trimming
7. Operates from 4 to 30 volts.

C. LDR:

LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1,000,000 ohms, but when they are illuminated with light, the resistance drops dramatically. Thus in this paper, LDR plays an important role in switching on the lights based on the intensity of light i.e., if the intensity of light is more (during daytime) the lights will be turned off using GSM. And if the intensity of light is less (during nights), the lights will be switched on. The output of the LDR is given to ADC which converts the analog intensity value into corresponding digital data and presents this data as the input to the microcontroller.

D. Gas Sensor:

Gas sensor measures the concentration of gas in its vicinity. Gas sensor interacts with a gas to measure its concentration. Each gas has a unique breakdown voltage i.e. the electric field at which it is ionized. Sensor identifies gases by measuring these voltages. The concentration of the gas can be determined by measuring the current discharge in the device. Gas sensors main aim is to sense hazardous gases that evolve its surroundings. It has High sensitivity to LPG, Propane and Hydrogen.

E. Fire Sensor:

The Fire sensor, as the name suggests, is used as a simple and compact device for protection against fire. The module makes use of IR sensor and comparator to detect fire up to a range of 1 - 2 meters depending on fire density. It gives a high output on detecting fire. It has Features to Allows your robot to detect flames from 2m away, Fire indicator led, Calibration preset for range adjustment.

F. PIR Sensor:

The PIR (Passive Infra-Red) Sensor is a pyroelectric device that detects motion by measuring changes in the infrared levels emitted by surrounding objects. This motion can be detected by checking for a high signal on a single I/O pin.

G. LCD Display:

LCD display is used for displaying the continuously monitored values from the sensors. All the sensor outputs will be displayed on the LCD. With user involvement controlling actions were performed by GSM. In this paper we use 16*2 LCD display.

H. GSM:

The user can use GSM mobile phone as a remote control module to monitor the greenhouse and can control the sensor parameters from any place by sending a message to the GSM modem which is at the greenhouse monitoring system. Also the monitoring device can send the environmental conditions to the user. The GSM modem is interfaced to the microcontroller to communicate and it is done with the help of UART (universal asynchronous receiver transmitter) serial communication. A valid SIM card will be inserted into the modem to enable wireless communication. The GSM module functionality is such that the microcontroller enables the GSM module to send the message to the configured mobile and vice versa.

Figure 2. Picture of implemented Green house system.

III. SOFTWARE IMPLEMENTATION

In this project we use keil software. Embedded C is used for the programming because of its highly reliable and fast execution. ARM7 are more appropriate and fast execution in keil using embedded C code language. The architecture of the ARM7 is more suitable and easily accessible for present code sofrware like as Keil. In addition the ARM7 microcontrollers contain wide range of applications and bandwidth requirement and voltage requirements. Keil version is user friendly software tool.

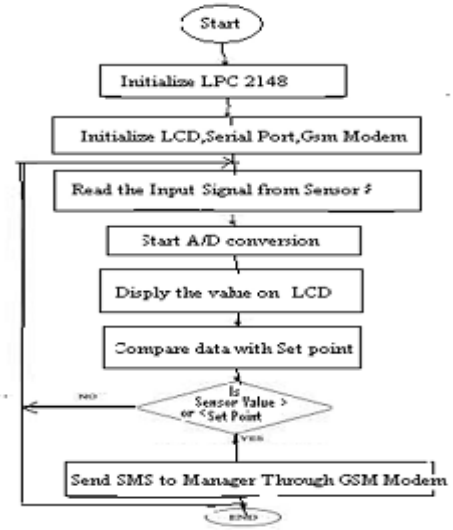

Figure 3. The flowcharts depicting the measurement.

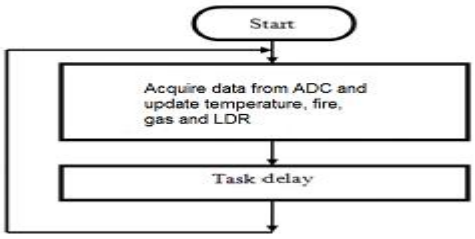

Figure 4. ADC driver dataflow diagram

IV. RESULTS

The architecture is implemented with free RTOS using embedded C and simulated in Keil IDE. In this paper we allow the users to set the conditions appropriate to the crop is growing. This will be done via GSM interface. The more accurate a sensor is, better it will perform. The unit will monitor the conditions of various parameter considerations and take appropriate action.

Figure 5. LCD display of sensor outputs

The sensor outputs are monitored by the monitoring unit and are displayed in the LCD display, which is shown in the Figure 5. If a user get registered with mobile number then the user get information about sensor through GSM modem by SMS. If the temperature is high then we need to ON the cooler fan. For that purpose the user has to type 1 and send to cell number of this system. Then the cooler fan is in on position. To OFF the fan we have to send 2 to the system.

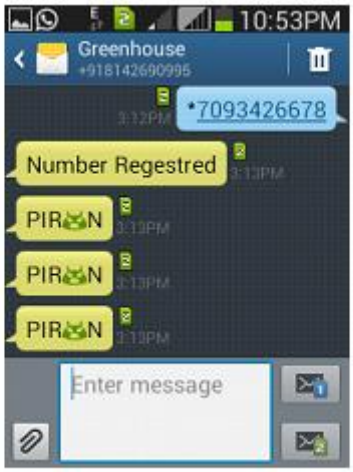

Figure 6. Mobile number registration using GSM

The system has capability to provide the information about sensor outputs. Figure 6 shows the registration of mobile number which is provided by the user. Figure 7-9 shows the sensor outputs.

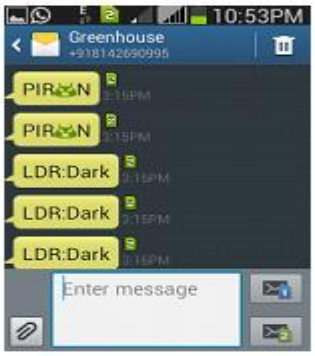

Figure 7. LDR sensor output sent by system to user

When lighting is dark then system sends message that LDR dark to user which is shown in Figure 7. The user has to type 3 and send to cell number of this system. Then light ON, if we want to make lighting off then we need to send 4 to system. Then light OFF condition will occur.

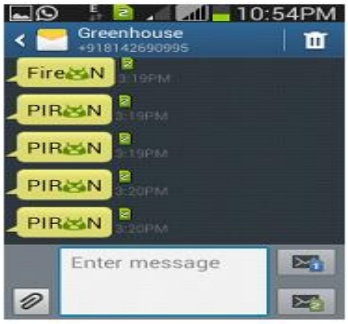

Figure 8. Fire and PIR sensor outputs sent by system to user

Figure 9. Gas sensor output sent by system to user

The occurrences of gas and flame sensed by sensor are sent to user mobile number. The PIR sensor output is sent to user mobile number as PIR ON, which are shown in Figure 8 and Figure 9.

V. CONCLUSION AND FUTURE WORK

The monitoring and control system for environment parameters in greenhouse based on global system for mobile communications technology is developed and initially experimented. The experimental results indicate that the system has some features as follows:

1) It can be used in agriculture vegetable greenhouse to monitor and control the environmental parameters to overcome the disadvantage of traditional measuring and controlling.
2) It can be kept long distance, real time monitoring for parameter of greenhouse and the information can be obtained of greenhouse at any time.
3) It has the advantages of GSM technology , not needing cables, low power consumption, cheap cost, good robustness, flexible extension, convenient installing over the traditional measurement and control system.

Future enhancement is part of all products life cycle. This lists out some missing things in the current product. It also indicates adding more features to the existing product. Following are the future enhancements which could be implemented.
1) The system can be extending by using the webcam at the monitoring side.
2) Other control parameters like water supply, soil moisture and pressure sensors can be added.
3) We can find out the variations in the controlling parameter values in different environmental conditions not only in irrigation field.

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Ms.P.Lavanya is currently studying M.Tech in Digital Electronics and Communication Systems at Bharath College of Engineering & Technology for Women, Kadapa, A.P.

Mr.A.Rajendra Babu, M.Tech, (Ph.D), MIE. Associate Professor at Bharath College of Engineering & Technology for Women, Kadapa, A.P.