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Validation of Range of Resistance of Sensor through Sensor Data Acquisition using SimPlot: A Case Study

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Abstract— This paper presents a novel validation technique of sensor data acquisition, using analog values produced by potentiometer in connection to Arduino platform with help of SimPlot, a real time serial data visualization tool. DHT11 is used as a case sensor while working in this paper.

Keywords— Sensor, data acquisition, Arduino, Simplot

I. Introduction

Data acquisition is the essential component for any embedded system [1] computer system with specific functionality having real time implications, if any, used in vital areas of application, such as military, production line, transportation, medical and scientific. Data acquisition [2] stands for conversion of sampled physical world data i.e., analog into machine readable bit format i.e., digital values that can be processed by computer systems later on. A sensor [3] is an electro-chem-mechanical system often designed to convert the analog values into electrical form. Potentiometer is a three terminal resistor meant for voltage division. Arduino [4] is a next generation open source microcontroller based platform engineered to pave the growing need of experiments in innovative and curricular activities. Atmel [5] manufactured 8-bit AVR [6] or 32-bit ARM [7] microcontroller based Arduino is a popular example of on board computer, often used to build applications complying environments interactive. Simplot [8][9] is a simple real time data visualization tool, plots real time data from serial port [10], serial communication interface between digital or mixed signal devices.

Validation of data acquisition activities plays a crucial role in understanding and measuring the performance zone of various sensors. Many costly, complex and proprietary techniques have already been developed and extensively used with sensors in production lines and laboratories mostly in one-to-one relationship among them. However, easy, simple and universal techniques have been missed out from literatures till date. This paper presents a novel technique which neutralizes the issues given above. By the use of SimPlot, a novel process is examined and the results are produced in this paper. DHT11, temperature and humidity sensor has been chosen in this experiment due to its low cost, easy availability of library and large live forum as a case study. First, sensor data is collected by bridging Arduino and serial port of PC (specification: Intel Core i3 @ 2.27 GHz, 2 GB RAM, Windows 7 Ultimate 32-bit) and streamed to SimPlot. Finally, by the method of manual approximation and mathematical calculation the actual operating range has been identified where the DHT11 sensor could work satisfactorily.

This paper is organized as below. Section II presents experimental setup. Section III shows the result and analysis. Section IV concludes the paper.

II. Experimental Setup

This section describes the idea and setup of the experiment done in this work. DHT11 sensor is duo of temperature and humidity parameters used extensively in practical situations in many places, from laboratory to end line products. Though, it has been popular choice in related media of researchers, the validation of the working scenario in respect to potentiometer value has not been done by any literature. Datasheets available in various vendors only depicts the fixed value of resistance i.e., 5KΩ. This work specifically identifies the working range of resistance on DHT11 using SimPlot, a serial data plotter connected to PC.

This experiment connects various modules such as DHT11, Arduino Duemilanove; 8-bit ATmega328 based microcontroller platform, PC with serial port connected and installed with SimPlot. This whole Data Acquisition system is framed as per the given specifications and circuitry mechanisms in various literatures available [9][11][12][13][14]. Fig. 1 shows the complete structure of the above said system used for acquire data from DHT11, as first stage and analyse it with help of SimPlot, as final stage. The data acquisition and potentiometer range analysis algorithms are presented in Fig. 2.

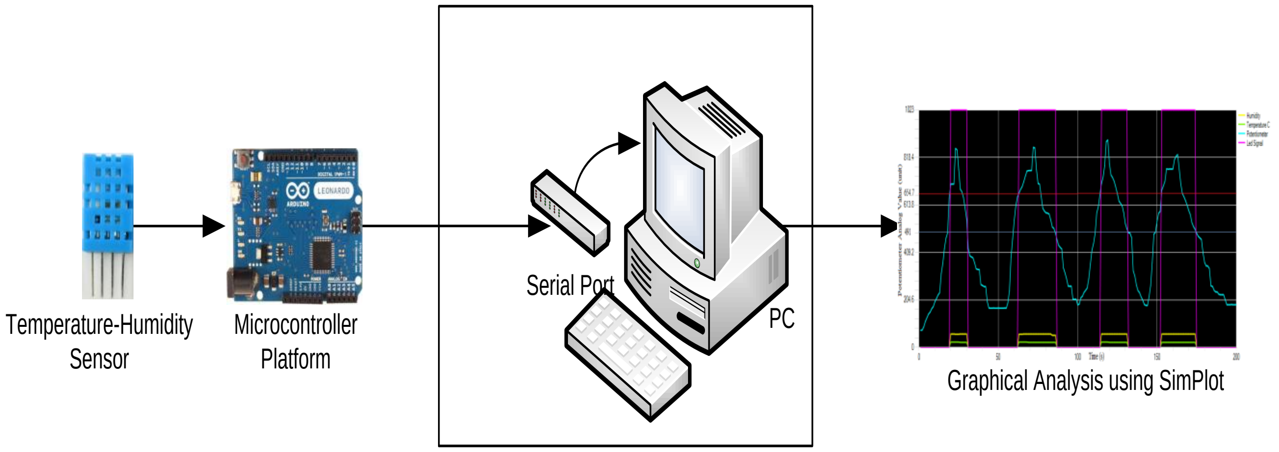

Fig. 1 Data acquisition system

```
Data_Acquisition(variable1, variable2, variable3, variable4)
1.    Start
2.    Define pins, buffer and library header files to be used in context to
      begin with the data acquisition system
3.    Loop infinitely steps 4-5
4.    Setup the serial port bit rate in bps
5.    Begin the library instance
6.    Loop infinitely steps 7-9
7.    Set variable.1 = input Humidity data
      Set variable.2 = input Temperature data
      Set variable.3 = input Potentiometer data
8.    If (input sensor data == 0)
          Set variable.4 = (Led signal = 0)
      Else
          Set variable.4 = (Led signal = 1023)
9.    Call plot(input variable1, variable3, variable3, variable4)
10.   Plot(variable1, variable3, variable3, variable4)
11        Set buffer.0=data packet header
12.       Set buffer.1=data size
13.       Set buffer.2= variable1
13.       Set buffer.3= variable2
13.       Set buffer.4= variable3
13.       Set buffer.5= variable4
14.   End of Plot()
15.   End
```

```
Potentiometer_Range_Analysis()
1.    Start
2.    Identify the intersection points between graph lines Potentiometer to
      Led value on raising edge and falling edge
3.    Connect the intersecting points through a straight line on raising
      edge
3.    Connect the intersecting points through a straight line on falling edge
4.    Determine the value on Potentiometer axis
5.    End
```

Fig. 2 Data acquisition and potentiometer range analysis algorithm

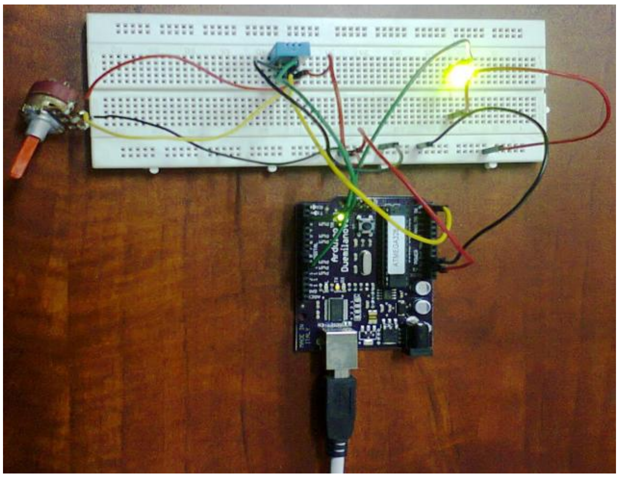

Fig. 3 Partial view of data acquisition system (Potentiometer, DHT11, Led (left to right) (top) and Arduino Duemilanove (Below))

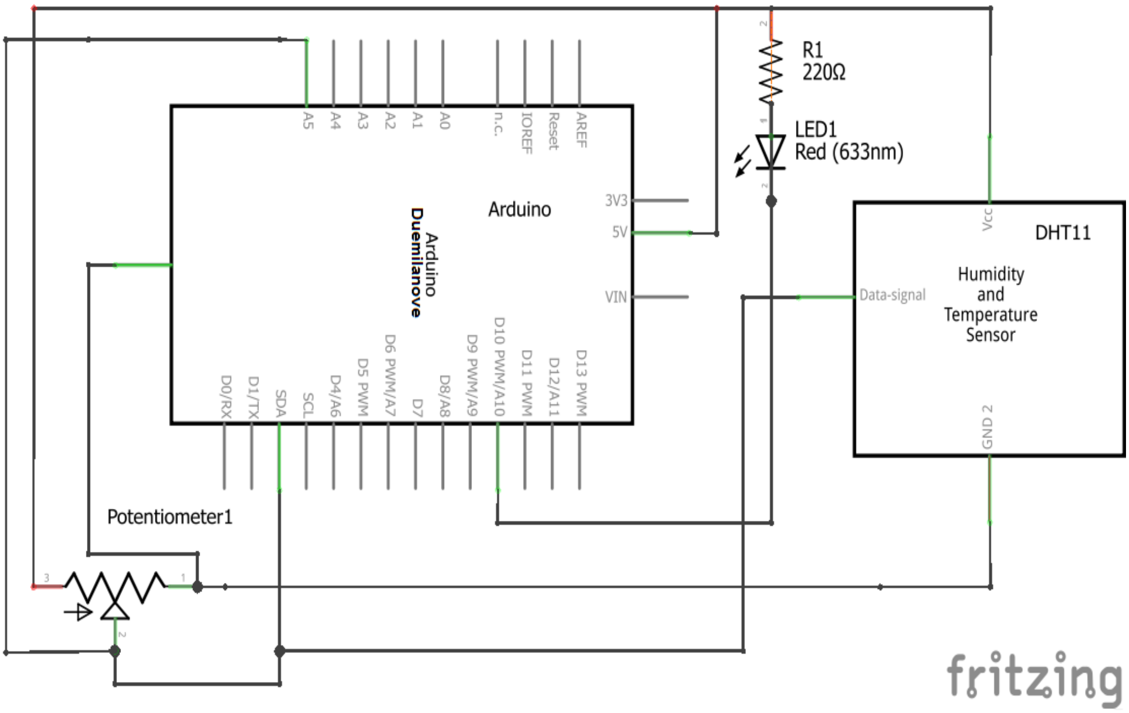

Fig. 4 Schematic diagram of the data acquisition system comprising Arduino Duemilanove, Led, DHT11 and Potentiometer (designed by fritzing [15])

Fig. 3 and Fig. 4 shows partial circuit diagram and schematic diagram of the data acquisition system described earlier in the literature. Fig. 3 shows the breadboard based circuit design comprising one potentiometer (10K) (upper leftmost red colour), DHT11 temperature and humidity sensor (upper middle green colour), Led (upper rightmost yellow colour), and Arduino Duemilanove. The corresponding schematic is shown below (Fig. 4) designed by fritzing [15], a open-source circuit designer tool. Arduino Duemilanove is shown at the centre of the diagram connected by its peripherals such as Led, DHT11, and Potentiometer.

III. Result and Analysis

This section presents the results and analysis of the graphical plot obtained from SimPlot after running it in connection to data acquisition system presented in section II. While Plotting graph using SimPlot, bit rate of 9600 bits per second (bps) is preset in system. Fig. 5 depicts the SimPlot graph of humidity and temperature data inputs (variable1, variable2 (Data_Acquisition of Fig. 2 of Section II)) counting 20 degree Celsius and 52% Relative Humidity, respectively. Yellow line represents humidity input and green line for temperature. The glitches shown on the graph advocates the minor change of values on the respective data, caused due to the inconsistency in sensing the analog value from environment and sampling it into digital version at DHT11sensor. The Y-axis of the plot shows the amplitude (units) (degree celsius and relative humidity in %), where as X-axis is time in seconds (s).

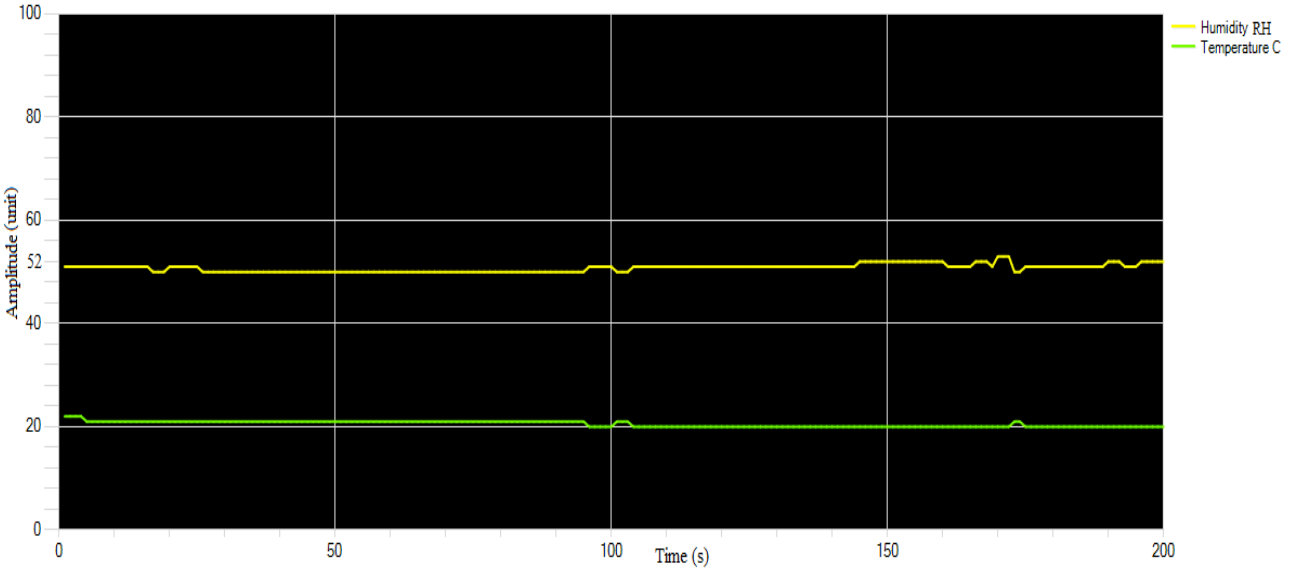

Fig. 5 Humidity and temperature sensor data using SimPlot

Fig. 6 shows the analysis of the graphical output generated on SimPlot from the data acquisition system presented in section II, which includes the input data variable1, variable2, variable3, and variable4 presented in the Data_Acquistion() algorithm (Fig. 2 of section II). Various waveforms in form of humidity, temperature (degree celsius), analog value of potentiometer, and led signal (variable1, variable2, variable3 and variable4 respectively) are shown on the figure given below. Humidity and temperature input values are plotted in yellow and green colour lines. Potentiometer and led signal values are made sky blue and pink colour. Y-axis of the graph shows the analog potentiometer value in the range between 0-1023, this is due to the fact that 8-bit sampling of analog value results in 1024 which is often done in Arduino Duemilanove platform. X-axis is the time, measuring in seconds (s). While studying the graph thoroughly, two things come into account:

1) Potentiometer analog value of 654.7 is the threshold limit to start the DHT11 producing its samples towards serial port, hence SimPlot (shown in red string line), passing through the common intersecting points of potentiometer values and led signal. Led signal signifies two things; i) physical visual output on the breadboard and ii) logical discrimination on SimPlot establishing the fact of starting and ending of DHT11sensor. Here from, one thing can be noted that DHT11 sensor becomes operational/activated (ON) after the 654.7 unit while increasing its value from 0 to10K (0-1023 analog value) in rising edge which is 6.393KΩ. (1024 analog value=10kΩ). The DHT11 sensor operational range is between 6.397 KΩ - 10KΩ.

2) Potentiometer analog value of 491 signifies the fact that DHT11 gets OFF (deactivated) during the downgrading the value of potentiometer from 10K to 0 (1023-0 analog value) in falling edges which is 4.794KΩ. The deep blue line passing through the intersections between led signal and potentiometer proves the fact. The DHT11 sensor remains OFF in the range between 4.794 KΩ - 0KΩ while on falling edge.

Both the situations comply with the led signal in cross sectioning with potentiometer signal. The cross sectional points are taken as threshold.

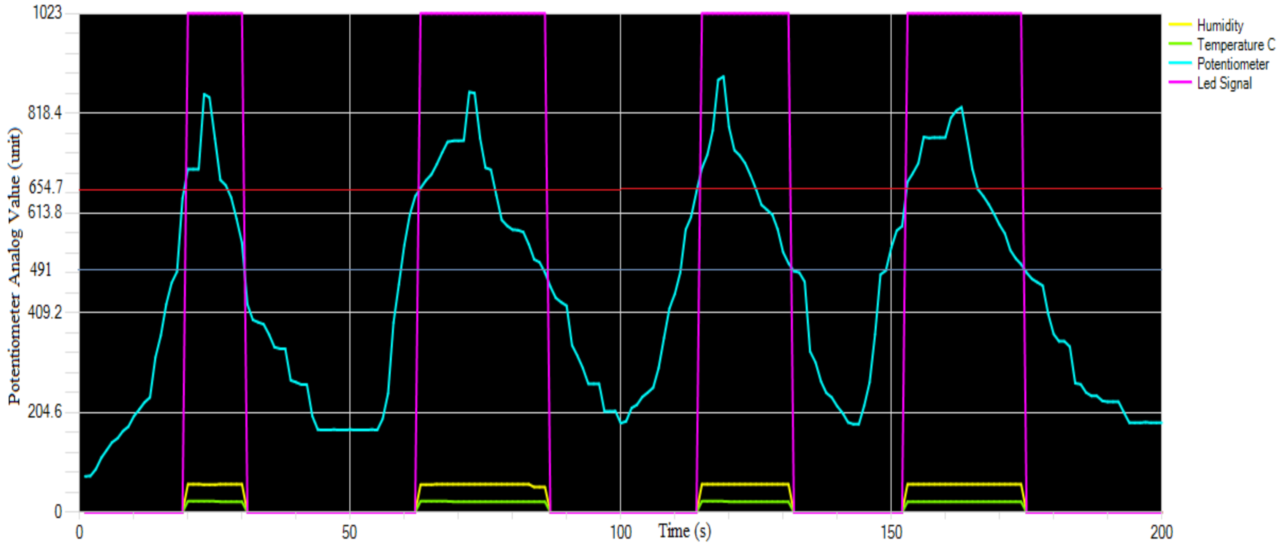

Fig. 6 Analysis of potentiometer analog reading to input data using SimPlot

IV. CONCLUSIONS

This paper presents a novel procedure to find the range of resistance of activation of DHT11 sensor using simple data acquisition system and SimPlot through serial port. The analysis part is done manually which could be automated later on, after revising in code of Simplot or integrating the values provided on SimPlot to proprietary word processor applications available in market. This area could be challenging for the researchers to take on in future.

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