INDUSTRIAL AUTOMATION WITH ELECTRO–PNEUMATIC SYSTEM USING PLC & WIRELESS/LAN ENVIRONMENT - A REMOTE EXPERIMENT

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Abstract - With the advancement of new technologies, automation plays a vital role in industries. Through automation one can run a system or a plant with least effort. The history of automation can be traced since ancient times, when the wheel (3200 B.C.) was invented. This development of technology kept on going on for the betterment of mankind so as to help the work done in lesser efforts and to get maximum efficiency. Steam boats (1787) and first programmable logic controller (PLC-1969) and commercial personal computer (PC-1978) are some of the important inventions of this era. Thus the advancement and enhancement in these technologies is an ongoing process.

This Research paper is an attempt to develop virtual automation and utilise it for remote experimentation. The experiment represents the automatic control of Pneumatic equipment which can be remotely operated through PLC using Wireless technology from any location of the lab/Institution. The Laboratory is equipped with LAN system & Wireless technology and it allows to control through remote access & monitor in a real time environment from any location of the Institution. The structure of the entire system and the developed virtual environment is described in this paper. This allows industry personnel/students to carry out experiment/ automation without location restriction. The performance & functionality of the system is validated by faculties & group of students. The results of the experiment set-up are presented here.

1. Introduction

Automation means to run the things automatically through electronic controllers. While in automation, other systems are also necessary such as electrical control signals, computerized network and mechanical device. The history of automation can be traced since ancient times, from the development of wheel (3200 B.C.) to Steamboats (1787). After the first steam engine in 1765, many other automated equipment came into picture, around 1969, first programmable logic controller was introduced and in 1978 first commercial personal computer (PC) had been introduced. Automation can be done for any system in a plant or in a machine, the plant automation can be done with the electronics circuits and/or through PLC (programmable logic controller).Now a days automation is done through small microprocessor chip, or Supervisory Control and Data Acquisition

(SCADA),and Distributed Control System (DCS).

A. Automation

Automation is the technology by which a process or procedure is accomplished without human assistance. It is implemented executing instructions in form of a program combined with a control system, this works to automate a process. Although automation can be applied in a wide variety of areas, and it is most closely associated with the manufacturing industries. The controlling of the plant can be done by automation, through PLC using input-outputs as per process requirement to avoid lacking of process and its measurements. [1].

B. Basic elements of an automated system -

An automated system consists of three basic elements.

a) Power to accomplish the process and operate the system

b) A program of instructions to direct the process, and

c) A control system to activate the instructions.

C. Advanced automation functions

Advanced automation functions include the following.

   a) Safety monitoring

   b) Maintenance and repair diagnostics.

   c) Error detection and recovery.

2. Description of the System.

A. Overview of the entire system.

The Electro–Pneumatic system is configured in lab, with connection to PLC and the same is connected to Intranet i.e. Local Area Network (LAN) of the Institution, Project Manual [2,3]. Later the PLC program is incorporated in the computer using PLC software. The interfacing through WiFi, using Virtual Environment for remote access [4], & Electro–Pneumatic within web learning [5] is shown in Block diagram, Figure 1.

Apart from this PLC software is required to interface with Electro – Pneumatic circuit &

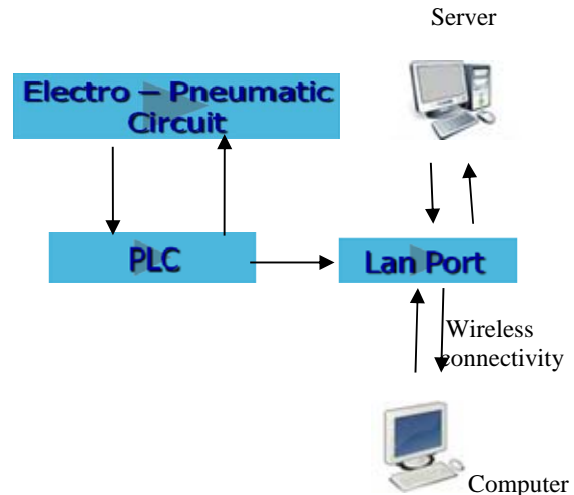PLC, and I/O box which is connected with PLC for connection.

Figure 1. Interfacing Electro-Pneumatic circuit with PLC and PC using Lan & WiFi.

Virtual presentation is developed using Wireless/LAN connectivity & Electro – Pneumatic Circuit to perform the process.

In this, manual operation is replaced by remote access from computer. The program for PLC is made in computer and with remote access through server it is feed in PLC, later by pressing Virtual start button in computer the operation is performed which operates the Electro – Pneumatic circuit. If virtual stop button is pressed the operation stops.

The users can operate the same from any place using LAN cable or WiFi and Institute/organization server.

B. Description of Electro–Pneumatic Circuit.

The Electro–Pneumatic circuit consists of three double acting cylinders, controlled by three electrically actuated 5/2 way (i.e. 5 stroke 2 position) single solenoid spring return valve, respectively. An output port of the valve supply compressed air to the pneumatic system, Figure 3. Flow control valves can also be used to control the speed of cylinders in both the direction, Simulation [6]. For example, its application can be used, in Industries, for clamping & bending a metallic sheet or in any other application. More details of the set-up can be had from the Pneumatic Trainer Bosch-Rexroth Manual [7].

Regarding the electrical part of the circuit, the solenoid coils thus actuate the valve simultaneously, the two cylinder clamps the object and bending operation takes place.

While pressing the start button from PC in the program or manually, the two Solenoids energizes & thus the respective cylinders moves forward facing opposite to each other to clamp the object.

There is a timer which delays timing between the clamping cylinder 1 & 2 and Bending cylinder 3. After the time delay for 2sec, the Solenoid Y3 is energized, thus enabling the cylinder 3 to perform the bending operation.

After the execution of bending operation another timer executes delay to the operation for 2sec to ensure that bending is complete and then the cylinder 3 retracts to its home position. Thus after completion of bending operation one more timer executes and with another delay of 2sec both clamping cylinders retracts thus completing the whole cycle.

Further this cycle continues until the stop button is pressed remotely or manually.

The movement of the cylinder takes place with the help of PLC interfacing. The start button gives signal to PLC, where it processes the signal and gives the output. The input to PLC is given by two components i.e. start button and stop button.
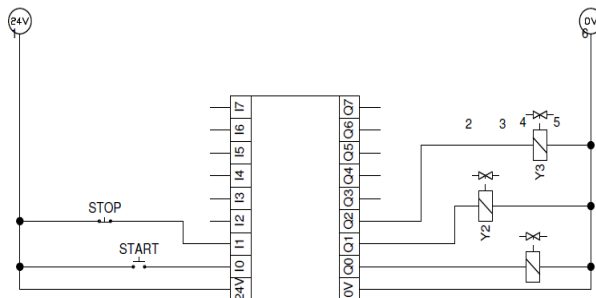

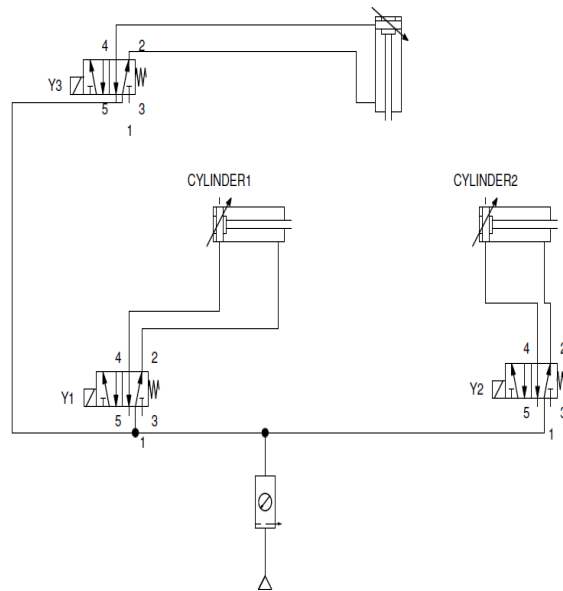Figure 2. PLC connections with hardware units as start button & solenoid valve.

Figure 3. Electro – Pneumatic circuit diagram. Simulation[6]

3. Implementation of the virtual environment

For system implementation in a virtual environment, PLC software is installed in Laptop/PC, & programming is incorporated. PLC should have I/O modules with input output connection interface, and connected to LAN port via Ethernet cable.

PLC programming is done, from any location, through LAN or WiFi in real time. Programming with Indra Logic [8,9,10] has been performed. Based on the physical connections done to PLC & Electro–Pneumatic system, the interfacing takes place and thus the circuit works. The circuit works in simulation mode, by pressing the START button in the program, thus PLC executes the same and stops when STOP button is pressed.

3.1 Physical Instrumentation :

The PLC and Electro–Pneumatic circuit representation has been implemented in one of the Bosch centres for Automation technologies in India, shown in Figure 4. [11,12].
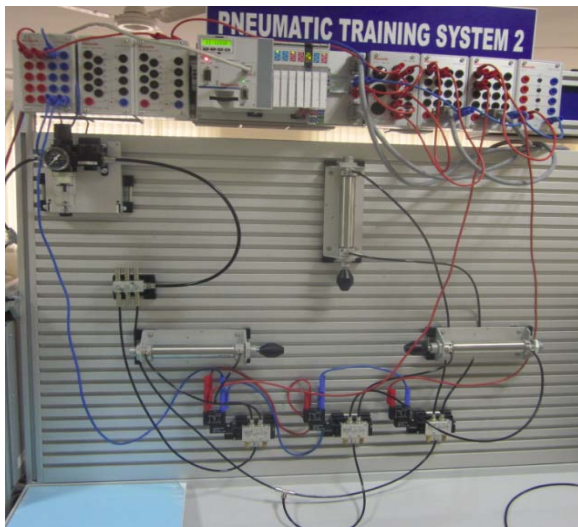
Figure 4. Entire Electro – Pneumatic with PLC circuit diagram in Lab

The main programming of the PLC is in Relay Ladder Logic (RLL) diagram and shown in the figure 5.
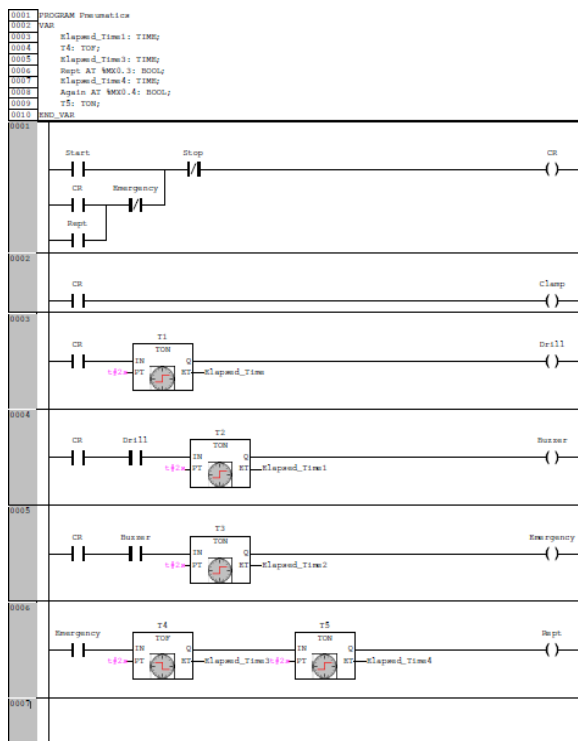

Figure 5. PLC Programming – Ladder diagram.

The equipment is physically installed at the laboratory. The Figure 5 shows the Virtual RLL diagram developed equivalent to the Physical System. This virtual instrument was created so as to ensure that the user has the required knowledge to perform the experiment and to control the physical system remotely.

4. Remote access operation

In the perception of Industry personnel/students, the remote operation of the system have shown that WIFI is a powerful learning tool, for use of resources in digital & collaborative schemes. Remote access can be used to program PLC through server in real time by one user at a time.

5. Results and evaluation

The virtual environment for the control of the Electro–Pneumatic circuit was implemented both locally and remotely. The Electro–Pneumatic circuit was connected employing Bosch Rexroth equipment, in Bosch Rexroth Centre of Excellence for Automation Technologies available in one of the Institution i.e. in SDMCET, Dharwad, India.

First of all, the system was locally implemented and the working was as per our expectation. The virtual instrument was executed and tested in order to verify for its proper functioning. Once the functionality of the virtual environment was validated, a group of faculty/students was selected to evaluate the remote operation of the system and find out the signal propagation parameters.

This evaluation was divided into two stages: first, it was checked by manual operation from the switches on Pneumatic board in Lab. Second, it was checked through remote operation with the help of WiFi, & PC, the result was evaluated for the first cycle of operation in laboratory by faculty/students. The Pressure is kept at 6 Bar in both the cases and as per the standard Process Measurement practices [1]. Evaluation is shown in the Table 1,

Table 1. Signal Propagation Time

Operation	Time taken per cycle	
set	for one set with Faculty	For other with Students
Manual	9.09 Sec	9.25 Sec
Remote Access (LAN/WiFi)	9.13 Sec	9.34 Sec
Time Lag	0.04 Sec	0.09 Sec

In general, the remote approach was well accepted by the Faculties/students, who also suggested that it is a useful learning instrument.

6. Conclusions and further work -

The overall structure for industrial automation using LAN & WiFi has been successfully developed and presented. The system allows remote access to the experiment; it consists of control and monitoring of an Electro – Pneumatic circuit, and represent an industrial process, which can be implemented for better performance.

Remote operation of the experiment permits flexibility, the use of resources in digital & collaborative platform among various automation industries/academia, giving access to experimental & training, regardless of their location.

The study on perception of students/industry persons, about this remote laboratory practice is still in progress and likely to be implemented shortly. The system will be integrated as a part of the industrial automation curricula.

Future work is focused on the development of other experiments for industrial automation for control of Electronics, Mechatronics and Hydraulics devices, adding a new faster and a convenient mode of delivering training and implementation.

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