LabVIEW based Greenhouse Automation

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Abstract: **The main aim of this paper is to control the basic parameters of greenhouse using LabVIEW. LabVIEW is an environment that consists of several components which are required for any type of measurement, test or control application. This involves development of a prototype model which mimics the greenhouse system. This prototype contains beds of soil which has seeds planted in it. Small pipelines are used for irrigation of the same. As irrigation needs proper humidity and temperature control, sensors are used to control these parameters. Also the prototype has a Door monitoring system which enables better ambient conditions control. Every parameter is monitored and controlled using LabVIEW software. Web service is used for the real time applications. This enables the monitoring and control from a remote place also**

Index Terms: **Greenhouse effect, LabVIEW, Front panel, Temperature sensor, Humidity sensor**

I. Introduction

Greenhouse is a place where plants are grown under optimal conditions. It includes ambient temperature, light intensity, soil fertility, water irrigation, and humidity. Different plants require different conditions for their growth which may not be possible at all times [1]. To overcome this and help the maintenance of optimal conditions inside a greenhouse, automation is done using LabVIEW [2]. By using Lab VIEW and Data Acquisition systems we can measure and monitor the parameters required inside a greenhouse. In this paper, humidity, door monitoring, water irrigation and temperature are monitored and controlled for the developed prototype. Different sensors are used for the measurement of the parameters which are then interfaced with DAQ and are controlled using LabVIEW.

A. Hardware

The prototype is constructed as shown in figure 1. Four beds of soils are made on a wooden plank. Seeds are sown in it. Four tubes are provided above the soil bed, to promote timely water supply. It is covered with a transparent sheet to provide sunlight. Sensors are used for measuring the parameters. These sensors are interfaced with DAQ and controlled using LabVIEW software. These sensors are run using external power supply taken from regulated power supply. Outputs from the DAC are very low mostly in milli volts. Low voltages and current may not run the motors and other devices used in the project, hence amplifier circuits and relays are used for the devices to run.

Figure 1. Prototype of the Greenhouse setup

B. Software:

National Instruments Compact Field Point (CFP) is used to interface the hardware with the digital controller developed in LabVIEW. LabVIEW is a graphical programming tool that enables the user to develop programs swiftly without worrying about the syntax.

II. Block diagram

The following are the technologies implemented for executing the project

- LabVIEW Graphical Programming
- High Speed Data Acquisition using NI CFP

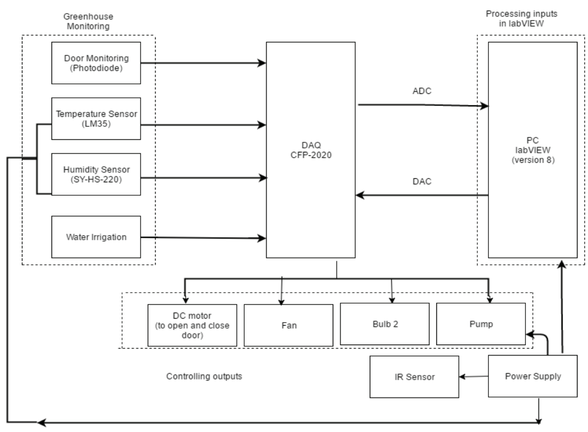

Figure 2. Block diagram

The block diagram shown in figure 2 illustrates the blocks of greenhouse monitoring and control set up. This is divided into three sections comprising of a monitoring system, processing system and a feedback system. All programs which are written inside the LabVIEW version 8 environment are called VIs. A VI consists of a Block Diagram and a corresponding Front Panel. The Front Panel includes various controls and indicators while the Block Diagram contains various functions and other VIs that are inter wired among themselves.

III. Temperature Control

Temperature is one of the important parameters to be maintained in the greenhouse. Greenhouse is mostly constructed in the cold countries where temperature is very low and plants would get freezed in that climate [3]. If temperature is above the required point then fan should be turned ON. If the temperature is below the set point then bulb should be turned ON. This is all done using a feedback loop and continuous monitoring. The control system associated with this may appear as an open loop system and to reduce errors it is more common to use negative feedback. The diagram shown in Figure 3 represents the basic structure of a closed loop control system.

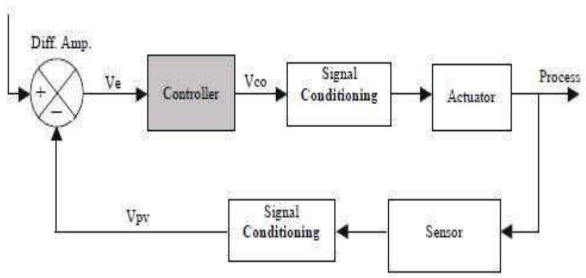

Figure 3. Closed Loop Control System

The Process block in the above diagram represents a physical characteristic. This characteristic chosen has to be maintained at the desired operating point. In this paper, Temperature is selected as the physical quantity. Hence it is to be maintained at the desired value. The feedback loop provides the current value of the process thereby enabling the generation of error signal. A solid state temperature sensor is used to monitor the temperature in this application [4]. It sends an output voltage that is very small for practical purpose, typically in the millivolt range. The signal is amplified by the signal conditioning block that follows it. The signal conditioning block may also be used for calibration purposes by scaling the voltage from the sensor to the corresponding temperature. The current value of the process variable is obtained from the signal conditioning block and it is designated as VPV. The data flow of the temperature control operation is shown in the Block Diagram panel. Figure 4 shows the details of the Front panel [5] which describes the operation of the ON/OFF controller of the process. The operation begins with a check on whether the Controller is ON or OFF. This is accomplished with VI 2 (AI Sample Channel.vi) and the comparator C1. The output of C1 is either TRUE or FALSE. If TRUE, then the Controller is OFF, and if FALSE then the Controller is ON. VI 2 takes its input from Channel 1 of Device 1 (DAQ Board number). Analog input Channel 1 is physically wired to DAC output Ch. 0 which controls the operation of the fan. Thus by testing the DAC output Ch. 0, one can determine whether the Controller is ON or OFF.

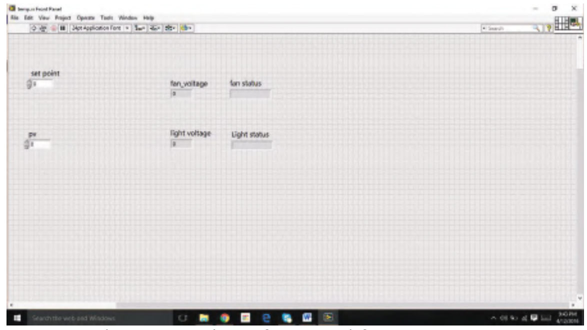

Figure 4. LabVIEW version 8 front panel for temperature measurement and control

IV. Humidity Control

The measure of the amount of water in the air is called RELATIVE HUMIDITY (RH). Relative humidity is the ratio of actual water vapour content to the saturated water vapour. RH is not a direct measurement as it is measured on a relative basis. Hence this may make Relative Humidity a little harder to understand unlike the measurement of temperature, pressure and other parameters. However the role of RH is extremely important in determining the plant health. To make the measurement of RH more user friendly to the plants, proper equipments have to be chosen. As the temperature of the air increases, its potential water-holding capacity also greatly increases. For example, air at 60ºF (~16ºC) can hold over five times as much water as the same air at 20ºF (~ –7ºC). As an example it can be seen that water or frost settles out on automobiles, grass and the rooftops of our houses during cool nights of even warm spring days. This is called DEW POINT where the warm air cools and reaches a point of SATURATION. In parts of the world where there is higher relative humidity, this is a common occurrence when there are marked temperature differences between day and night. But in many places where there is a wide temperature difference, infrequent dew formation can be seen if the place is less humid. The air holds so little water that it does not reach saturation even at the lower night temperatures. To measure humidity, a smart humidity sensor module SY-HS-220 is used for this design. The humidity sensor SY-HS-220 is shown in the Figure 5. It can be seen that the board consists of signal conditioning circuits along with the humidity sensor.

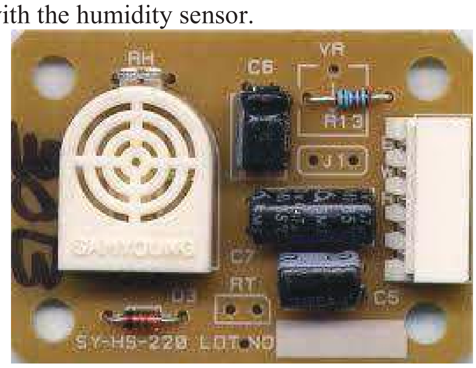

Figure 5. SY HS 220 humidity sensor

The humidity sensor used here is capacitive type. It consists of an on chip signal conditioner. The whole setup is mounted on a PCB (Printed Circuit Board) which enables markings for other stages. The sensor is pulsed with the help of CMOS Timers which provides the output voltage. The other units are frequency to voltage converter, AC amplifier, Oscillator and Precision Rectifiers. Incorporation of such stages on the board significantly helps to enhance the performance of the sensor. It also helps to provide great impediment to the noise. The humidity sensor is highly precise and reliable. The output of the sensor is in terms of DC voltage and it voltage is directly proportional to the humidity [6] and it decreases the need for conversion of voltage to RH%. This work with +5 Volt power supply and the typical current consumption is less than 3 mA. The operating humidity range is 30%.

The following code is written to measure the relative humidity and SY-HS-220 is used to measure the relative humidity .The output of the sensor is voltage .This code is used to convert the voltage to %RH and it is done by calculating the slope by taking into considerations the output voltage ratings of the sensor used. The code also indicates the status of %RH if it is within the sensor operating range or beyond. When the relative humidity falls beyond the sensor operating range then an LED will glow indicating to perform the necessary operations to maintain the humidity. If the humidity is less then humidifier then it must be turned ON and if the humidity is more than a small inlet, it must be opened until there is required humidity in the room. The front panel in figure 6 indicates the relative humidity after conversion using a numeric indicator and gauge. The status tab shows if the relative humidity is within the sensor operating range or beyond.

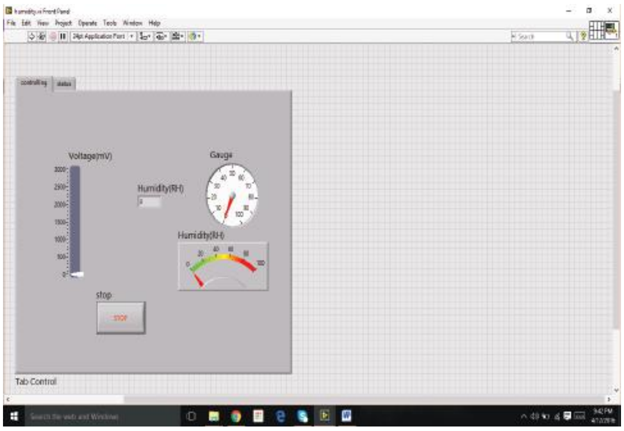

Figure 6. LabVIEW version 8 front panel for humidity measurement

V. Door Monitoring

The main aim to include door monitoring in our project is to maintain the required parameters [7] (ie. set conditions) in our greenhouse prototype. When the door is kept open the air may flow in and would disturb the temperature and humidity in the room. To prevent that we will be automatically closing the door after a certain time once it is opened .When a person arrives at the door he would sensed by the proximity sensor first and then the door gets opened by some mechanical function. The IR sensors follow a principle of using a specific light sensor which detects the IR wavelength in the electromagnetic spectrum. An infrared (IR) sensor is an electronic device, that emits light in the IR wavelength in order to sense some aspects of the surroundings. Applications of IR sensors involves motion detection and even thermal energy i.e heat variation of objects. This type of sensor is called passive IR sensor as it can measure only infrared radiation rather than emitting. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes which can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, the resistances and these output voltages change in proportion to the magnitude of the IR light received**.** When any object strikes the IR region then it produces the minimum amount of voltage which is given to the DAQ [8] and again from the DAQ input voltage it is given to the motor driver and from the motor driver, the motors operate. Figure 7 shows the block diagram of the door monitoring.

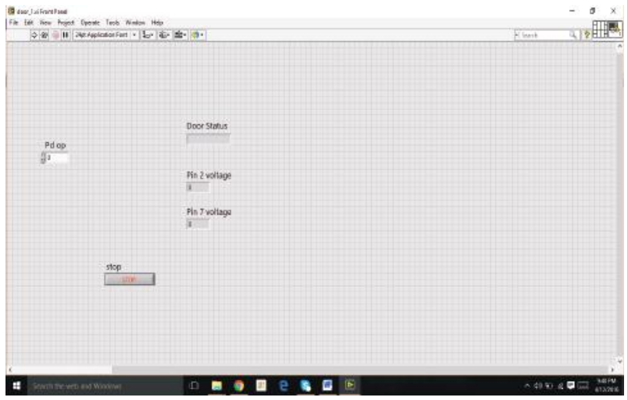

Figure 7. LabVIEW version 8 front panel for door monitoring

VI. Drawbacks

The two main drawbacks faced in the above setup are as follows. Appropriate sensor has to be chosen in temperature control as the output required was in centigrade. So a signal conditioning IC LM35 was used. The IC senses the temperature and gives an output in voltage. Later the voltage was calibrated to temperature and it was used for controlling. The second main drawback was that the sensor used for humidity measurement. It gave an output in terms of voltage which had to be converted to humidity (%RH) in order to monitor. Controlling humidity was big deal because humidity varies consistently and maintaining it was a tough task. Automatic controlling of humidity is more tedious as it involves huge hardware like humidifier etc.

VII. Conclusions

The main aim of this paper is to control and monitor the basic parameters of the green house using LabVIEW version 8. Different parameters like temperature, automatic door monitoring, water irrigation are studied, monitored and controlled. Humidity is a parameter which is measured and indications are given accordingly. Problems faced in terms of interfacing, programming, circuitry and power amplifications are overcome. All these are done using LabVIEW and DAQ. A prototype has been designed to resemble the greenhouse and all the measurements are taken within the prototype. Hence by implementing this we are able to monitor and control certain parameters like temperature, humidity and able to meet the required optimal conditions for greenhouse. The door monitoring and water irrigation is also done.

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