

Designing an Online Digital Input Card with Arduino boards using OPC Server technique in Siemens 1200 PLCs

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Abstract—In this research, Arduino boards as signal modules in Siemens 1200 series Programmable Logic Controllers (PLCs) have been proposed. It should be noted that this method can be used for both analog and digital inputs. Due to the low cost of Arduino boards, this method can be used to expand analog and digital inputs and outputs in this PLC and even PLCs related to other companies. There is even the ability to monitor data with expanded inputs and outputs. Cost-effectiveness of the final price of the project will be one of the advantages of the scheme. This article consists of three sections. The first part involves connecting Arduino boards to LabVIEW software through the LabVIEW Interface for Arduino (LIFA) toolkit. The second part includes the connection of Siemens 1200 series PLCs to LabVIEW software through the Object-Linking and Embedding for Process Control protocol (OPC) Server technique. The final part involves connecting Arduino boards to Siemens 1200 Series PLCs with LabVIEW software via the OPC Server technique.

Keywords— Arduino, LabVIEW, OPC Server, PLC, LIFA

I. INTRODUCTION

In today's world of electronics, there are many development boards to get started and get projects done; two of the most popular boards are Arduino and Raspberry Pi [1]. But which of these boards is more suitable for projects? The answer to this question, the number of inputs, outputs, and the processing speed of analog and digital signals must be carefully considered. One of the most common Arduino boards is the Arduino Uno board. This board is a microcontroller based on ATmega328. This board has 14 pins of digital input and output (6 of which can be used as PWM output), six analog inputs, a 16 MHz ceramic resonator, a USB port, a power jack (power supply input), and it has an ICSP header and a reset button [2]. National Instrument has designed two different toolkits, LIFA and LINX, to communicate with Arduino boards. In other words, LabVIEW software can be used to monitor the available information as one of the most powerful software that has found a special place in the industry today. This software can perform system data monitoring, image processing, neural network analysis, etc. It also has high speed and simple programming and graphics that can make the most complex programs easily done in this software. This software can support various devices like Arduino, PLC, DAQ cards, etc. One of the advantages of Arduino boards is their ability to connect to

software such as MATLAB and LabVIEW. They have extraordinary features that can easily do the most difficult projects [3]. The S7-1200 series controllers were introduced in 2009 to control small and medium-sized industrial processes but with high precision as a suitable replacement for the S7-200 series controllers. These PLCs are also designed in two models, compact and modular, and compared to the S7-200 series, they have advantages such as higher memory volume, more programming functions, higher speed, having a Profinet port on the module, connectivity to touch HMIs, connectivity to GPRS for remote control and support of Profibus protocols. The S7-1200 has five standard CPU models called CPU1211C, CPU 1212C, CPU1214C, CPU 1215C, and CPU 1217C, and two Fail-Safe models called CPU1214FC, and CPU1215FC [4]. There are articles on data monitoring and setting up a virtual lab with LabVIEW software and control with PLC. In [5], the authors designed the virtual laboratory and remote control of electric machines of Shiraz University through real-time monitoring and control under the network. The user observes a simulated graphic page similar to the main process and can make the necessary changes through it and by applying control commands. The data related to the changes made in the client is sent to the server address with the help of the network and under a special protocol. The data received by the server is transmitted to the laboratory devices through data exchange cards and several designed electronic boards, and the main process is done with real data. After completing the test and generating the actual data from the test, the results are transferred to the server via data exchange cards. After performing a series of control operations implemented in the LabVIEW program, the final data obtained from the user control commands, under the same protocol is sent to the client's address again via the Internet. The authors have created a virtual PLC laboratory via a smartphone with LabVIEW software [6]. Also, using STL programming language and the OPC Server technique, this design has been done in the software environment. In reference [7], the authors of the article performed information monitoring operations with LabVIEW software and using Siemens mini PLCs in HEX format, so the results of this research were used in the Caspian Motor Company. In [8], improved control of two different PLCs and data monitoring were performed with the OPC Server technique in the LabVIEW software environment. Reference [9] has also designed a graphical user interface with fuzzy control and

using PLC in the LabVIEW software environment. In addition, the user can change the controller parameters online and see the effect of changes in the controller parameters on the behavior of a servomotor in real-time. In [10], Dimethoxic Propionic acid data monitoring was performed using LabVIEW and OPC techniques. Inspired by existing articles and the OPC Server technique in implementing a virtual lab, in this paper, a digital input card will be designed using Arduino boards. First, the Arduino boards are connected to the LabVIEW software via the LIFA toolkit. Then the connection of Siemens 1200 series PLCs with LabVIEW software is made through the OPC Server technique. Finally, Arduino boards are connected to Siemens 1200 series PLCs with LabVIEW software using the OPC Server technique. The results of this article were made in hardware in the form of a research project. The article contributions are as follows: First, the design of a digital input card for PLC, with an Arduino board as online. Second, is the ability to use the proposed method to design an analog input card with an Arduino board.

II. UNO BOARD CONNECTION WITH LABVIEW SOFTWARE

National Instrument has designed the LIFA toolkit to connect to Arduino boards. To conduct research, the LIFA toolkit has been used in the LabVIEW software. In Figures 1, and 2, the control panel of LabVIEW software has been designed practically with the Arduino Uno board. The third pin of the Arduino board is considered to be the START button, and the fifth base is the STOP button, which are the digital inputs of the project.

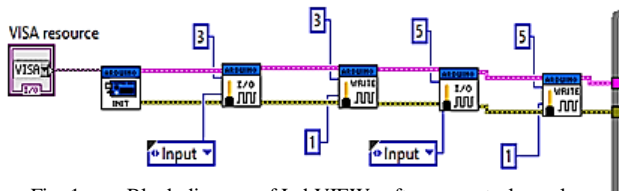


Fig. 1. Block diagram of LabVIEW software control panel

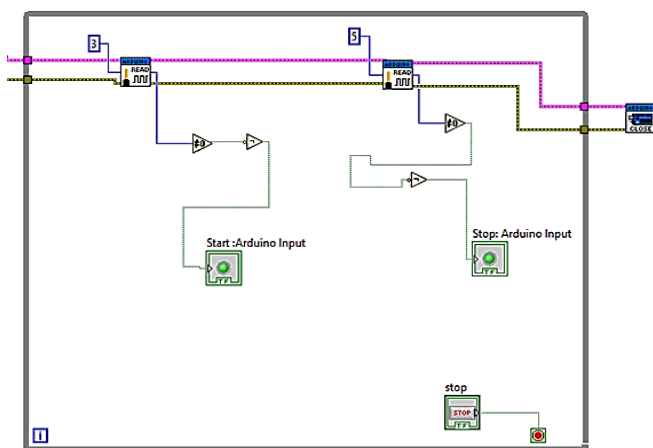


Fig. 2. Block diagram of LabVIEW software control panel

III. SIEMENS 1200 SERIES PLC CONNECTION WITH LABVIEW

1212C CPU is used to connect the Arduino board to the PLC. Figures (3), (4) first show the program in the ladder programming language. The inputs in the program are defined with the third pin Arduino for START and the fifth pin Arduino for STOP. The program's function is that by activating pin 3 of Arduino, the first output of PLC is triggered first. Then, the second output is triggered after five seconds, and finally, the third output is triggered after five seconds. By activating the fifth pin of the Arduino, all three PLC outputs are disabled.

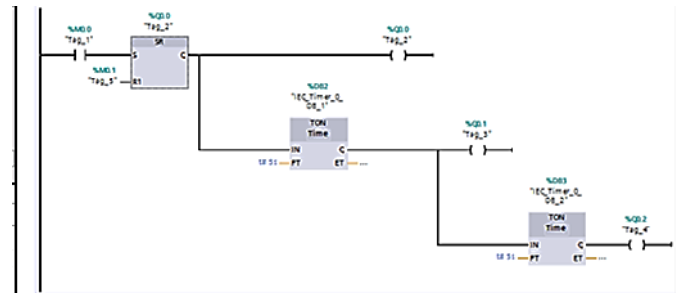


Fig. 3. Ladder programmer language (Network1)

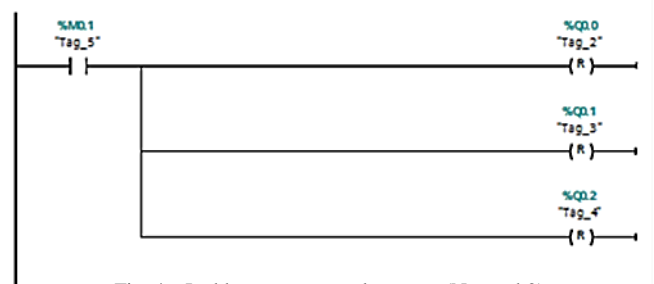


Fig. 4. Ladder programmer language (Network2)

Figure (5) shows all the input /output tags of the project in the NI OPC Server and OPC Client environments.

NI OPC Servers - Runtime					
Tag Name	Address	Data Type	Scan Rate	Scaling	Description
Memory1	M0.0	Boolean	100	None	
Memory2	M0.1	Boolean	100	None	
output1	Q0.0	Boolean	100	None	
output2	Q0.1	Boolean	100	None	
output3	Q0.2	Boolean	100	None	

OPC Quick Client - Untitled *			
Item ID	Data Type	Value	Timestamp
Test.service1_Rack	Byte	0	11:56:54.525
Test.service1_Slot	Byte	1	11:56:54.525
Test.service1.Memory1	Boolean	Unknown	11:56:57.526
Test.service1.Memory2	Boolean	Unknown	11:56:57.526
Test.service1.output1	Boolean	Unknown	11:56:57.526
Test.service1.output2	Boolean	Unknown	11:56:57.526
Test.service1.output3	Boolean	Unknown	11:56:57.526

Fig. 5. OPC Server

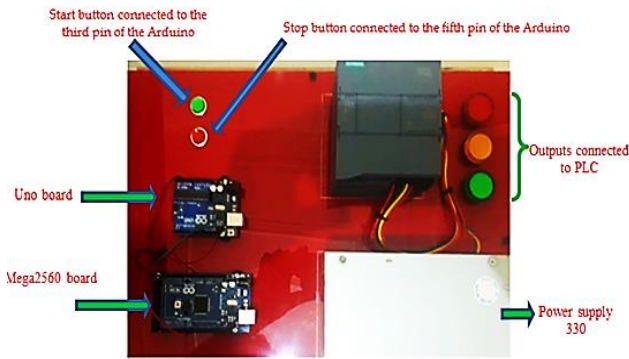


Fig. 6. Experimental setup

Figure (6) shows the image of the implemented hardware. In addition to Arduino Uno boards, Mega2560 boards have been used in the project to verify the proposed method. The proposed method uses memory bits or flags in the PLC programming language as the START and STOP in the Arduino. Note that to use analog inputs in Arduino; you can use its zero to fifth pins and memory byte or WORD in PLC programming. Since in peripheral addressing, it is not possible to address in bits, addresses must be byte or WORD.

IV. CONNECTING ARDUINO BOARD WITH SIEMENS 1200 SERIES PLCs

In this section, according to the designs and settings, in the front panel of the LabVIEW software, Arduino inputs and PLC outputs are illustrated.

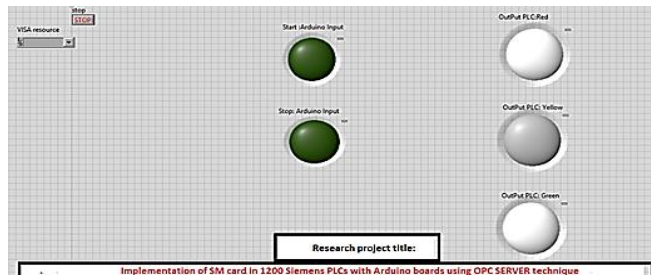


Fig. 7. LIFA toolkit used in the front panel window

In Figure 8, the block diagram of the proposed method is drawn.

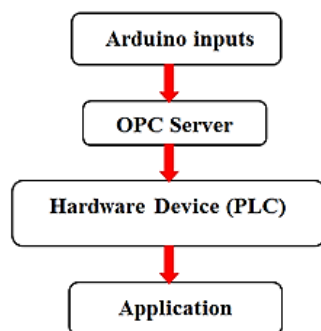


Fig. 8. Block diagram of the proposed method

Table I shows the addresses of Arduino inputs and PLC outputs.

TABLE I. ADDRESSES OF ARDUINO INPUTS AND PLC OUTPUTS

Output 1(PLC)	Q0.0
Output 2(PLC)	Q0.1
Output 3(PLC)	Q0.2
Input 1(Arduino)	M0.0
Input 2(Arduino)	M0.01

V. CONCLUSION

One of the essential points in industrial automation is the cost of its implementation. Due to the high price of input /output cards in PLCs, Arduino boards as online input cards were suggested in this article. M0.0 memory bit was used for the third base of the Arduino, and an M0.1 memory bit was used for the fifth base of the Arduino. The proposed method was successfully verified on two models of Arduino. The subject of future research is the use of Arduino boards as analog inputs in the PLC, using byte memory or WORD, in the temperature control process.

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