Multi-Vendor Remote Monitoring and Control System for Hydraulic Drive Systems

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Abstract— **The main idea of this paper is to interface two most powerful technologies LabVIEW (Laboratory Virtual Instrument Engineering Workbench) ,PLC(Programmable Logic Controller) and internet control which are ruling the industries and lead to many new features like acquiring data at faster rate, controlling the process accurately, providing multi-tasking operations, remote controlling and several other features. The aim of this paper is to provide more effective and efficient process control and automation by interfacing Allen-Bradley PLC with LabVIEW 10.0 software using OPC Server which is a complete communication server providing plant and floor device connectivity for a wide variety of platforms. Also to control the industrial processes remotely with web publishing tool which can implement a powerful real-time performance monitoring and control system using graphical programming with LabVIEW. Thereby creating a multivendor system, in Automation Company which can choose and apply the best products and systems for any given application often requires investing a significant amount of money on system integration. A Hydraulic Drive System is connected to PLC I/O module and controlled remotely through Internet using OPC as an interface between PLC and LabVIEW.**

Index Terms—**LabVIEW, PLC, web publishing, remote monitoring, control, automation**

I. Introduction

Most manufacturers pressing need of making hardware and software work together. The main problem of manufacturers is interfaces not standard. The proprietary system not integrates among each other. The solution is having a standard that provides real plug-and-play software technology for process control and factory automation for every system, every device and every driver can freely communicate, connect and integrated. The standard is OPC (OLE for Process Control) where OLE is Object Linking and Embedding. OPC will mean the dawning of a new day for users of industrial software and hardware.

Also remotely control applications over a wide area had been commonly used in the industries today. One of the common applications requires remote control and monitoring is Stepper motor drive system. Drive system has various types of controller, in order to perform some actions such as control the speed, forward and reverse turning direction of the motor. This approach can be done by Programmable Logic Controller (PLC), and with the rise of the technology, will be used in order to achieve the remote control system. Plus the PLC today can be controlled not only using its original software, but 3rd party software as well, such as LabVIEW. Whereas the OPC Server will provide interface between LabVIEW and PLC.

With this en-user will receive benefit not only from the improvement in salability and integration, but also from continual improvement in technology. Vendors of industrial application, who until now spent time and money on developing software incompatible with other vendors' products, will now make an effort to develop high-quality products totally compatible with all applications. Improvement in function, quality and service will be possible throughout the industry. And enabling the remote panels feature of LabVIEW in a process that walks the user through the creation of a Web page that automatically embeds the appropriate LabVIEW application into the new Web Page.

This paper implements the idea of adding advanced analysis and control functionality to any PLC using the OPC servers with LabVIEW software and web based control for real time systems to solve the problem of remote monitoring and control.

II. OPC Server For LabView – PLC Integration

A Programmable Logic Controller (PLC) is a digital computer used for automation of processes which is designed for multiple inputs and outputs. Programs to control machine operation are typically stored in battery-backed or non-volatile memory. A PLC is an example of a hard real time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result.

But one major disadvantage of PLCs is lack of standardization. This causes a lot of confusion if the PLC used for an application is replaced by one from a different manufacturer, or if a PLC programmer is replaced by a person with a different understanding of PLC programming. The Ladder Logic or FBD Logic which are used to program PLCs are very tedious to work with. This makes the programming a very challenging and difficult job.

LabVIEW ties the creation of user interfaces (called front panels) into the development cycle. LabVIEW programs/subroutines are called virtual instruments (VIs). Each VI has three components: a block diagram, a front panel, and a connector panel. The last is used to represent the VI in the block diagrams of other, calling VIs. Controls and indicators on the front panel allow an operator to input data into or extract data from a running virtual instrument. However, the front panel can also serve as a programmatic interface. Thus a virtual instrument can either be run as a program, with the front panel serving as a user interface, or, when dropped as a

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node onto the block diagram, the front panel defines the inputs and outputs for the given node through the connector pane. This implies each VI can be easily tested before being embedded as a subroutine into a larger program.

The graphical approach also allows non-programmers to build programs simply by dragging and dropping virtual representations of lab equipment with which they are already familiar. With LabVIEW Creating our application is as simple as dragging and dropping graphical functions and wiring the objects together to form a dataflow program with LabVIEW which is a graphical programming. Before OPC, we had to write separate client application code to communicate with each device.

OLE for Process Control (OPC), which stands for Object Linking and Embedding (OLE) for Process Control, is the original name for a standard specification developed in 1996. OPC servers provide a method for many different software packages to access data from a process control device, such as a PLC (Programmable Logic Controller) or DCS (Distributed Control System). Traditionally, any time a package needed access to data from a device, a custom interface, or driver, had to be written. The purpose of OPC is to define a common interface that is written once and then reused by any business, SCADA, HMI, or custom software packages.

Once an OPC server is written for a particular device, it can be reused by any application that is able to act as an OPC client. OPC servers use Microsoft's OLE technology (also known as the Component Object Model, or COM) to communicate with clients. COM technology permits a standard for real-time information exchange between software applications and process hardware to be defined.

The basic concept in OPC is that we have an OPC Server and one or more OPC Clients that communicate with the server in order to write or read data. An OPC server has implemented a set of services, and the clients are using these services. At a high level, an OPC server is comprised of several objects: the server, the group, and the item. The OPC server object maintains information about the server and serves as a container for OPC group objects. The OPC group object maintains information about itself and provides the mechanism for containing and logically organizing OPC items.

An OPC Client can connect to OPC Servers provided by one or more vendors. Tags are used a lot in the process industry and are normally assigned to a piece of information. A tag consists of a name describing a single point of information so a process system can consists of hundreds and even thousands of tags. The OPC server has one tag for each measurement points and controller points in the plant and it is the responsibility of the OPC server to get the information from the controllers. This is one of the reasons for the complexity of the servers; they need to have drivers for a lot of controllers and measurement systems.

OPC Servers provides a single consistent interface to communicate with multiple devices, saving you from learning new communication protocols or spending time understanding new applications. The combination of OPC Servers and LabVIEW provides a single platform for delivering high performance measurements and control to both new and existing industrial systems. The OPC servers connect through the OPC client in LabVIEW Data logging and Supervisory Control (DSC) Module to enable you develop a fully fledged HMI/SCADA system with PLCs, PACs and smart sensors.

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LabVIEW software can communicate with any programmable logic controller (PLC) in a variety of ways. OPC Servers are available for virtually all PLCs.

Now, this cross connectivity between LabVIEW and PLC is done through OPC server which results in complete control of PLC hardware under LabVIEW software as shown in figure 1.

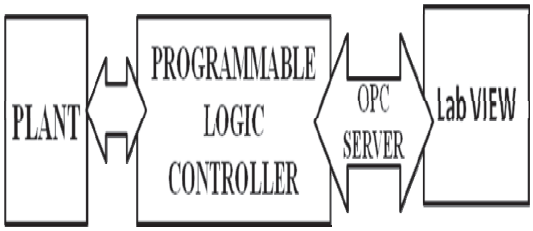

Figure1. PLC LabVIEW Interface with OPC Server

At the other end we use LabVIEW to connect to this OPC server through OPC Client. OPC Client is software that connects OPC servers provided one or more vendors as shown in Figure 2.

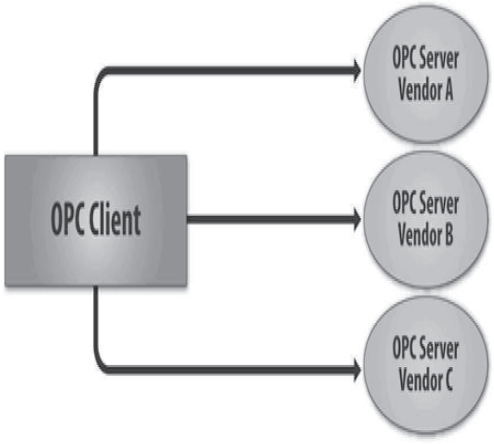

Figure 2. OPC Client and Server

III. Hydraulic Drive System

A Hydraulic Drive System is connected to PLC I/O module and controlled remotely through Internet using OPC as an interface between PLC and LabVIEW. The Hydraulic drive/actuator is used for loading and unloading application as shown in Figure 3.

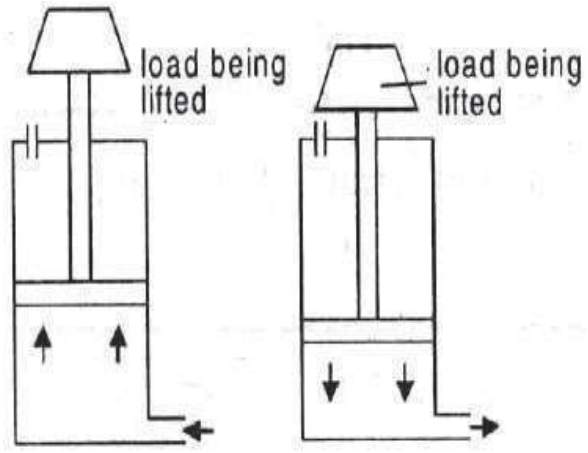

Figure 3. Loading and Unloading with Hydraulic Actuator

Hydraulic systems are used to control & transmit power .A pump driven by prime mover (electric motor) creates flow of fluid. An actuator is used to convert the energy of the fluid back into mechanical power. Amount of output power developed depends upon the flow rate, pressure drop across the actuator & its overall efficiency. Fluid enters through inlet port into piston end or blank end–pressure build up-force generation on piston-movement of piston –extension or forward stroke. Retraction or return by compression spring or under the influence of gravity.

This Hydraulic System is shown in figure 4.

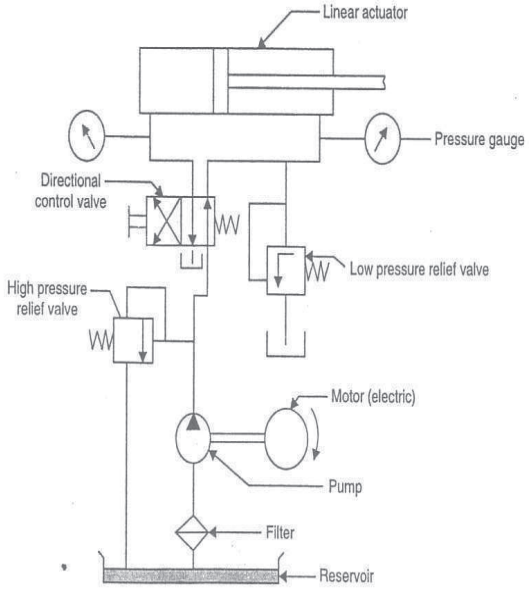

Figure 4. Hydraulic Drive System

Initially the motor is switched ON and then the Hydraulic drive/ Actuator arm is operated based on the requirement and conditions. The condition for activating the Hydraulic drive/ Actuator arm upwards is set when the micro switch sensor (forward) of lower position is active .When the Hydraulic drive/ Actuator arm moves up the upper micro switch sensor is activated and the condition is reset.

The condition for bringing Hydraulic drive/ Actuator arm downwards (retract) is when the micro switch of upper position is active .When the Hydraulic drive/ Actuator arm reaches the lower position, the lower micro switch sensor is activated and the condition is reset. To have forward (up) or Reverse (down) movement of the hydraulic cylinder piston, activate the corresponding solenoids with PLC.

IV. Remote Monitoring And Control With Web Publishing For LabVIEW – Internet Application

Remote Monitoring and Control can be performed in LabVIEW by using the Web Publishing Tool. LabVIEW uses its own web server to publish the front panel to a web browser so the VI can be accessed remotely. Web Publishing Tool is a tool which can help to publish VIs (Virtual Instrument which is a LabVIEW program) on the internet. It generates a URL which can be used to access the VI from any computer with an active internet connection. From the Tools Menu in LabVIEW, select the Web Publishing Tool, The web publishing tool dialog box appears. Change the Viewing Options either Monitor or Embed as shown in figure 5.

Monitor is the simplest kind of remote connection and it allows a remote computer to view the operation of the file. Embed gives a remote connection that allows a remote computer to control the operation of the file. Take this in steps. Click on Save to Disk.

Now save the Webpage to the default location with the default file name. The web publishing tool should then display the web address to use to remotely monitor the VI (program) as shown in figure 6.

Write this web address down as it will be necessary to enter this on a different computer to observe the VI. Then Click OK to close the Document URL dialog box. Then click Start Web Server in the Web Publishing Tool Dialog Box and then click Done. Now Run the program.

One can also select the Preview in Browser button at any time to see what your current settings would look like in a Web browser. The next screen allows to create the document title, header, and footer for the Web page where the VI will be published.

Go to a different computer and open a web browser. Enter the website into the Address box of the web browser, while the program is running. The Front panel should be displayed.

At this point, one can view the user interface over the Web. To obtain control, right-click within the web page and select Request Control of VI. Now the VI can be controlled remotely. One can now run the VI, interact with controls, and view data in indicators as if viewer was running the VI from within the development environment. Another user at a different location can also open a Web Browser and navigate to the specified URL and now have their own instance of this VI that can be controlled without being affected by any other user connected to the URL.

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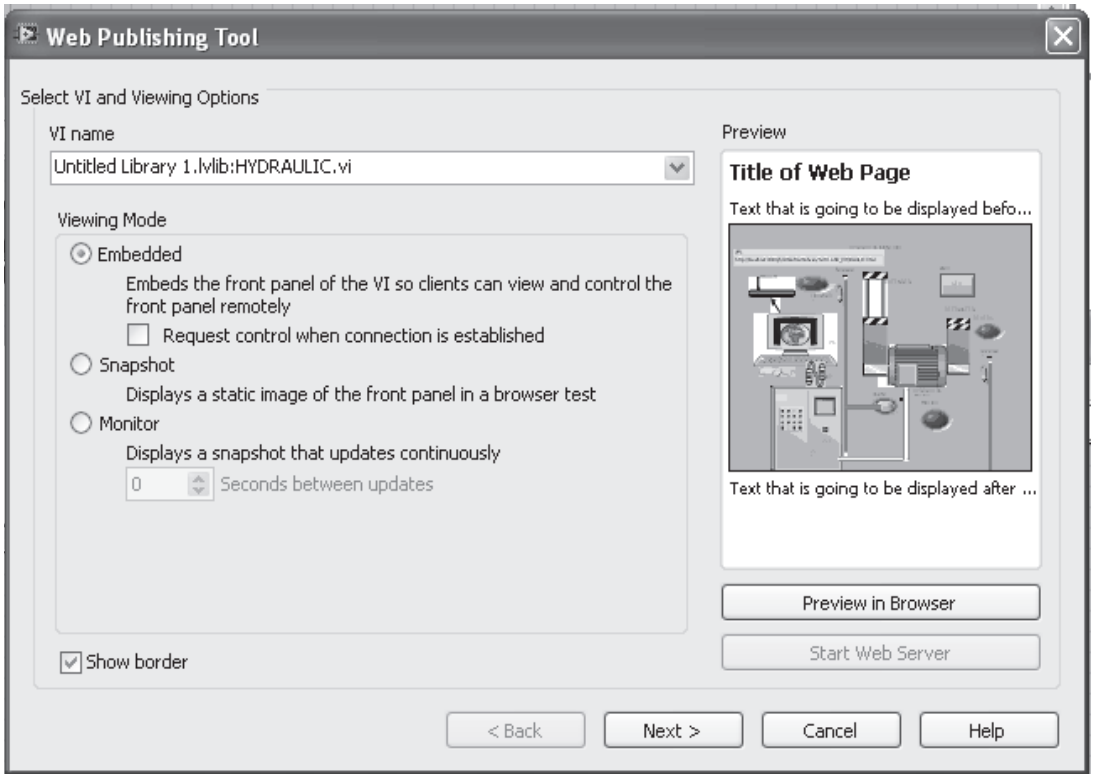

Figure5 .Web Publishing of Remote monitoring and Control of Hydraulic Drive Control

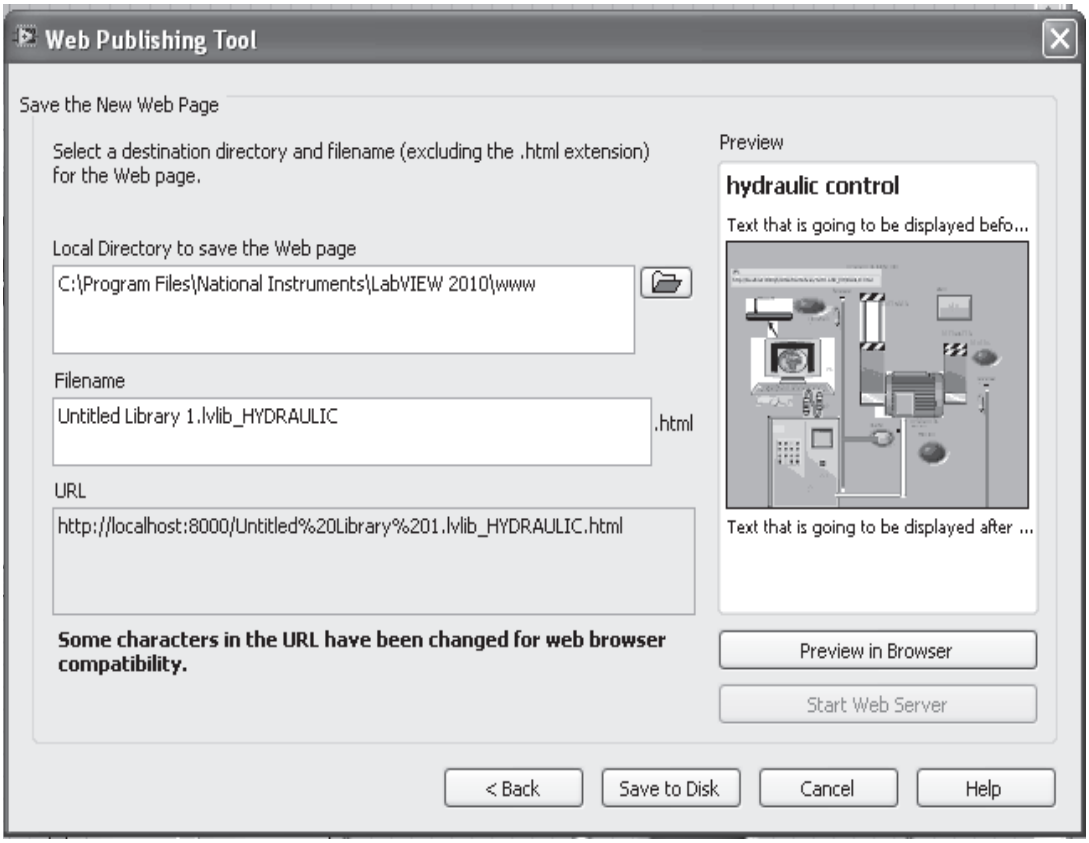

Figure 6.Creating URL for the LabVIEW VI by Web Publishing of Remote monitoring and Control of Hydraulic Drive Control

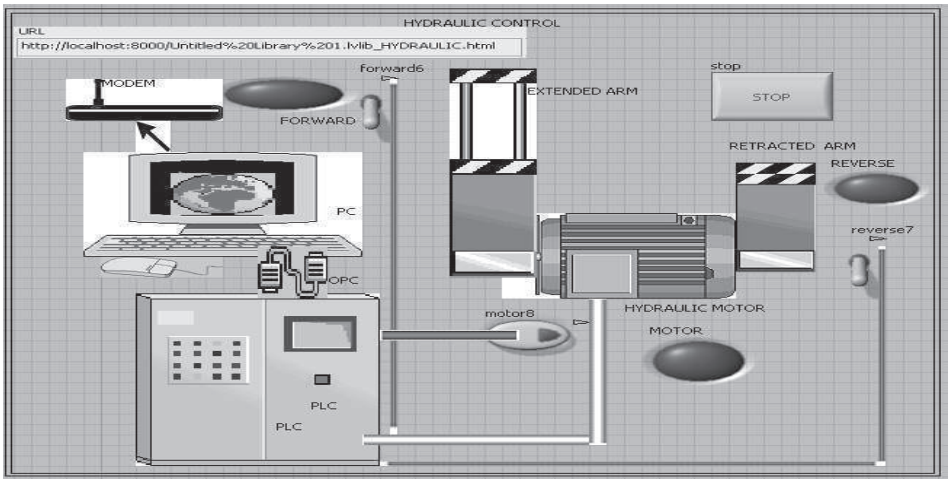

Figure 7. Front Panel of Hydraulic Drive Control with PLC –LabVIEW interface via OPC

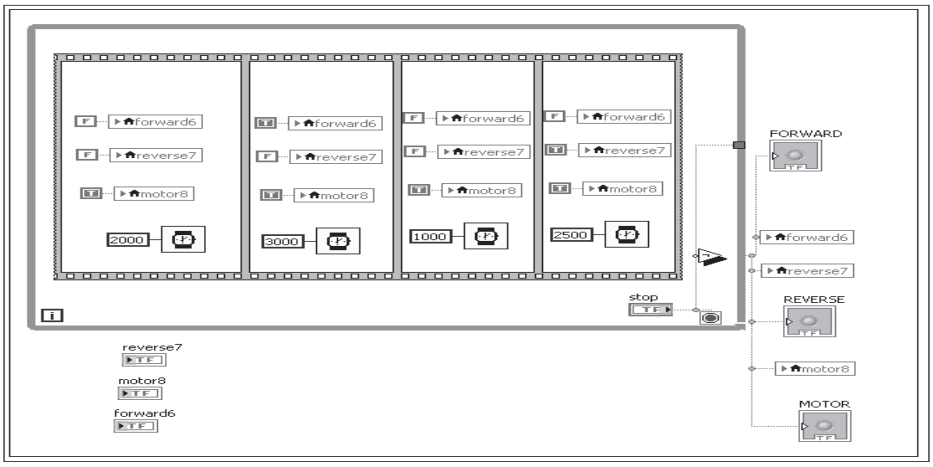

Figure 8. Block Diagram of Hydraulic Drive Control with PLC – LabVIEW interface via OPC

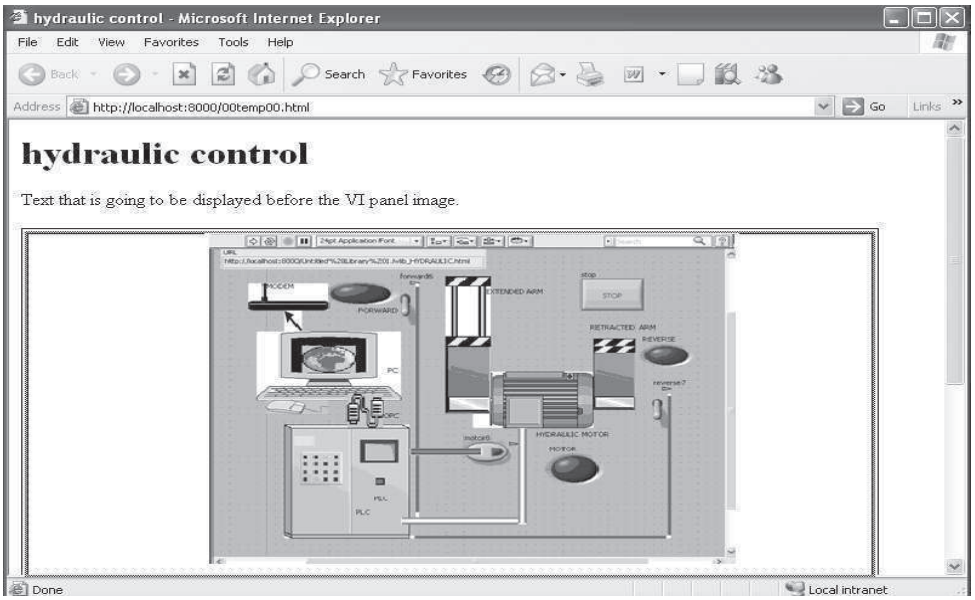

Figure 9. Remote monitoring and Control of Hydraulic Drive Control By Internet Access.

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V. IMPLEMENTATION

Following steps are implemented to achieve desired objective to monitor and control Hydraulic drive/actuator.

1) Connecting PLC to the computer using an RS232 serial communication cable and also connecting sensor and actuator to PLC I/O module.
2) Configuring PLC Driver.
3) Creating new OPC Server
4) Creating a new Group
5) Creating Item/Tag
6) Creating new I/O variables.
7) Selecting data type.
8) Connect LabVIEW to OPC Tags by Creating an I/O Server.
9) Creating and Running VI as shown in Figure 7 and Figure 8.
10) Publishing this VI through web publishing tool.
11) Using created URL, monitoring and controlling the Hydraulic drive remotely. Thus now the control is transferred to remote place as shown in Figure 9.

CONCLUSION

Thus interfacing two most powerful technologies ruling the industries lead to many new features like acquiring data at faster rate, controlling the process accurately, remote controlling and several other features. Thus the PLC has been interfaced with LabVIEW through OPC Server and hydraulic drive system which is a real time processes have been controlled. Also the OPC enables a fully scalable solution for future changes and expansion. Thus the users will be no longer tied or locked in to a single vendor.

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