Monitoring System of a Greenhouse

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DOI: 10.23956/ijarcsse/V7I6/0151

Abstract- A greenhouse (also known as glass house) is a building where plants are kept in a controlled environment. Greenhouses are made by transparent materials such as glass and plastics and thus sometimes it is necessary to change the environmental condition in the greenhouse. This research paper deals with an economical and efficient system to monitor and modify the weather of the greenhouse. An embedded system is used to monitor and change different parameters which directly affect plants. Sensors are used to monitor the temperature, soil moisture, humidity and sun light. According to the interpretation of the sensors, microcontroller controls various devices so that a constant weather condition can be maintained. The complete project is aimed to implement on Arduino Uno, an open source software which is simple to use and maintenance cost is low. It is used to control all devices and sensors.

Keywords- Greenhouse, embedded system, Arduino Uno, sensors, open source software.

I. INTRODUCTION

Greenhouse is the need of Morden age agriculture. A former can grow any crop in the artificial environment. The greenhouse is a popular method of precision agriculture. Greenhouse required a monitoring system which can monitor the weather condition inside the greenhouse. These systems are used to monitor the soil humidity, air humidity, sun light intensity and wind speed. Some systems not only monitor the environmental condition but can alter the weather condition. This helps to grow the crops which are not suitable for the territory where the greenhouse is situated.

The proposed system offers a complete solution for the greenhouse. It is an embedded system which is used to monitor and control the weather conditions. The proposed system monitors the soil humidity, air humidity, percentage of gasses in the air (mainly CO₂) sun light intensity and wind speed. A series of sensors is used for the same. All sensors are connected using I2C protocol. A lookup table stores various parameter of the desired weather condition so that user can easily select the desired weather condition. A manual mode is also provided to control the environmental condition manually. The proposed system is designed to monitor the weather condition inside and outside of the greenhouse. Microcontroller compares the both outside and inside weather condition of the greenhouse. This helps in economical control of weather. All information collected by microcontroller send using Bluetooth transmitter and received by Bluetooth receiver.

II. BLOCK DIAGRAM OF SYSTEM

Figure 1 represents the block diagram of the proposed system. Arduino Uno is the heart of the system. It contains atmega 328 microcontroller which controls all sensors and peripheral. Arduino Uno has I2C protocol. I2C stands for inter integrated circuit and it help sto connect more than one digital integrated circuits using only two wire i.e. serial data line and serial clock line. In the proposed system gas sensor, temperature and humidity sensor and key-pad is connected through a I2C protocol. An I2C bus is required to interface key-pad. Various electrical equipment such as air cooler, water pump and heater are used to control the internal weather conditions. A 16X2 LCD is provided to get instant readings of the sensors.

Fig: 1 Block Diagram of Proposed system
An outdoor unit is provided to monitor the surrounding temperature of greenhouse.

### III. HARDWARE

- **Arduino Uno** is a microcontroller board which is used in small projects. All sensors and equipment are controlled by the Arduino Uno board. It provides a hassle-free solution for interfacing different sensors.
- **SHT10** is a temperature and moisture sensor. It is a digital sensor which uses I2C protocol to communicate with Arduino. The sensor is used to monitor the soil temperature and moisture.
- **LM-35** is a low-cost temperature sensor. It provides a wide range of sensing. In the proposed system, this sensor is used to detect the temperature surrounding of the greenhouse.
- **DHT-22** is a humidity and temperature sensor. It gives digital output so that no one ADC is required. Any digital I/O pin of Arduino can receive the output of the sensor.
- **Light dependent resistor** that uses Cadmium Sulphide (CdS) film as a photoconductor. In the dark, the sensor offers a high resistance. In this condition output voltage of sensor is nearly zero. Output voltage gradually increases with light intensity.
- **A gas sensor MQ-9** is used to determine the presence of unwanted gases in the greenhouse. The sensor gives analog output which is further changed in digital format using ADC.
- **HS-05** is a Bluetooth module. It can be used as transmitter and receiver. In the proposed system HS-05 is used as transmitter.
- **A key pad** is an input device. It is used to give information in numbers to the microcontroller. Key pad works as a link between user and microcontroller.
- **An I2C bus** is required to connect devices which cannot use I2C protocol. An I2C bus shield which contains PCF4574 IC is a low-cost device and thus used widely in small projects.
- **A relay** is an electro-mechanical switch. It is required to connect two devices with unequal power ratings. The device which drives the relay is known as master device and the device, which is to be controlled is known as slave device.
- **Liquid crystal display** is an output device. The display is made by tiny dotes of liquid crystal which can be controlled individually. A 16x2 LCD is sufficient to display the weather condition inside the greenhouse.

### IV. SOFTWARE

**Arduino-IDE** is an open source software that uses C/C++ function. There are various library files are provided in the software which makes programming easier. There are different variations of software available such as pc version and android version.

At the receiver site, any digital device with Bluetooth transceiver can go well. The device must have Bluetooth messenger application to communicate with proposed system.

### V. WORKING

Working of proposed system involves fetching data (from sensors) and processing. Arduino takes analog as well as digital data from various sensors. These data then processed and compared by the required condition of green-house environment. A lookup table contains data about temperature humidity and sunlight. These data are stored in the form of set. Each set represents a particular environmental condition. A user can set the threshold point of all sensors by selecting a set of data from the lookup table. A keypad is provided to do the same. A user can also set the environmental parameters manually. Once environmental condition has been set, the Arduino starts to comparing data from sensors to selected conditions. If data mismatch condition accrues, Arduino turns on appropriate system to overcome the mismatch and thus the rated condition has been maintained. Table 1 tells the relation between green-house environmental condition and their corresponding systems.

<table>
<thead>
<tr>
<th>Environmental Condition</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low temperature</td>
<td>Heater on</td>
</tr>
<tr>
<td>Low humidity</td>
<td>Sprayers on</td>
</tr>
<tr>
<td>Low soil moisture</td>
<td>water pump on</td>
</tr>
<tr>
<td>Low sun-light</td>
<td>UV lamp on</td>
</tr>
<tr>
<td>High temperature</td>
<td>Air cooler on</td>
</tr>
</tbody>
</table>

A LCD display is provided to see the sensors’ output. These outputs can also be seen at any Bluetooth device. A Bluetooth messenger application helps to decode the received data.

### VI. RESULT AND ANALYSIS

Total number of sensors and actuators is proportional to the size of greenhouse. The proposed system is sufficient for 10mx10m greenhouse (as the maximum range of Bluetooth is 10m). Table 2 shows the environmental condition for some plant. Table 2 works as a lookup table for the program and is stored in the microcontroller in the form of array.
Different type of tables is used for different kind of crop. This table can be modified by the operator to ensure maximum yield.

Table 2: Lookup Table

<table>
<thead>
<tr>
<th>Crop</th>
<th>Temperature °C</th>
<th>CO₂ PPM</th>
<th>Light K Lux</th>
<th>Moist Air</th>
<th>Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnation</td>
<td>16-22</td>
<td>1000</td>
<td>45-50</td>
<td>65</td>
<td>16</td>
</tr>
<tr>
<td>Peach</td>
<td>23-26</td>
<td>1000</td>
<td>40-46</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>Tomato</td>
<td>16-35</td>
<td>1500</td>
<td>45-50</td>
<td>65</td>
<td>16</td>
</tr>
<tr>
<td>Gerberas</td>
<td>27-30</td>
<td>1000</td>
<td>53-40</td>
<td>65</td>
<td>17</td>
</tr>
<tr>
<td>Roses</td>
<td>15-30</td>
<td>1000</td>
<td>30-40</td>
<td>70</td>
<td>17</td>
</tr>
<tr>
<td>Anthurium</td>
<td>24-26</td>
<td>1000</td>
<td>18-35</td>
<td>75</td>
<td>20</td>
</tr>
</tbody>
</table>

A. Sensors

1) Temperature Sensor (LM-35): The formula for temperature sensing is given as,

\[
\text{Temperature (°C)} = \left( \frac{\text{Vout}}{5} \right) \times 100 \text{ (°C/V)}
\]

Figure 2 represents the reading of the temperature sensor.

Graph shows that the sensor is almost linear. This ensures better accuracy and performance.

3) Gas Sensor (MQ-9): The relationship between surface resistance of the sensor Rs and load resistance RL is described:

\[
RsRL = \left( \frac{Vc - VR}{} \right) / VR
\]

Fig 3: Relationship between 5v pulse and output of sensor

3) Humidity and Temperature Sensor (DHT 22): Humidity Tolerance= ±0.1V

\[
\text{RH} = \left( \frac{\text{Vout}}{\text{Vcc}} - 0.16 \right) \times 0.0062, \text{ typical at 25°C}
\]

where, Vsupply = 4.96V

DHT 22 gives digital output. Check sum bits are used to eliminate any error. Arduino has received 40 bits data from DHT 22 as,

0000 0001 1101 1100 0000 0001 01 01 1011 0010 1011

16 bits RH data 16 bits T data check sum

Where T data =temperature data and RH data =relative humidity data

The binary data is now converted in to decimal data in order to get the result

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0000 0001 1101 1100 → 476
Binary system       Decimal system
RH=476/10=47.6%RH

Same as above, we can get temperature data in decimal using 16-bit binary data.

0000 0001 0110 1101 → 365
Binary system       Decimal system
T=365/10=36.5°C

In temperature output, MSB is used to show the sign of the result. If MSB is 1 then it means the temperature is below 0 degree Celsius. For example

1000 0001 1111 1111, T= minus 28.6°C
16 bits T data

Sum=0000 0001+1101 1100+0000 0001+0110 1101=101001011
Check-sum=the last 8 bits of Sum=101001011

3) Soil moisture and temperature sensor (SHT 10): SHT 10 is a digital sensor which works almost like DHT 10. The data packets are same as DHT 10. Due to nonlinearity of humidity sensor, it does not gives actuate result. To compensate this, we use the following formula.

\[ RH_{linear} = c_1 + c_2 \times SO_{RH} + c_3 \times SO_{RH}^2 \%

\]

Where \( SO_{RH} \) is output of humidity sensor and \( RH_{linear} \) is the humidity of soil.
In spite of this change, working of SHT10 is same as DHT 22.

5) Light Sensor: Light sensor is an analog device. Some properties of LDR is given below.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>75 mA</td>
</tr>
<tr>
<td>Power Dissipated at 30°C</td>
<td>250 mW</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>-60°C to 75°C</td>
</tr>
</tbody>
</table>

Tolerance = ±0.1V

<table>
<thead>
<tr>
<th>Illumination Status</th>
<th>Transducer Optimum Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPTIMUM ILLUMINATION</td>
<td>0V-0.69V</td>
</tr>
<tr>
<td>DIM LIGHT</td>
<td>0.7V-2.5V</td>
</tr>
<tr>
<td>DARK</td>
<td>2.6V-3.1V</td>
</tr>
<tr>
<td>NIGHT</td>
<td>3.2V-4.6V</td>
</tr>
</tbody>
</table>

B. Simulation of hardware circuit

Fig 4: Proteus output of the proposed system
VII. CONCLUSION

A monitoring system can increase the yield of the crop planted in greenhouse. Efficiency of monitoring system is proportional to the efficiency of the greenhouse. Step by step modelling procedure is very important for any system. Bluetooth technology can decrease the cost of overall system and it does not require any specific receiver as Bluetooth is very common component in almost all cell phones and computers. Due to use of Bluetooth, the dimension of greenhouse limited to 10 meters.

The continually increasing technology and decreasing cost of hardware encourage use of electronic system in agriculture. Now a day’s technology becomes very economical and handy. This ensures wider acceptance of electronic systems.

REFERENCES