Low Cost Data Acquisition and Control
using Arduino Prototyping Platform and LabVIEW

Naveenkumar R[1], Dr Prasad Krishna[2]

[1]M-Tech (Mechatronics), Mechanical Department
NITK, Surathkal, Mangalore, 575025, India
nar.11MC14F@nitk.edu.in

[2]Professor, HOD Mechanical Department
NITK, Surathkal, Mangalore, 575025, India
krishnprasad@gmail.com

Abstract*: For the shortcomings of poor flexibility and versatility of traditional industrial data acquisition monitoring system, the paper design a new type of industrial data acquisition monitoring system based on single chip computer (SCM) of ATmega32 (Arduino prototyping platform) and the LabVIEW software platform for virtual experiments. The system collects long distance data of industrial field to the PC for data acquisition and control through the USB communication, and users can set the parameters of collecting data for setting and adjustment, at the same time can be conveniently to being sampled data for storage and playback. The experiments show that the data collection and monitoring system has some features of being low cost, easy to use and a wide range of application, and has a very important application for collection and monitoring data in industrial areas and laboratory.*

Keywords: LabVIEW; data acquisition; Arduino UNO, LIFA.

1. Introduction

The main objective is to implement a low cost acquisition system intended for control applications using the Arduino prototyping platform. Arduino has become a popular open-source single-board microcontroller among electronic hobbyists, and it is gaining acceptance as a quick prototyping tool for engineering and educational projects also. The system meets the following requirements:

➢ Suitable for educational purpose
  o Low cost: The components are affordable.
  o Easy to assembly due to the constitution of the modules.
  o Able to run on different platforms: the overall system can operate in different operating systems.
  o Open hardware and open source: This means that the hardware and the software used has a public access. Anyone can use it and improve it.
➢ Suitable for control applications
  o Bidirectional: It is possible for data to be transmitted in both directions via USB serial communication.
➢ Wired / Wireless connection
➢ Autonomous or dependent system

A computer, using a control application done in LabVIEW, controls all the system by cable or wireless. This control application display all the data obtained from the acquisition system, and save it into a file document in order to obtain a history of the measures.

In this project various sensors like Infrared sensor, Light Dependant Resistors (LDR), Analog POT are used and there data is gathered using Arduino microcontroller, control action can also be done simultaneously like DC motor control using Pulse Width Modulation as demonstrated further. Simple block to demonstrate is shown in Figure 1 LabVIEW-Arduino Interaction with physical world
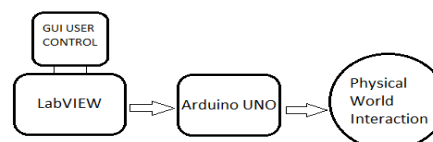

Figure 1 LabVIEW-Arduino Interaction with physical world

2. Data Acquisition System (DAQ) using Arduino

Arduino's are teeny computers with a bunch of analog and digital Input/output channels. You write programs for them and send them via USB to the device. With the appropriate program (firmware) you can have your Arduino duplicate the functionality of the USB-600x, but with much less impressive resolution and sample rate. The Arduino analog inputs are only 10-bit and my best estimate of the sample rate is roughly 100 samples per second (*you should be able to do better than this if you temporarily store data in Arduino's memory and then send it to the computer in chunks*). Keep in mind that the Arduino's only cost $30 compared to >$200 for the USB-600x (and in my example DAQ task I only needed 1 sample every 10 seconds). That resolution and sample rate is also more than adequate for monitoring and controlling a lot of experiments. You can also use the Arduino as a remote data logger and controller with the help of wireless/Bluetooth chips, SD card readers and all sorts of other fun things [3].

Considering small scale applications where accuracy and high speed is not so important, industrial scale DAQ's with high price tag is not necessary. But instead a low cost micro controller like Atmel 328 (arduino Uno) is enough to meet the requirement.

3. LabVIEW Interface for Arduino (LIFA)

The NI LabVIEW toolkit [2] helps us easily to interface LabVIEW software with Arduino microcontroller. With this toolkit and LabVIEW, you can control or acquire data from the Arduino microcontroller. Once the information is in LabVIEW, analyze it using the hundreds of built-in LabVIEW libraries, develop algorithms to control the Arduino hardware, and present your findings on a polished User Interface (UI).

A sketch for the Arduino microcontroller acts as an I/O engine that interfaces with LabVIEW VI's through a serial connection. This helps you quickly move information from Arduino pins to LabVIEW without adjusting the communication, synchronization, or even a single line of C code.

Using the common Open, Read/Write, Close convention in LabVIEW, you can access the digital, analog, pulse-width-modulated, I2C, and SPI signals of the Arduino microcontroller.

Top 5 reasons LabVIEW makes us more productive when using Arduino:

1. Interact with your system through a graphical user interface.
2. Streamline your design process with intuitive graphical programming.
3. Improve your debugging experience with interactive tools.
4. Leverage built in resources/functions for implementing simple to complex tasks.
5. Open API (Application Programming Interface) allows for complete customization.

4. Setup

1. With Arduino board ready, make sure you have LabVIEW 2009 or newer version installed.
2. Install NI-VISA Drivers.
3. Install the Arduino IDE and drivers for Windows.
4. Install the LIFA (LabVIEW Interface for Arduino).
5. Upload the sketch 'LIFA_Base.pde' to the Arduino and we are done with the setup.

5. Lab Setup

➢ To demonstrate the potential applications of the Arduino based Data Acquisition and Control using LabVIEW a simple lab setup is built as shown in the fig.1. Arduino UNO with Atmel-328 8-Bit microcontroller is used.

➢ To demonstrate the sensorial data collection ability a photocell (Light Dependant Resistor) is used and also Infrared based RPM measurement is demonstrated.

➢ Analog sensor is replaced by a Variable Potentiometer.

➢ To demonstrate the control ability a standalone DC motor controller using PWM (Pulse Width Modulation) is built using LabVIEW GUI code, Arduino and L293D motor driver IC.
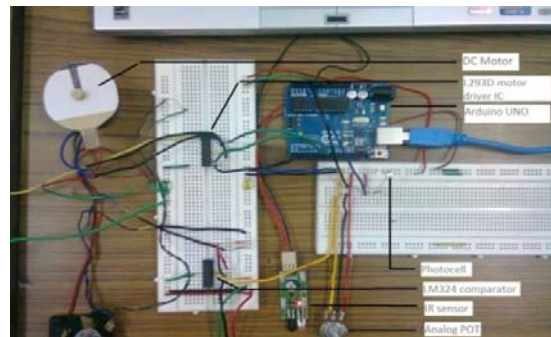

Figure 2 Lab setup

5.1 Creating

The program usually begins with the while loop on the block diagram and initializing the Arduino connections to LabVIEW interface for Arduino sketch [1]. The tools required can be found in the Arduino palette (available after installing LIFA package) as shown in the Figure 3 and Figure 4.
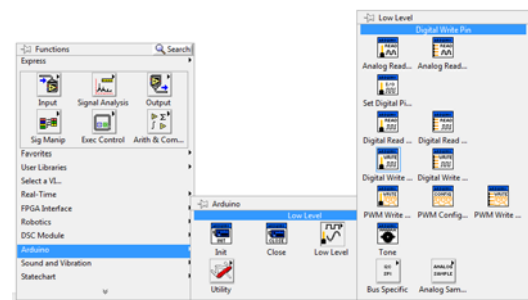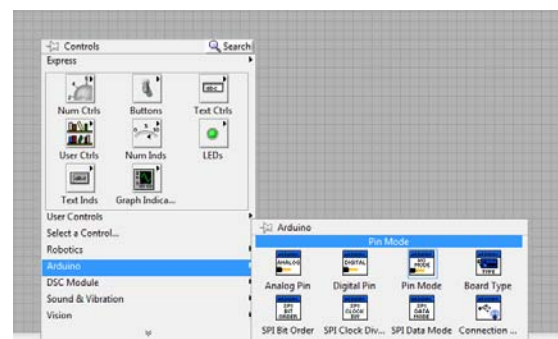

Figure 3 Block Diagram Arduino Palette

Figure 4 Front Panel Arduino Palette

5.2 DC Motor controller

DC motor control using Pulse Width Modulation (PWM) signifies the controllability of the Arduino hardware and LabVIEW software. Graphical User Interface created by the LabVIEW is extremely pleasing and user friendly. Various controls like PID controllers, Analog and digital Filters etc can be incorporated in the advance versions (PID block is available in LabVIEW control system palette) [4].Controller

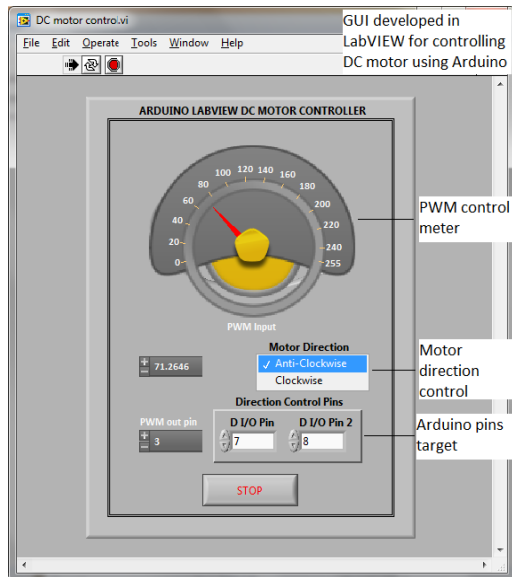created for this paper is shown in the Figure 5, also with its block diagram in Figure 6.

Figure 5 LabVIEW-Arduino based DC motor controller Front Panel
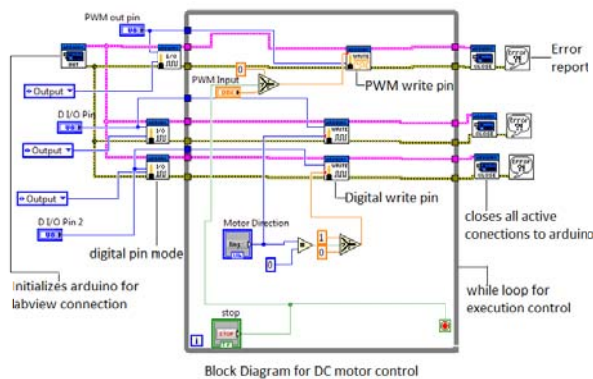

Figure 6 LabVIEW-Arduino based DC motor controller Block Diagram

The control signals are fed into the motor driver IC L293D, which handles the power required for the motor to run. Duty Cycle can be varied from 0-100% by varying the user controlled interactive graphical dial on the front panel. Even the motor direction of rotation is controlled from the front panel of program by the user PC integrated with Arduino board.

5.3 Acquiring Analog and Digital Data

Infrared (IR) sensor based proximity detector is demonstrated in the Figure 7 and Figure 8. The virtual graph in Figure 7 shows the variation with respect to the object nearing the IR sensor. The response of the system can be controlled by the sampling rate, fast response for higher sampling rate. Closer the object higher the graph value, using the calibration formula one can display the actual distance
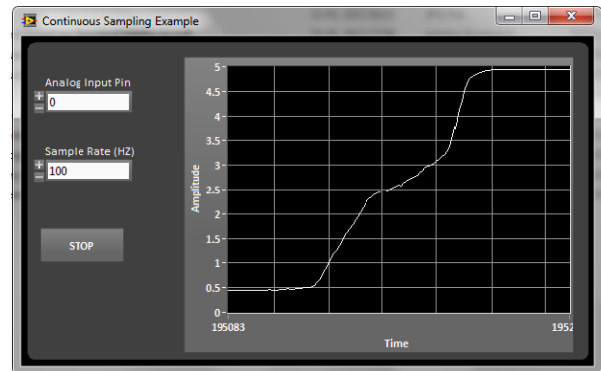
between the object and the sensor. Based on this data further control action can be triggered.

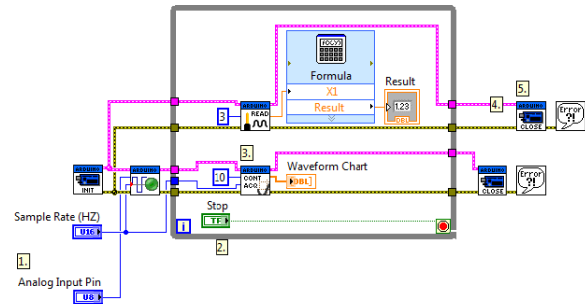**Figure 7** IR based Proximity detector front panel

Figure 8 IR based proximity sensor block diagram

Similarly various sensors can be integrated and data can be acquired for further analysis or control can be triggered based on control algorithm. Analog input meter on Figure 9 and Photocell intensity meter on Figure 10.
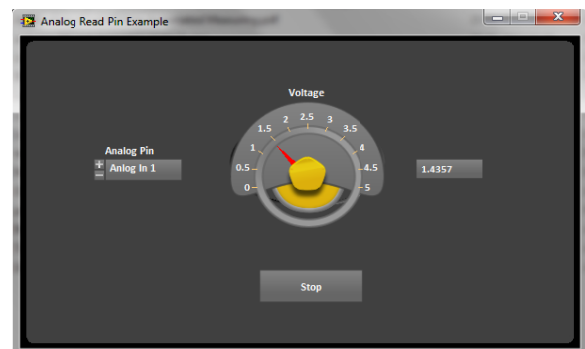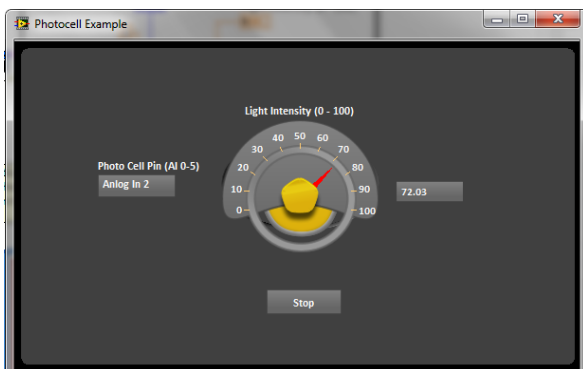

Figure 9 Analog Input meter

Figure 10 Photocell Intensity meter

engineering from National Institute of Technology, Surathkal during 1978-1983. He is currently Head of the Mechanical engineering department at National Institute of Technology, Surathkal, India.

6. Potential Applications

I. Because the hardware required is low cost and general user license potential applications is limited to the user.

- In educational institutions this apparatus can be modified to function as a Remote Virtual Lab.
- Small scale industries can employ this method of control if accuracy and speed is of less importance (since Arduino microcontroller has certain limitations over speed i.e. clock frequency).
- In a large scale farming for collecting data from hundreds of sensors like temperature and humidity sensors and then taking collective decision over a period of time for control action like sprinkler operation, can be implemented effectively and economically using Arduino and LabVIEW.

7. Conclusion

A cost effective means of employing powerful programming tool for various applications using prototyping board Arduino is developed. The potential of this method will be extended for various other engineering applications in the near future.

References

[1] National Instruments, sine.ni.com
[2] LabVIEW Interface for Arduino [LIFA], decibel.ni.com
[3] Arduino Community, arduino.cc
[4] Olden. P, "Open Loop motor speed control with LabVIEW", SoutheastCon, Proceedings IEEE, pp. 259-262, 2001, (Conference Publications)

Authors Profile

Naveenkumar R received B.E. degree in Electrical & Electronics Engineering from B.V Bhoomaraddi college of Engineering and Technology, Hubli, Karnataka, India during 2006 2010. Currently pursuing M.Tech in Mechatronics from National Institute of Technology, Surathkal, Karnataka, India under the guidance of Dr. Prasad Krishna.

Dr. Prasad Krishna received Doctor of Engineering in Manufacturing from University of Michigan Ann Arbor, USA during 1998-2001. M.Tech in Manufacturing engineering from IIT Madras during 1988-1990. He received B.Tech in Mechanical