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Data Acquisition System using Arduino and MATLAB

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ABSTRACT: The field of automation has influenced almost all areas and it reduces the work of humans. This easiness has made it to become more widespread across various industries ranging from manufacturing to health care. The benefits of these automations seem to be most noticeable in terms of productivity, safety, money and time. In most industries there are several equipment to sense the environment information, but it is preferable to automate the measurement process. A data acquisition system can be used as an early detector of fire in forest and also as a sensor kit in warehouses, hospitals, etc. Nowadays, embedded systems are widely used in the world. The applications of embedded systems vary from smartphones to automation. Arduino is a popular open-source microcontroller which has been widely used in many applications. Due to its low cost, convenient and flexible, it development rapidly and application widely in recent years, especially in various system prototype.

This paper describes a simple data acquisition system using Arduino and MATLAB. The objective of this work is to construct a real-time monitoring system that expresses values that occurs at high speed in a large industrial field. The Arduino has become a different application that it has developed many software to support various sensors. It has also developed software to support MATLAB which allows to obtain and plot real-time data directly from the command window. These Arduino and MATLAB can be used to automate an IoT gateway for a data visualization system like real-time infographics based on web.

Keywords: Arduino, MATLAB, IoT, Sensor, Web Socket, Real-time

1 INTRODUCTION

One of the most important parts of data visualization system is digitizing and displaying data of measurements. Some of data visualization system is running with a data acquisition system that is gathering the structured data. So, data acquisition system is important parts of data visualization system. One of the main function of data acquisition system is a converting to digital from analog data [1]. PLC (Programmable Logic Controller) is a famous one of data acquisition systems and most of PLC is a commercial systems, usually have rather high price. PLC has been widely accepted in various process industries which is a solid state device designed to perform logic functions. PLC has several known features including, flexibility, reliability, low power consumption and ease of expandability [2]. SCADA(Supervisory Control and Data Acquisition) stands for Supervisory, control and data acquisition which offers graphical visual representation of process parameters even from the remote places. It creates the possibility of controlling as well as monitoring of process parameters through GUI interface. PLC can have the communication with SCADA through tags of information. In literature, many reports are found pertinent to successful integration of PLC with SCADA for number of applications [3].

In today scenario in control industries, many more sophisticated instruments are introduced which supports higher data rate. The new enhancements made in the automation of industrial processes have been realized through OPC(OLE for Process Control) server. OPC provides the open connectivity for industrial automation. The specification is defined as set of objects, interfaces and methods to facilitate interoperability [4]. However, OPC and PLC is very expensive and exploitation cost is also expensive to consist of a small size IoT.

Nowadays, there is a possibility to design and manufacture quite simple and low-cost system on

the basis of independent embedded Arduino. Data acquisition is very important because through it, the accurate behavior of devices can be known. Data acquisition involves gathering of signals from measurement sources and digitizing the signals for analysis, storage, and displaying on a monitoring systems. Through data acquisition we can measure physical phenomenon. It could be the optical sensing value of an optical sensor, the RPM of a DC motor, altitude and latitude of a GPS, or many other things.

2 RELATED WORKS

Several works in different fields have been done for data acquisition using Arduino. Many companies and research institutes have developed various kinds of micro controller based on open source licenses. The following are some of the latest data acquisition systems designed to help a lot of developer in many situation. The well-known R&D groups MIT have invested in advanced data acquisition systems such as solar photovoltaic power generation systems, temperature monitoring systems of server room, entertainment controller like drone and etc. The developments of data acquisition systems have been published in recently year by more and more research organizations. In this paper, we focus on the Arduino, MATLAB interaction in the web environment.

In the previous research, [5] presented an application independent embedded platform for a wireless distributed data acquisition and control system. It was designed and implemented, comprises a set of nodes composed by microcontrollers, wireless communication modules based on Bluetooth technology, and sensing/actuation devices. [6] described application in medical field. In addition, this paper provide a remote monitor for measuring and analyzing along with logging of data from patients. The proposed system comprises of two parts. A data acquisition part connected to patient side and an android based display device on the receiving end. [7] designed a mobile robot which has been used for autonomous temperature measurements, as an early detector of fire in forests and also as a sensor kit in warehouses, hospitals, etc. [8] presented a simple data acquisition system based on Arduino Nano. It has been used a Bluetooth for data transmission and Android for data visualization and recoding.

3 SYSTEM DESCRIPTIONS

In this paper, the main emphasis is given on data acquisition and displaying. The data acquisition is obtained through the MATLAB and the data displaying is obtained through the web browser. So this would be more user friendly and would be cheaper way of obtaining real-time data acquisition. On the other hand the data displaying is obtained with the help of MATLAB and well-known web browser, by interfacing the TCP/IP socket.

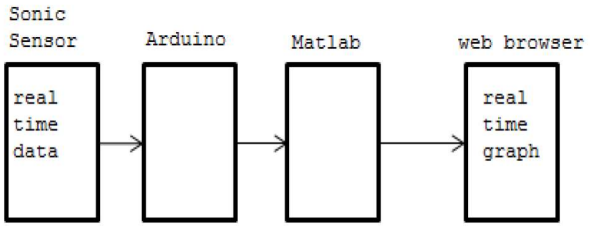

Figure 1: System Block Diagram

Figure 1 shows the system block diagram. The designed system consists of a ultrasonic sensor (HC-SR04), Arduino Uno board, USB serial cable, MATLAB and web browser. The Arduino which has been used in this paper, is a micro processing unit board based on the ATmega328P-PU. It has 6 analog inputs, 14 digital input/output pins and oscillator of 16 MHz. The Arduino has an advantage of being open source and debugging easily from any user. Arduino receives distance information from the ultrasonic sensor and sends the information to MATLAB via serial cable. MATLAB receives a data from Arduino and send the data to web browser via web socket.

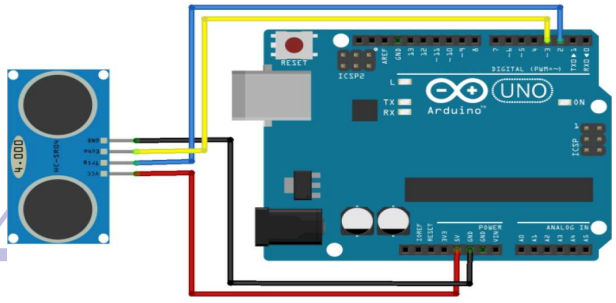

Figure 2: Arduino with Ultrasonic Sensor

Figure 2 shows the specific Arduino and ultrasonic sensor. HC-SR04 is a sensor which is able to detect the distance of obstacles, allows a maneuver or stops before a collision occurence. The sonic sensor signal is issued when it hits an obstacle, this obstacle reflects back towards the sensor. The process calculates the time that the signal spends to go to the object and go back. The speed of sound in air is 340 m/s, so it is possible to calculate the distance between the sensor until the obstacle with the time according to the following equation.

$$D = \frac{V \times T}{2} \qquad (1)$$

D, V and T denote a distance between the sensor and the obstacle, a velocity of sound in air 340 m/s, a time for the signal to reach the obstacle and go back. The equation (1) should be divided by two, because the time measured by the sensor is actually the time for the signal to go to the obstacle and back.

MATLAB can utilize all of the functions specified by Arduino.m library so as to perform digital and analog input/output functions. Then write a script to read and plot analog values from a sonic sensor according the real values obtained. The value of the sonic sensor can be transferred to the web browser by the MATLAB.

4 RESULTS OF PROBE MEASUREMENTS

In this paper, real-time graphs of sonic sensor has been obtained as shown in Figure 3 and Figure 4. In the graph, distance is being plotted against time. The distance is taken on y-axis and its unit is centi-meter and time is taken on x-axis and its unit is 100 mili-seconds.

Figure 3 and 4 show the graph on MATLAB and web browser, repeatedly, and represent an equivalent shape. This means that MATLAB can relay the data via web socket without delay.

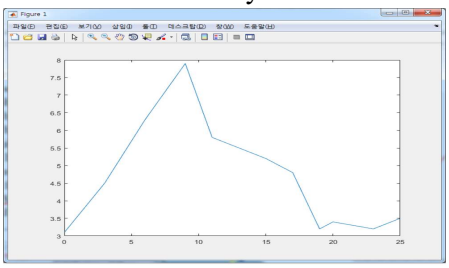

Figure 3: Graph on MATLAB

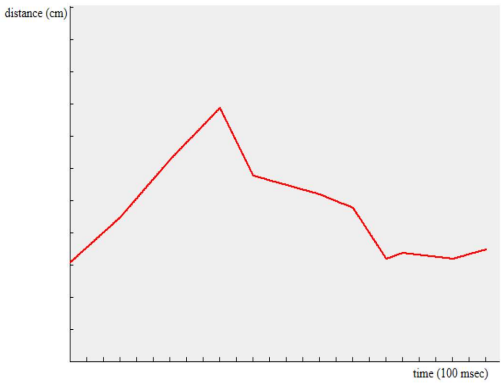

Figure 4: Graph on Web Browser

5 CONCLUSION

By using Arduino and MATLAB, data acquisition and displaying becomes very easy. MATLAB can be an interface with any analog device using Arduino, to gets the reading of the sensor and relay the data for the web based system. So that this is easy to consist of IoT gateway using MATLAB. Further in this study more sensors can be added for example temperature sensor or photonics sensor. And the behavior of the sensors can be gained through MATLAB by using real time plots.

In order to show flexibility and functionality of web based network, flexible and low cost gathering and monitoring system using Arduino as an interoperable system layer for communicating between the digital/ analog sensors and IoT gateway has been designed and implemented. Our research and experimental results have been shown that by using the MATLAB and Web browser. It can be concluded that the discussed system, and proposed prototype present the basic level of IoT gateway and web based monitoring system like web inforgraphic.

Directions of future work will be to move MATLAB to embedded linux device like Raspberry Pi or Beagle Bone. For that purpose embedded linux device will be expanded with real world.

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