Real Time Standalone Data Acquisition System for Environmental Data

Vasant Raj Mutha[1], Narendra Kumar[2] and Parikshit Pareek[3]
[1,2]Department of Electrical Engineering, Delhi Technological University, Delhi, India
[3]Department of Electrical Engineering, Rajasthan Technical University, Kota, India
E-mail: [1]vasantrajmutha@yahoo.in, [2]ndeshwalus@yahoo.com, [3]parikshit.mailbox@gmail.com

***Abstract*—Dispensation of environmental data is gaining importance with time. Real time monitoring of environment facilitates us in identification of suitable locations for agriculture, industry and other purposes. In this paper, Arduino-UNO microcontroller based board is used to implement the data acquisition strategy and to interface both analog and digital sensors. Temperature, humidity, light intensity and gas concentration are monitored in real time and dew point has been calculated simultaneously. LabView 2015 is employed to provide the required user interface for end user. It assists in understanding the situation fast and effectively. This system also provides data for further processing and to extract the required results. System is useful for agricultural, industrial as well as living environment monitoring. For the purpose of independent weather station in standalone condition, Wi-Fi is used for data transmission which is stored in a cloud account. This data can be used anywhere in the world for different purposes.**

Keywords—Environment Monitoring; Data Acquisition (DA); Independent Weather Station

I. Introduction

In Indian economic scenario, industries related to agriculture, bio medics and pharmaceutics are of high importance. All these require a real time monitoring system to accomplish tasks with required quality and efficiency [1]. Also serious consequences of climate change in recent times have made it important to monitor current environmental situations in real time. Recent progress in electronics has made it possible to develop low power sensors for continuous monitoring [2-4]. Industrial requirements of precise environments are very specific as any departure of temperature, humidity, etc. from present parameters will cost a heavy productivity loss.

Advancements in agriculture sector are a must in Indian context. Slow agricultural growth has been a concern since independence. Agriculture and related sectors take 24% of total Indian GDP [5]. Poor irrigation system, overdependence on rain, wrong crop selection are major reasons behind lower growth rate. Arduino-UNO microcontroller being an open source platform is used in various applications in the past. Principle of working of an Arduino has been explained in [6]. Its applications can be found in measurement of electrical power [7], digital control of power electronics [8] etc. LabView is one of the best available software for data acquisitions and for better user interface [9, 10].

Importance of the proposed system lies in the fact that it can store the environmental data on a cloud account using Wi-Fi technology and hence data can be used anywhere. It contributes in such a manner that environmental data can be monitored and processed without going to that actual location. Also a comparative analysis and study of environmental data of different locations can be done quite effectively and easily [11].

Organization of rest of the paper is in following way: Section II gives a brief review of sensors and software used in system. Section III describes the connection and circuits involved in the proposed system while section IV contains GUI. Section V has Results and Discussion obtained from the system. Conclusion is presented in section VI. The last section contains references.

II. Hardware and Sensors

A. Arduino-UNO

Arduino is an open source platform consisting of easy to use hardware board designed around 8 bit AVR microcontroller and software consisting of standard Arduino compiler and a boot loader. The Programming language for Arduino is based on Wiring and the Arduino software (also called IDE) is based on Processing.

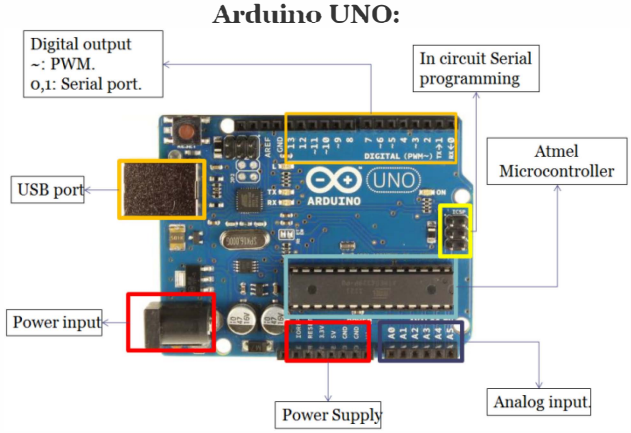

Fig. 1: Arduino UNO Board

Arduino boards are capable of taking inputs in the form of analog or digital signals- light on a sensor and produce an output which in turn can turn on an LED or can start a motor. It can also publish a message or alarm online. There are a number of different Arduino boards available; some of them are Arduino UNO, Arduino Nano, and Arduino Mega etc. The board used in the present work is Arduino UNO. It consists of a power input port, USB port, analog input pins, digital I/O pins, serial programming pins and power supply pins in addition to Atmel microcontroller [12].

The Integrated Development Environment of Arduino contains an editor for writing the code of the desired program which can be uploaded on the Arduino UNO board.

B. LM35DZ Temprature Sensor

Temperature in degree centigrade is obtained using a three pin temperature sensor IC having output response of 10mV per degree Celsius. This particular IC gives a linear response and interfaces with ADC of any microcontroller. The conversion of ADC values to temperature measurement is done by a suitable program instruction.

C. NORP 12 LDR Light Sensor

The Light Dependent Resistor (LDR) model no NORP 12 gives the luminance values. The typical light intensity value for an outdoor sunny day is greater than 10000 lux; standard living room is 70 to 100 Lux; 60 W bulbs at 1m distance is around 50 to 60 Lux etc. The highly non-linear response of LDR is approximated by piecewise linear approximation to get suitable result.

D. DHT 11 Humidity Sensor

It is a cost effective sensor to measure temperature and relative humidity of air. The sensor has three terminals; VCC, GND and DATA. By means of handshake, the values of the temperature and relative humidity are clocked over the data line. By using suitable library, different data formats can be handled. Using the output values of temperature and humidity, dew point can also be calculated.

E. MQ6 Gas Sensor

The MQ gas sensor consists of electrochemical sensor with a heater. At room temperature, it detects a range of gases with good sensitivity. This sensor is mainly used indoors. The MQ6 sensor is suitable for detecting LPG/IsoButane/Propane in homes and industries. The variable resistor provided within adjusts the sensitivity of the sensor.

F. CC300 Wi-Fi Chip

The CC300 breakout board can be easily integrated in any Arduino project. This module consists of a low power Wi-Fi and a microcontroller friendly interface. This chip can be used for home and industrial automation.

III. CIRCUIT DIAGRAM

The Arduino hardware circuit implemented is also interfaced with LabView with the help of VI Package Manager and LIFA. Fig. 2 shows the actual circuit photograph. The circuit connections are done using the breadboard and jumper wires. All sensors are interfaced with Arduino UNO board. Output of temperature, light and gas sensors are connected to analog pins and output of DHT11 is connected to digital pin of the board. Arduino UNO board consists of an ADC which converts analog output of sensors into digital quantities.

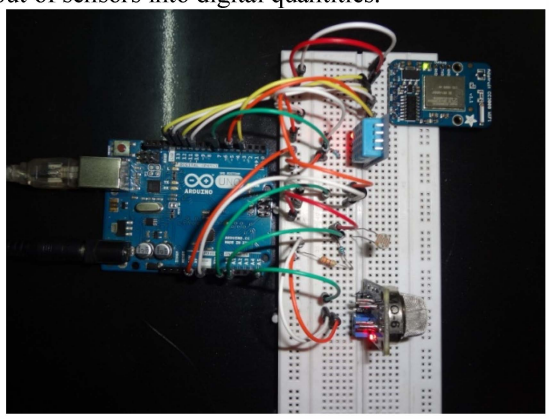

Fig. 2: Hardware Circuit

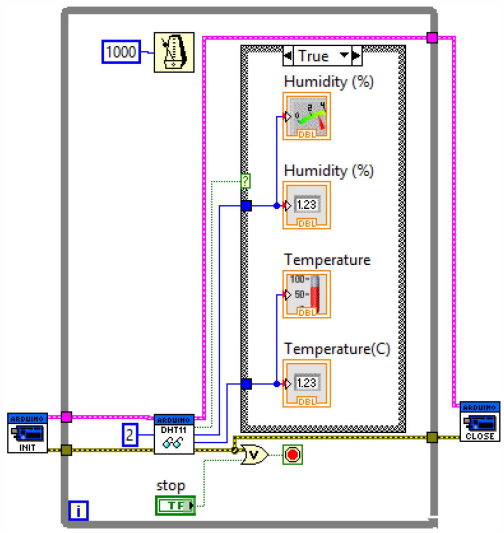

Fig. 3: DHT11 VI Block Diagram

IV. GRAPHICAL USER INTERFACE

For facilitating the data acquisition and improved user interface, this hardware circuit is interfaced with LabView. Each sensor strategy is displayed in terms of block diagrams. Fig.3 shows the combined temperature and humidity sensor VI block diagram. Fig.4 shows the NORP 12 LDR Light Sensor VI block diagram for lux

calculation. Fig.5 displays the combined block diagram for temperature, humidity and lux calculations. These VI block diagrams are representations of actual hardware interfaced with the LabView. These VI block diagrams help in error identification and hence improve the accuracy of the system. They also facilitate the user to see results on different displays and compare them together at a particular time simultaneously.

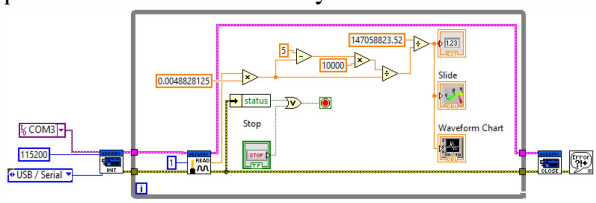

Fig. 4: NORP 12 LDR Light Sensor VI Block Diagram

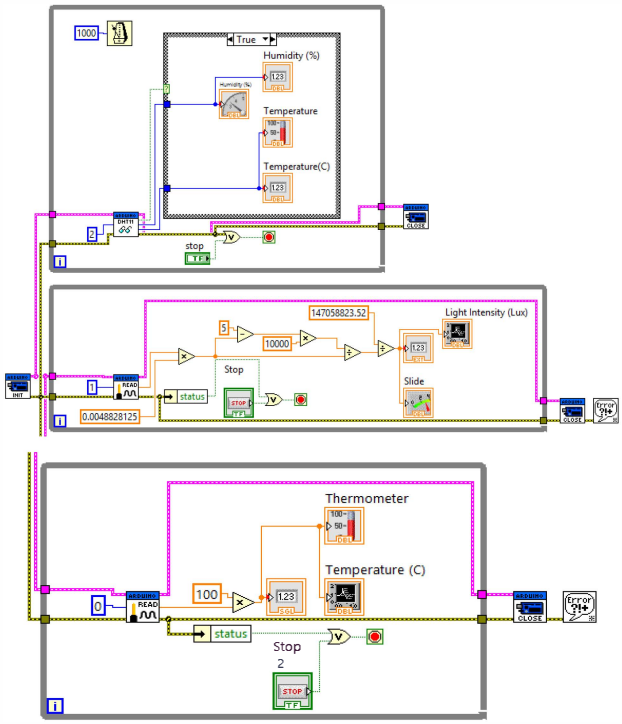

Fig. 5: Combined VI Block Diagram

V. Results and Discussion

In the proposed system, results have been presented in three different manners. First is by serial monitor of Arduino IDE, second is LabView Graphical Programming Environment and third is on cloud account via Wi-Fi mode for transmission of data. Fig.6 shows the serial monitor output. Reading starting from left is: light luminance in lux; gas quantity in parts per million (ppm); relative humidity in percentage; dew point in degree Celsius; temperature in degree Celsius. The real time recording of data is highly advantageous as it helps keep track of any deviations from the normal values in case of any undesirable changes in the environment which may be due to any inadvertent hazardous situations at homes or in the industries.

The second form of presentation is shown in Fig.7. It shows the screen shot of the Front Panel of LabView. The leftmost section shows the values for luminance in the units of lux by means of a slide, numeric indicator and a waveform graph. The STOP button helps terminate the running of the VI block at any instant. The central section shows the values of relative humidity and temperature as acquired from DHT11. It represents the relative humidity and temperature together. It is important to understand here that by measuring same parameter with more than one sensor improves the accuracy. Relative humidity is shown on a gauge ranging from 0 to 100 and temperature is shown on a thermometer clubbed with numeric indicators.

In the rightmost section, only temperature in measured through LM35. Two types of representation are used; one is thermometer and other is graphical representation with time. The thermometer shows the actual value at a certain time while the purpose of graph is to show the change in temperature with time. By changing the sampling rate, we can modify the time after witch next value is to be calculated and shown. Major advantage of graph is that it can be used to study the trend for a shorter as well as for a longer period of time. Same things are applicable on the lux graph in the leftmost section of Fig. 7.

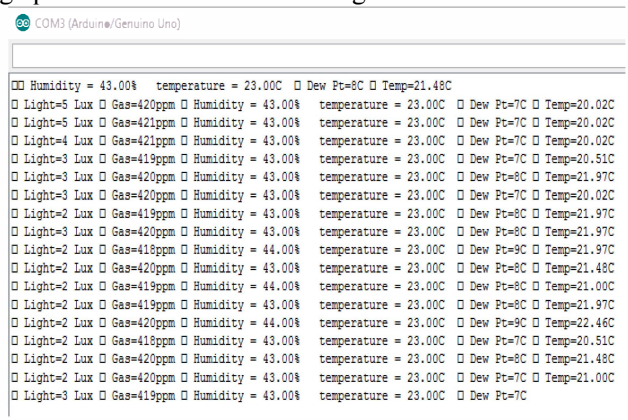

Fig. 6: Serial Monitor Output

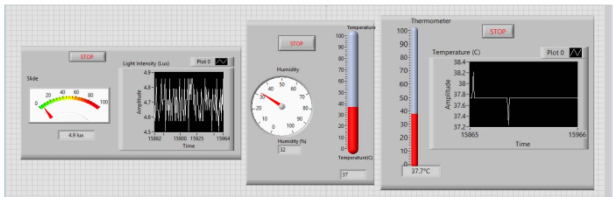

Fig. 7: LabView GUI with Real Time Results

To make this hardware a standalone system of environmental data acquisition, it is important make data available everywhere in the world. For this purpose, a cloud account is used on which the device transfers the data through Wi-Fi link and user can access it from

anywhere. The cloud data can also be fetched with required time interval and can be used for trend study like in Fig.8. The x-axis shows specific date and time values while the y-axis displays the magnitude of temperature and relative humidity. Fig.9 displays the cloud account data accessed by the user. It can also be used to send an alert or a message to user via an email or SMS as shown in Fig.9. It is highly advantageous for the situations and places where continuous presence of human being in not possible. With the help of line chart we can easily mark the time regions where temperature or humidity is below or above our specifications and can take precautionary measures to facilitate improvements.

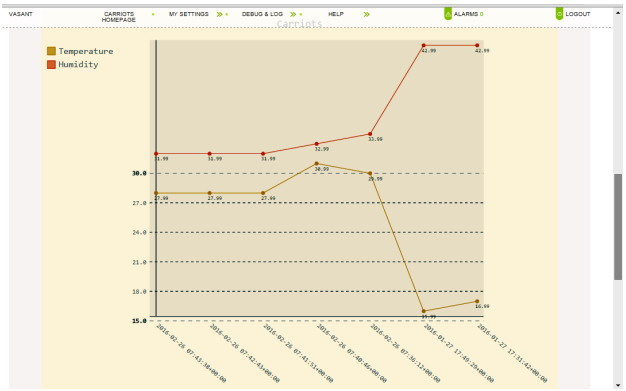

Fig. 8: Line Chart of Temprature and Humidity Made by Cloud Data Online

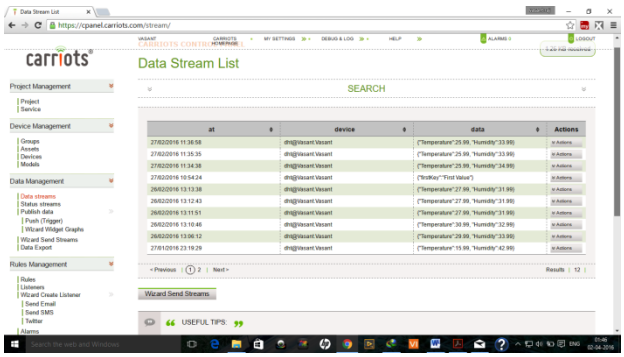

Fig. 9: Data Accessed via Cloud Account

VI. CONCLUSION

With gaining importance of real time data monitoring of environment, both user monitored and standalone system of data acquisition are needed. The system presented in this paper has many advantages: it is quite easy to manufacture and process in addition to being a low cost system as it uses the Arduino UNO open source platform; GUI constructed on LabView helps to illustrate the results quite effectively to even a non technical person; this system can be used for precautionary measures automatically; data stored on cloud account can be used for trend analysis and study for a longer time, etc. Alarm systems and precautionary measures like sending an email or SMS to user increase the applicability and usefulness of the proposed system. For green houses, biomedical industries, etc. this system can be coupled with some advance actions like turning on an exhaust fan or refrigeration motor etc. to make this system fully capable of not only acquiring data but also to became a fully autonomous system to maintain the environmental conditions within a specific range.

REFERENCES

[1] F.J. Arregui, I.R. Matias, K.L. Cooper, and R.O. Claus, "Simultaneous measurement of humidity and temperature by combining a reflective intensity-based optical fiber sensor and a fiber Bragg grating," Sensors Journal, IEEE, vol. 2, pp. 482-487, 2002.

[2] J. Yang and X. Li, "Design and implementation of low-power wirelesssensor networks for environmental monitoring", Proc. of IEEE International Conference on Wireless Communications, Networking and Information Security, Beijing, China, June 2010, pp. 593-597.

[3] F. Cuomo S. Della Luna, U. Monaco, U, and T. Melodia "Routing in ZigBee: Benefits from Exploiting the IEEE 802.15.4 Association Tree", Proc. of IEEE International Conference on Communications, Glasgow,Scotland, June 2007, pp. 3271-3276.

[4] N. Giannopoulos, C. Giannopoulos, A. Kameas "Design Guidelines for Building a Wireless Sensor Network for Environmental Monitoring" Proc. of 2009 Panhellenic Conference on Informatics, Corfu Greek, September 2009, pp. 148-152.

[5] Agricultural Statistics at a Glance (2008), Department ofAgriculture and Cooperation, Ministry of Agriculture, Governmentof India.

[6] Yusuf Abdullahi Badamasi " The Working Principle of an Arduino" 11th International Conference on Electronics, Computer and Computation (ICECCO), 2014, September 2014, pp 1-4

[7] R.W. Fransiska, E. M. P. Septia, W. K. Vessabhu, W. Frans and more Electrical power measurement using Arduino Uno microcontroller and LabVIEW, 3rd International Conference on Instrumentation, Communications, Information Technology, and Biomedical Engineering (ICICI-BME), 2013, pp 226-229

[8] Muller, L.; Mohammed, M.; Kimball, J.W. "Using the Arduino Uno to teach digital control of power electronics", Control and Modeling for Power Electronics (COMPEL), 2015 IEEE 16th Workshop on, On page(s): 1 – 8

[9] LabView User Manuals, National Instruments

[10] A.Ganiand M. J. E. Salami "A LabVIEW based data acquisition system for vibration monitoring and analysis" Student conference on Research and Development, 2002. SCOReD 2002. Pp 62-65

[11] Marc-Olivier Schwartz, WiFi Weather Station, Adafruit learning system, https://learn.adafruit.com/wifi-weather-station-arduino-cc3000

[12] www.arduino.cc