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Greenhouse Management Using Embedded System and Zigbee Technology

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ABSTRACT: Monitoring and control of greenhouse environment play an 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 both manual and automatic manner. For manual control purpose, zigbee wireless network is used, which will send status of greenhouse environment automatic control process to control room. There we can control the activities through PC and send to controller back which is in greenhouse environment. There it will activates the actuator according to our wish. The main objective is to design a simple, easy to install, microcontroller-based circuit to monitor and record the values of temperature, humidity, and sunlight of the natural environment that are continuously modified and controlled in order optimize them to achieve maximum plant growth and yield. PIC 16F877A controller is used. It communicates with the a variety of sensor modules in order to control the light, aeration and drainage process efficiently inside a greenhouse by actuating a cooler, fogger, dripper and lights respectively according to the necessary condition of the crops.

KEYWORDS: PIC Microcontroller, Zigbee wireless network, Environmental parameters, Environmental monitoring and controlling.

I. INTRODUCTION

The rising demands for crop production and quality have significantly increased the utilization of high quality and productivity of green house. The system which we proposed ,helps us to closely monitor and control the microclimatic parameters of a greenhouse environment. The system comprises of sensors, microcontroller with inbuilt ADC and actuators(motors, led). When any of the climatic parameters cross a safety threshold which has to be maintained to protect the crops, the sensors sense the change and the microcontroller reads this from the data at its input ports after being converted to a digital form by the ADC. The controller then performs the required actions by employing relays until the strayed-out parameter has been brought back to its most advantageous level. Zigbee wireless sensor network takes a major part for manual controlling purpose. The zigbee based controller agent software is developed by using VB.NET. It consists of three main modules; namely data validation and identification module, controller module and data handling module.

II. EXISTING SYSTEM

In all our previous concept which we analysed has some disadvantages. In one of our existing system ,automatic controlling process takes place by fully based on microcontroller based circuit. In other case ,it is done by zigbee wireless network.where zigbee wireless network is used here for transferring information to the control room which is faraway from environment. There the person can control according to their wish and transfer the information via zigbee connected to controller and according to that performance will takes place. Major Drawbacks

- In microcontroller based circuit-The actions which we need to perform at any time cannot be done in any case.

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- In zigbee wireless network based controlling process -the all information stored in microcontroller is send to PC Which is far away in control room through zigbee transceiver. The person in control room will perform control action .According to that microcontroller will actuate the actuators.

III. PROPOSED SYSTEM

An attractive thing of our proposed system is that, it has extension in its concepts in an successful way. Here we have combined our all previous concepts for an effective and good productivity of plants. Both automatic controlling(microcontroller based) and manual controlling(zigbee wireless network based) takes place here. Automatic controlling process is get takes place continuously, **when any of input module ie., sensors does not work properly required actions is not get performed. At that time We can use zigbee wireless sensor network based controlling process.**The upper lines which I have denoted in bold is an great and successful changes made in this paper.

SOFTWARE TOOLS:

- Visual basic.
- Proteus.
- MPLAB IDE (CCS compiler).

IV. SYSTEM ARCHITECTURE

The system model consists of sensors, microcontroller, interface such as relay and actuators. Actuators such as ventilation fan, sprayer, heater, water pump, artificial lights are used. Our proposed system aim is to design a microcontroller-based circuit to monitor and record the values of temperature, humidity, soil moisture level and sunlight of the natural environment that are continuously modified and it is get controlled in order optimize them to achieve maximum plant growth and yield. Controlling process takes place effectively by both automatically and manually. Depending upon the application, we will set particular threshold level for each climatic parameter. when any of parameters level cross a safety threshold then microcontroller will perform the needed action by employing relay(motor driver) until the strayed-out parameter has been brought back to its optimum level. Manual controlling process is done by zigbee wireless network whenever necessary. Whose receiver side of zigbee is connected to PC in control room .VISUAL BASIC software is used here, which helps us to transmit the data back through zigbee wireless network to controller to perform, needed control action. Automatic controlling process takes place in the greenhouse environment itself as per designing microcontroller based circuit to monitor and control various parameters.

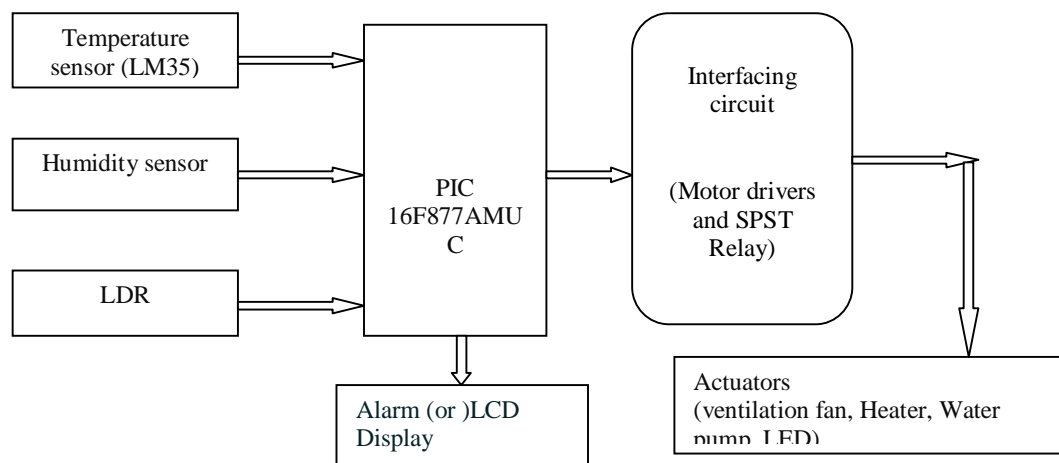


Fig .1 Basic system model of automatic controlling purpose

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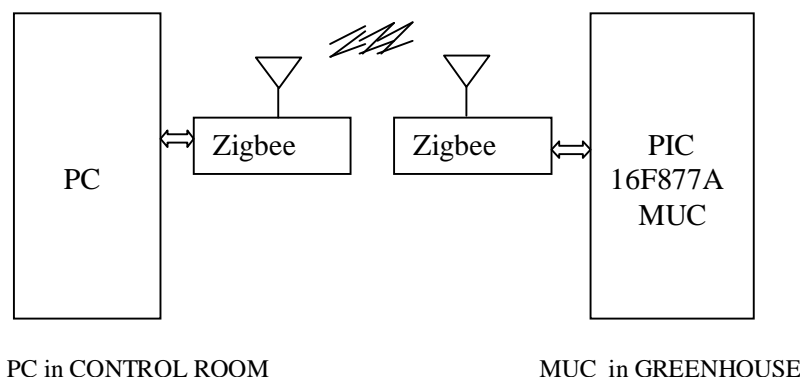


Fig. 2 Basic system model of manual controlling purpose.

V. HARDWARE DESCRIPTION

A. Sensor

Sensor is a device which is used to convert physical quantity into electrical signal. A sensor is a device, which responds to an input quantity by generating a functionally related output usually in the form of an electrical or optical signal. A sensor's sensitivity indicates how much the sensor's output changes when the measured quantity changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1 °C, the sensitivity is 1 cm/°C (it is basically the slope Dy/Dx assuming a linear characteristic). Sensors that measure very small changes must have very high sensitivities. Sensors also have an impact on what they measure; for instance, a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer. Sensors need to be designed to have a small effect on what is measured; making the sensor smaller often improves this and may introduce other advantages.

Sensors used to measure environmental parameters are

- Temperature sensor (LM35)
- Humidity sensor
- Light sensor(LDR)

B. Microcontroller

A microcontroller (MUC) is a small computer with all peripherals such as i/o, memory all mostly in build. Microcontrollers are used in automatically controlled devices. For Greenhouse effective management, here in our paper we are using PIC 16F877A Microcontroller. PIC Controller is an RISC machine (Reduced Instruction Set Computing). It has only 35 instructions to remember. And a two-stage pipeline method of fetch, decode and execution of instructions takes place. I.e., all single cycle instructions except for program branches which are two cycle.

C. Relay

A **relay** is an electrical switch. This electrical switch is operated by an electromagnet that opens and closes under the control of another electrical circuit. It is able to control an output circuit of higher power than the input circuit. Relays are used where it is necessary to control a circuit by a low-power signal or where several circuits must be controlled by one signal.

D. Actuation System

An actuator is a piece of equipment which will produce an movement when signal is given. Actuators are used in the computer control of an environment, industrial automation and in robotics or, more generally, actuators are the



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machines used for output in control applications. For the situation in a computer controlled greenhouse, the actuators receive their control signal from the microcontroller to control the inside climate variables of the greenhouse. The designed system includes the following actuators:

- A ventilation fan, its speed determines the exchange between inside and outside air, thus causing natural ventilation.
- Heating system consists of a number of heaters distributed along the greenhouse.
- As an artificial light LED (light emitting diode) is used .
- LDR is made from a piece of exposed semiconductor material such as cadmium sulphide that changes its electrical resistance from several thousand Ohms in the dark to only a few hundred Ohms when light falls upon it by creating hole-electron pairs in the material. The net effect is an improvement in its conductivity with a decrease in resistance for an increase in illumination..

VI. ZIGBEE TECHNOLOGY

ZigBee is a radio frequency (RF) communications standard based on IEEE 802.15.4. ZigBee is new short range wireless communication technology, representing a wireless sensor network which is highly reliable, secure, low data-rate, low power consumption, low cost and fast reaction. The Zigbee coordinator is responsible for creating and maintaining the network. Each electronic device (i.e. Washing Machine, Television, Lamp etc) in the system is a Zigbee device managed by the coordinator. All communication between devices propagates through the coordinator to the destination device. The wireless nature of ZigBee helps overcome the intrusive installation problem with the existing home automation systems identified earlier. The ZigBee standard theoretically provides 250kbps data rate, and as 40kbps can meet the requirements of most control systems, it is sufficient for controlling most home automation devices. The low installation and running cost offered by ZigBee helps tackle the expensive and complex architecture problems with existing home automation systems, as identified earlier.

A. Zigbee Topologies

Three types

- STAR
- MESH
- CLUSTER TREE

We can use zigbee wireless network based on any one of these three topologies. Each has its own advantage and disadvantages. Mostly star and mesh topologies are used frequently. Here in our paper, we can use mesh topologies. Each has its own PAN area network.

B. Wireless Sensor Network Standards-Comparisons

A wireless sensor network (WSN) is a computer network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations.

During the last decade wireless sensor networks are utilized in many civilian applications, including environment and habitat monitoring, healthcare applications, home automation, and traffic control. Several standards are currently either ratified or under development by organizations. Standards are used far less in WSNs than in other computing systems which make most systems incapable of direct communication between different systems.

The principal standards commonly used in WSN communications are:

- 1) Wi-Fi
- 2) Bluetooth
- 3) ZIGBEE

All the above mentioned technologies work at similar RF frequencies, and their applications sometimes overlap. In the current study, we chose the following five main factors of greenhouse networks to compare: cost, data rate, number of

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nodes, current consumption and battery life. From cost point of view, ZigBee chip is US\$ 1 or less, the lowest; Wi-Fi and Bluetooth chips are \$ 4 and \$ 3, respectively. The overall system cost can be significantly reduced by the employment of ZigBee chip. Data rate, ZigBee is 250 kbps, when Wi-Fi and Bluetooth are 54 Mbps and 1~2 Mbps, respectively. Despite the lowest data rate, ZigBee is sufficient for a greenhouse. Generally, data traffic in a greenhouse is low—usually small messages such as the change of temperature or a command from the controller to an actuator. If lower data rate it will helps for longer battery life.

It is also known that the capacity of network is determined by the number of nodes, and ZigBee has up to 254 nodes, the largest among the three. It meets the application demand of more and more sensors and actuators in a greenhouse. The power and current consumption, ZigBee has the lowest current consumption, 30 mA, while Wi-Fi, 350 mA, and Bluetooth, 65~170 mA. It also greatly helps to prolong the battery life.

VII. EXPERIMENTAL RESULTS

In our work we are using PIC microcontroller, so our program is successfully build and compiled in MPLAB IDE(ccs compiler) and output is successfully simulated in proteus tool. we got three different result based on effective management of greenhouse environment by both automatic manner and human involvement manner. Automatic controlling process is fully done based on coding. During this process if any of sensor module does not work properly no inputs will be given to microcontroller or wrong result will be obtained. so, at that time human involvement will be very useful for greenhouse environment. zigbee based wireless sensor network is used to successfully transfer the information stored in microcontroller to PC in control room which is faraway from environment. VISUAL BASIC SOFTWARE is used to vary the values according to our wish. so this software is installed in all PC and controlling process is done.

VIII. SIMULATION OUTPUT

1. Result obtained for Automatic controlling purpose .
2. Result obtained for Manual controlling purpose.
3. Result obtained for Artificial light blowing according to natural light intensity .

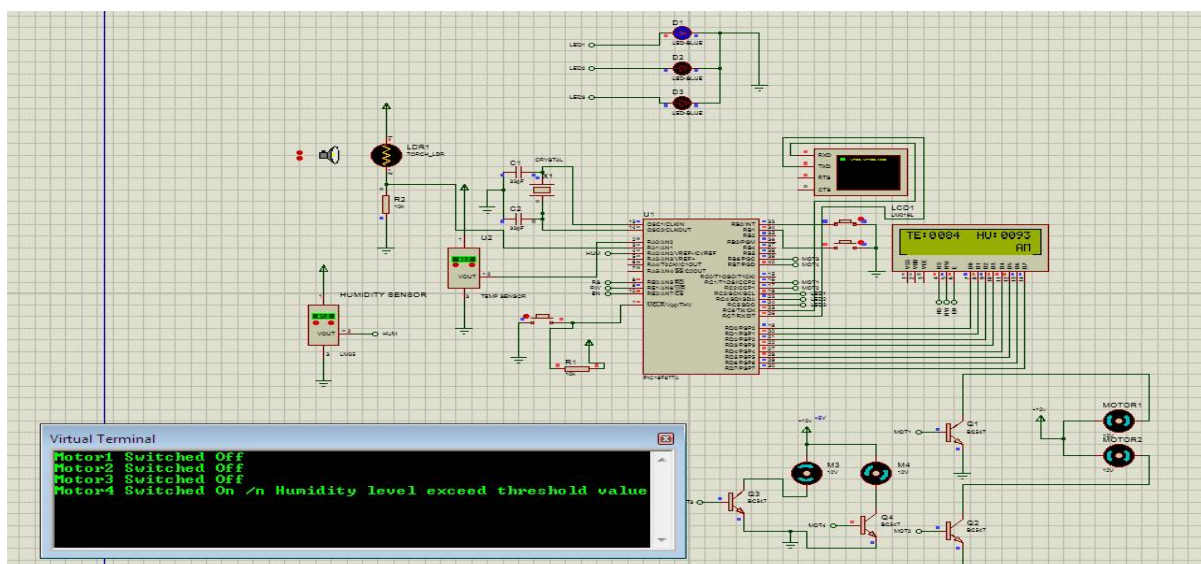


Fig.3 simulation output of Automatic controlling process

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In this figure. 3, output obtained for automatic controlling of greenhouse environment is shown clearly. Here two switches for two different mode of operation is used. It is connected in port B. It operates according to our program. As shown in LCD display now it is in AM ;where it means (AUTOMATIC MODE). Here in port A three input device i.e., Sensors like Temperature, Humidity and LDR is connected. In port c corresponding actuators are get connected. we will set an certain threshold value. When any of the environmental parameters crosses its safety threshold value,its corresponding actuators such us (ventilation fan , sprayer, heater ,water pump)is get activated automatically until it comes within limit.

Our proposed system consumes less power. Controller used here performs pipeline mechanism, so performance time is less .Less number of instructions is used .This all are our paper major advantages compared to our previous methods. Clear result is shown by virtual terminal.

In figure 4, shown below is an Simulation output of zigbee wireless sensor network; based manual controlling purpose. Zigbee wireless network is best recent wireless network used for high speed communication. Zigbee module connected in pc in control room will receive status of greenhouse environment in data format. It is used for maintaining database. VISUAL BASIC software installed in PC can used to view result and also effectively used to vary the data according to our wish. As shown in LCD display now the circuit is in MM (Manual mode).When any of environmental parameter sensor get damaged in any case or missed to sense accurate value ,we can automatically control the status according to our wish.

If we need to control any of actuators at any time we can control it with zigbee wireless network and with VISUAL BASIC software effectively.

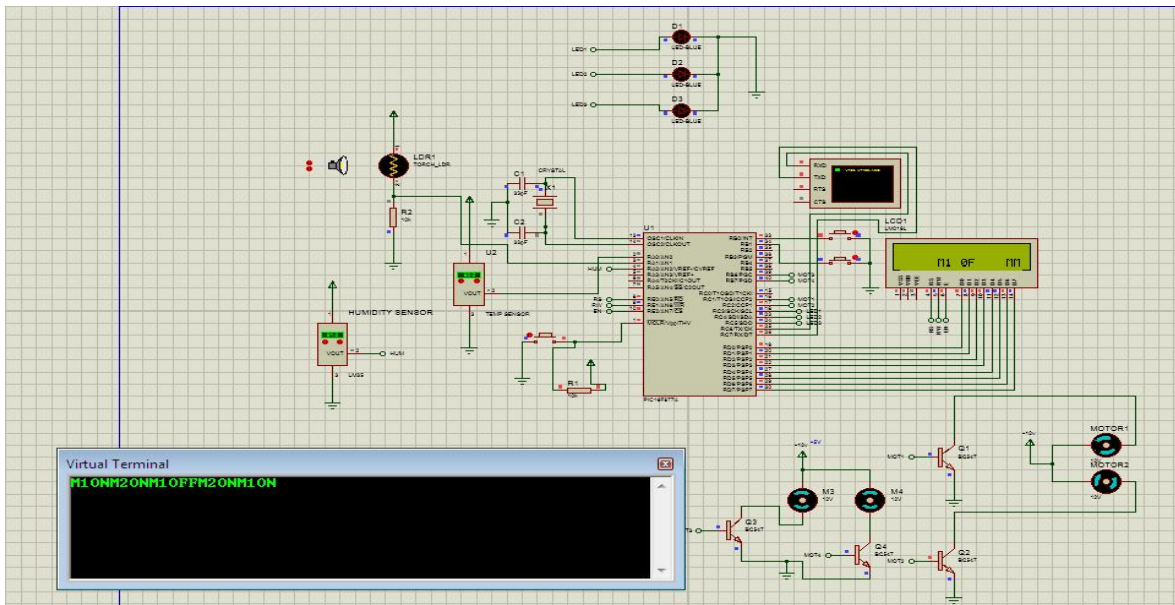


Fig. 4 Simulation output of zigbee wireless sensor network based manual controlling purpose.

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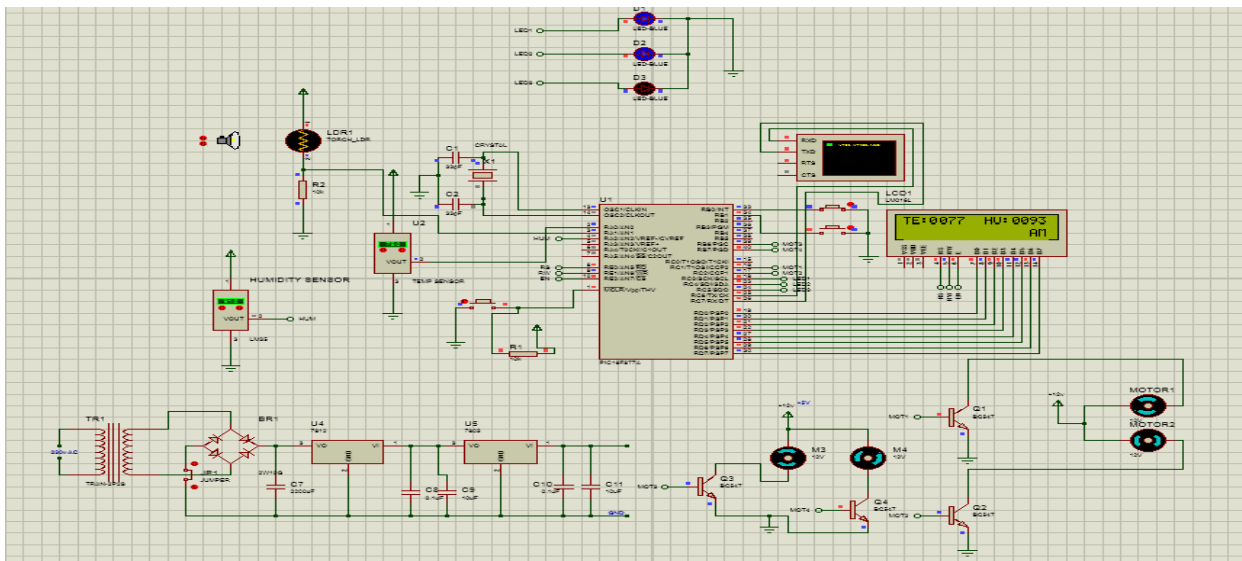


Fig. 5 Result obtained for Artificial light blowing according to natural light intensity.

Figure shows the result of artificial light blowing. As input to measure natural light intensity LDR (Light Dependent Resistor) is used. It is a resistor whose resistance value decreases as the light intensity increases. It depends on a negative temperature coefficient. Three LEDs (Light Emitting Diode) shown in figure are used here as an artificial light.

- When light intensity decreases to extreme low, all LEDs will glow.
- When it is in average condition, 2 LEDs out of 3 LEDs will glow.
- When it is in extreme high, no LED will glow.

Here 2 LEDs are glowing because the battery shown in figure is away from the LDR. So according to that intensity, LEDs are glowing. All three conditions will effectively be used for controlling and monitoring of greenhouse environment. It overcomes the disadvantages of existing systems in a very effective manner.

IX. CONCLUSION

A novel approach in designing the microcontroller-based system and ZigBee wireless sensor network for measurement and control of the three essential parameters for plant growth, i.e. temperature, humidity, and light intensity, has been followed. The results obtained have shown that the system performance is quite consistent and accurate. The system has successfully overcome quite a few shortcomings of the existing systems by reducing the power consumption, maintenance, and complexity, at the same time providing a flexible and precise form of maintaining the environment.

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BIOGRAPHY



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