Multi-Channel Data Acquisition and Data Logging for Green House Application

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Abstract— **This paper presents an overview of data acquisition, data logging and supervisory control of different parameters for green house application. In this work a Green House system is considered, where data from various parameters are needed to be acquired, logged in a database for further analysis and supervisory control. This paper acquires data of surrounding temperatures of the Green House and pH value of water in Green House and controls the parameters when an alarming situation occurs.**

***Keywords*— Data Acquisition; Data Logging; Green House; Supervisory Control**

I. INTRODUCTION

Data acquisition and data logging is one of the important aspect of any plant. Data is acquired using different sensors and these data are fed to the computers using different DAQ cards. The data from the sensor can be noisy, so before analyzing the data, pre-processing of data is necessary. Pre-processing of data includes noise removal, trend and bias removal. The resulting data is stored in a computer for further analysis and supervisory control. In a large plant, data are acquired remotely using either remote Input-Output modules or using WI-FI modules and the data is sent to a central server for record keeping and necessary action.

The objective of this paper is to acquire multiple data from the physical world with the help of different transducers and DAQ cards and store it in the computer for further analysis and control. A Green House is taken as a case study for data acquisition and data logging. Different physical parameters of Green House such as temperature, pH are acquired using different sensors and NI-DAQ cards and subsequently LabVIEW is used for display and analysis of data.

Apart from Introduction and concluding section, this paper is divided in to four different sections. The second section of the paper describes about the greenhouse and importance of greenhouse irrespective of agriculture point of view. Section three gives a brief literature review available in this topic. Section four describes different modules of data acquisition and control in a greenhouse and section five shows the results of data acquisition and data logging. Section six concludes the discussion.

II. GREEN HOUSE

Agriculture is the backbone of human civilization. Without it human would have starved to death long ago. Agricultural products are largely dependent on environmental conditions. Different plants require different kind of environment to grow so growing plants in harsh climatic conditions has always been a challenge to the mankind.

Way back in 13th century the concept of modern day Green House or glass house was developed in Italy. Green House concept helped human civilization in many ways. During world wars people of USA and UK developed roof top garden or kitchen garden to supplement the nation’s food reserve. Today Netherlands is a world leader in developing high end Green House system.

Green House is a technology where plant is grown in an artificial manner inside a controlled environment. In some of the regions where the climatic conditions are extremely adverse and no crops can be grown, greenhouse is used to grow fruits, vegetables, flowers. The primary advantage of greenhouse technology is that it is used to protect the plants from the adverse climatic conditions such as wind, cold, precipitation, excessive radiation, extreme temperature, insects and diseases.

To create a controlled climate inside the Green House, different physical parameters have to be monitored and controlled in a real time manner. Temperature, humidity, gas levels, light, air pressure, air velocity, soil moisture, pH of water, conductivity of the soil has to be monitored continuously. Real time data of above physical parameters has to be acquired in a continuous manner and if any kind of abnormality found then subsequent control action has to be undertaken.

This paper develops a data acquisition and data logging system which monitors two important parameter of the Green House, i.e. temperature and pH. If the temperature and pH level goes out of bound then subsequent control action is applied to maintain the normal level.

III. LITERATURE REVIEW

Data acquisition from field using different sensors is the most basic requirement of any industry. The data is acquired using different DAQ cards and transmitted to the server via different modes such as wired modes or wireless mode. In a large plant, wireless mode of data transmission is preferred as it is cost effective and reliable mode of communication.

Data logging and supervisory control of multiple boiler system is developed in [9]. Low cost wireless data acquisition system for a weather station is reported in [10]. To give an advanced warning system of Tsunami, data acquisition system is developed [11]. For a large plant like oil refinery supervisory control and data acquisition (SCADA) system is used [12] for proper monitoring and supervisory control of plant. GPRS based data acquisition and mobile phone based control technique is developed in [13].

Controlled Environment Agriculture (CEA) is one of the new research areas where researchers are trying to modernize the age old Green House concept so that different parameters can be monitored and controlled in a more efficient manner. This section gives a brief idea about the ongoing research that is being carried out in this domain.

Researchers developed remote monitoring system, where the embedded system sends SMS to cell phones of the farmers during any abrupt changes in reading of different environmental variables [1]. Many researchers developed wireless protocol based embedded system which monitors large stretch of greenhouse [2,3,7]. Data acquisition for Green House application is developed in [4-6,8].

IV. DATA ACQUSITION AND CONTROL OF GREEN HOUSE

This section shows the data acquisition and control logic of greenhouse monitoring system. Atmospheric temperature and pH of water are two of the most important parameter of the green house. Atmospheric temperature and pH of water has to be kept at a constant level for proper growth of the plant. Surrounding Temperature and pH of water are measured using thermocouple and pH probe respectively and the temperature and pH data are logged in a computer interface for subsequent action.

Thermocouple works in thermo-electric principle called as seeback effect. When two metals are pressed together and one end is placed in cold junction and the other end is placed in a hot junction, then thermoelectric EMF is produced which is calibrated in accordance to temperature by the following formula $T = C_0 + \sum_{i=1}^{9} C_i V^i$ (1)

Here C_0 to C_9 are coefficients of thermocouple.

K-type thermocouple is made up of chromel - alumel metals. The sensitivity of K-type thermocouple is 41µV/°C. The range of K-type thermocouple is -200°C to 1350°C. Research is going on to develop high precision thermocouple with online linearization and data logging features [14].

If the temperature exceeds a certain range then fan is switched ON and when the temperature falls below a certain level, heater is switched ON.

Fig. 1 shows the block diagram of data acquisition and control system of a greenhouse system.

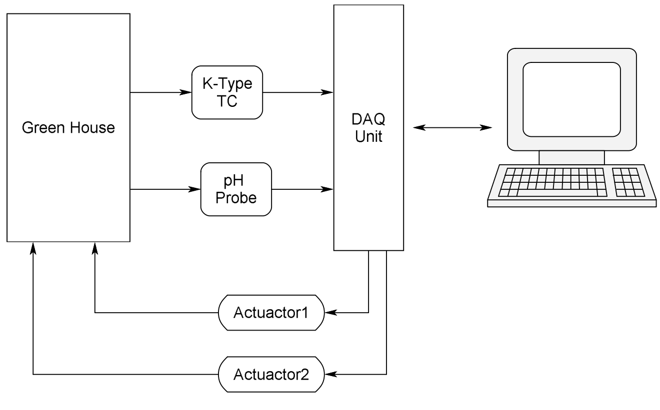


Fig. 1. Block Diagram of Data Acquisition and Control System

This paper uses National Instrument's DAQ units and LabVIEW 2010 for data acquisition and control applications. NI cDAQ 9178 Chassis with thermocouple module (NI 9219) is used for temperature measurement whereas NI-ELVIS-II+ is used for pH measurement. NI-cDAQ and NI-ELVIS-II+ are connected to a computer via USB-2 port.

Fig. 2 shows the data acquisition of temperature and ON-OFF control logic of temperature. If the temperature reading exceeds 35°C then fan is turned on and if the temperature reading falls below 30°C then heater is turned on to compensate the temperature.

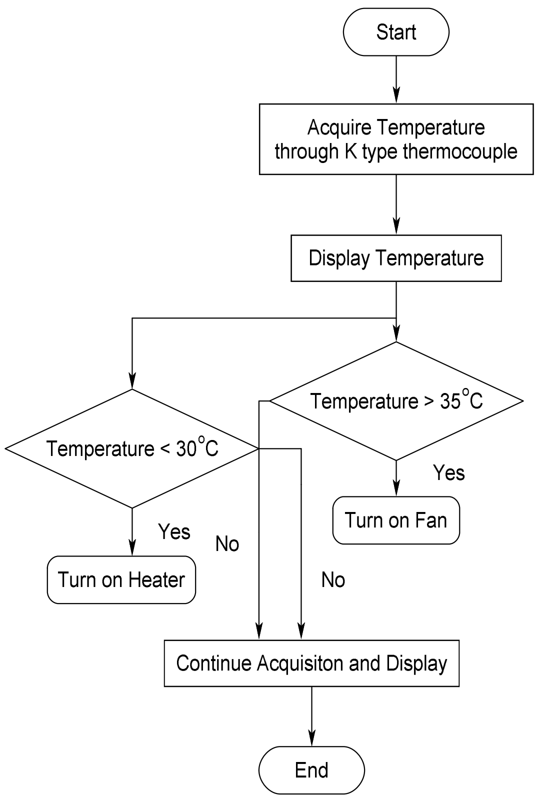


Fig. 2. Temperature Data Acquisition and Control

A pH probe is used to measure pH of incoming liquid to the Green House. pH is measured by the following formula

$$p^{H} = -\log_{10}\left[H^{+}\right] \qquad (2)$$

The pH probe gives the reading in voltage which has to be converted in to pH value. So the conversion formula is used to convert voltage reading in to pH reading which is shown in Fig. 3.

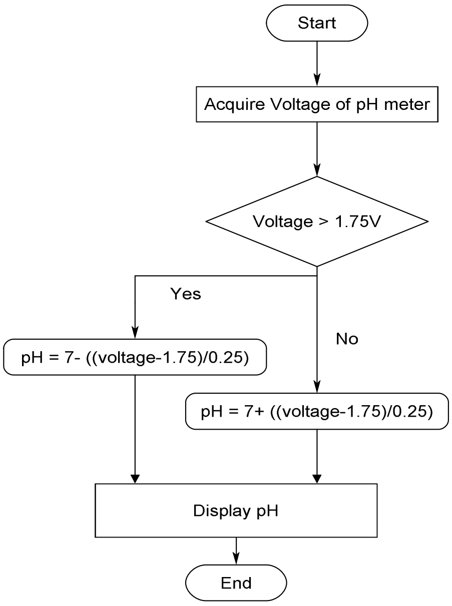


Fig. 3. Conversion of Voltage to pH

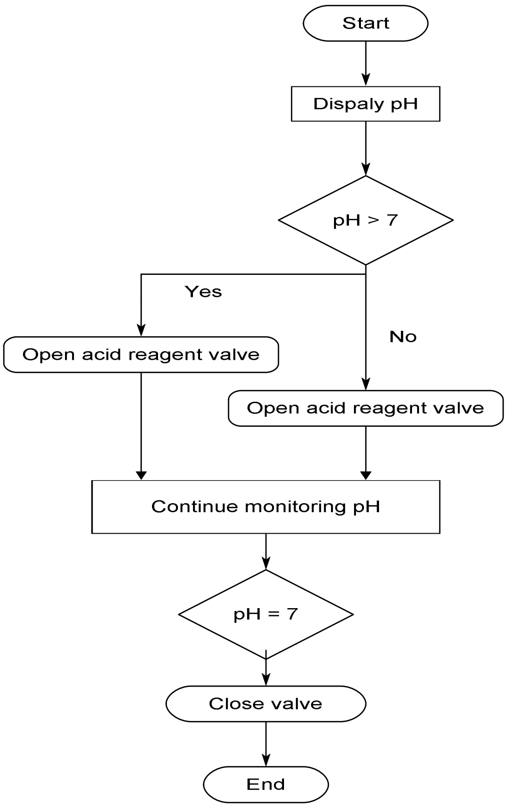
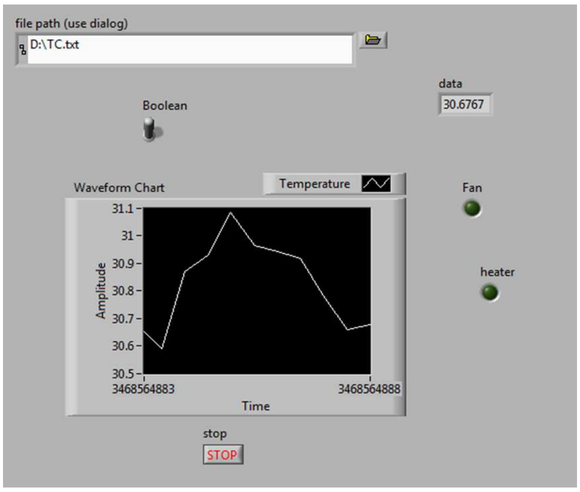


Fig. 4. Data Acquisition and Control of pH

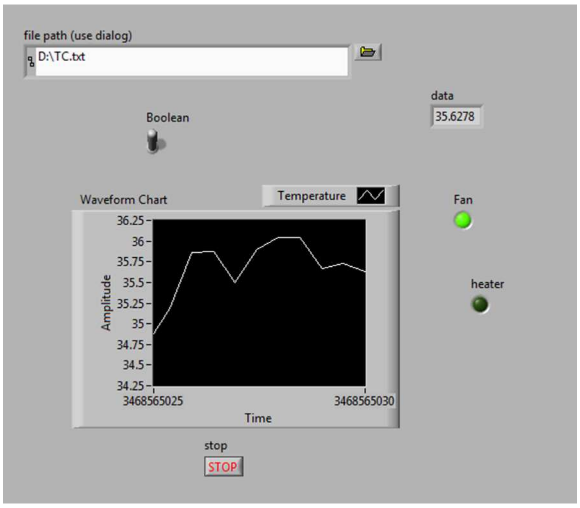
If the incoming liquid is detected with higher or lower pH, then subsequent acidic or alkaline valves is opened. The valves are closed when pH reading is back to a normal level. Fig. 4 shows the ON-OFF control logic of pH used in a green house.

V. Results And Discussions

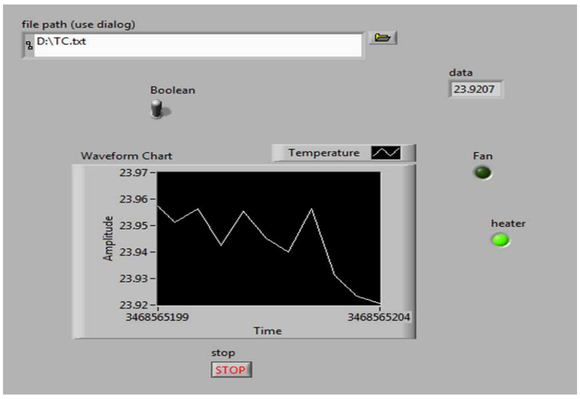
This section describes the results and discussions for the automation of green house. LabVIEW interface is developed for data acquisition, data logging and control of different parameters (temperature and pH) of a green house. Indicators are used to provide alarm situations and real time trend is used to monitor the data in a real time manner. The acquired data is stored in a database (Excel file) for further processing. Fig. 5 (a) shows the real time trend of temperature in normal condition. Fig. 5 (b) shows the real time trend of temperature while the fan is ON due to excessive temperature. Fig. 5 (c) represents the real time trend of temperature while the heater is ON due to low temperature.



(a)



(b)



(c)

Fig. 5. Real time trend of temperature (a) in normal condition (b) when fan is ON (c) when heater is ON

Table I shows the logged data of temperature in the database and Fig. 6 shows the hardware setup used for temperature measurement.

TABLE I. LOGGED DATA OF TEMPERATURE

Date	Time	Acquired data(°C)
29-11-2013	15:46:24	33.028375
29-11-2013	15:46:30	33.355144
29-11-2013	15:46:35	34.262662
29-11-2013	15:46:41	32.860314
29-11-2013	15:46:47	32.781768
29-11-2013	15:46:53	33.425015
29-11-2013	15:46:59	34.260694
29-11-2013	15:47:04	35.627848
29-11-2013	15:47:10	35.163953
29-11-2013	15:47:16	35.625671
29-11-2013	15:47:22	34.991601
29-11-2013	15:47:28	34.745216
29-11-2013	15:47:33	32.301676
29-11-2013	15:47:39	30.820601
29-11-2013	15:47:45	29.884953
29-11-2013	15:47:51	28.859861

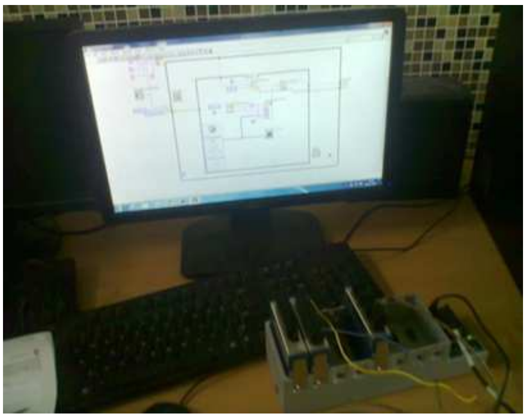


Fig. 6. Data Acquisition and Control of Temperature (Hardware)

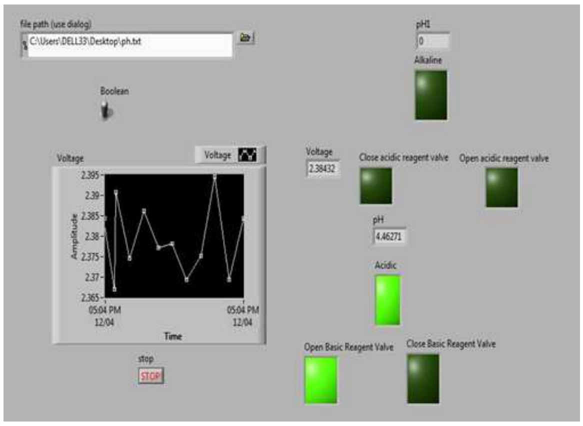


Fig. 7. Data Acquisition and Control of pH (Front Panel)

Fig. 8. Data Acquisition of pH (Hardware)

TABLE II. LOGGED DATA FOR PH

Date	Time	Acquired data
04-12-2013	17:03:24	4.46271
04-12-2013	17:03:30	4.46271
04-12-2013	17:03:35	4.46258
04-12-2013	17:03:41	4.46271
04-11-2013	17:03:47	4.46852
04-12-2013	17:03:53	4.48526
04-12-2013	17:03:59	4.46258
04-12-2013	17:04:04	4.46852
04-12-2013	17:04:10	4.46789
04-12-2013	17:04:16	4.46271
04-12-2013	17:04:22	4.46271
04-12-2013	17:04:28	4.46271
04-12-2013	17:04:33	4.46271
04-12-2013	17:04:39	4.46271
04-12-2013	17:04:45	4.46271
04-12-2013	17:04:51	4.46285

Fig. 7 shows the front panel of data acquisition and control of pH of liquid in Green House. Fig. 8 shows the hardware setup to measure pH of liquid and Table II shows the pH reading logged in the database.

VI. CONCLUSIONS

Data acquisition from physical world using different sensors and storing and displaying it in a PC is a basic need of an industry. With the advanced technology, many state-of-the art DAQ solutions are available. This paper takes this concept of data acquisition, data logging and control in agricultural domain. Green house is one of the best examples of controlled environment agriculture (CEA) principle. Many parameters of the Green House have to be acquired and controlled. This paper acquired data for surrounding temperature and pH of water with the help of NI-DAQ and displays the real time trend in a PC. Subsequent control action is initiated if the data is not in a normal range.

There are a lot of future scopes in this area. For a bigger Green House, TCP/IP and wireless based data acquisition can be performed and the complete application can be remotely controlled from the World Wide Web.

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