PLCs based Remote Laboratory Platform for Learning Electrical Drive Control Applications

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Abstract: The paper presents a low-cost PLCs based remote laboratory platform to learn practical work in the field of drive control. The platform is communicable through the internet enables students to perform experiments and to control laboratory equipment remotely. The Internet technology has provided additional teaching strategies, with online education being one of the most exciting enhancements. Many teaching institutions worldwide are working on distance learning applications. Distance learning can thereby share and make available their various resources, thereby maximizing their use of the laboratories and reducing costs. The present paper introduces a remote laboratory platform designed to be used in industries. The platform is communicable via Internet which includes programmable logic controllers and electrical drives. Furthermore, WiFi module is used to support for internet connection.

Keywords: Remote laboratory; Programmable Logic Controllers; Drive control; WiFi module.

Introduction

Technological advances lead to automation and remote laboratory platform at the engineering workplace. Remote laboratories represent an ever growing field in the distant teaching of engineering and technology. Automated technologies offer the students to understand the best with remote control technologies. However, real laboratories impose on time and place restrictions, making it unsuitable for distance education. Remote laboratories allows real experiments to be conducted without time and place limitations and emerged as a powerful distance learning environment that effectively supplements students to work in real laboratories [1], [2]. Remote laboratories introduced in the early decades [3], [4] and now in the field of industrial automation. To work on distance learning WiFi module is used. WiFi module ESP8266 is a highly integrated chip designed for the needs of a new connected world.

Programmable Logic Controllers is an industrial computer, which is capable of storing instructions to implement control functions such as sequencing, timing, counting, arithmetic, data manipulation and communication. In 1993, IEC 1131-3 (International Electrotechnical Commission) adopted different programming languages which are ladder diagrams (LAD), instruction list (IL), sequential function charts (SFC), structured text (ST) and functional block diagrams (FBD) [5]. The main objective of this paper is to present distance learning applications with the plant term accessible through the internet. It also provides a low-cost platform to develop practical work in the field of drive control with programmable logic controllers and provides a simple and visual model, which allows practice with the different experimental stations available in the remote laboratory [6], [7].

This paper introduces a low-cost PLCs based remote laboratory platform for learning electrical drive control applications. The platform was developed in The Visvesvaraya Technological University- Bosch Rexroth Centre of Competence in Automation Technology, Mysore.

The structure of the paper as follows, architecture and remote laboratory experiments are described in the section II and III respectively. Section IV discusses the remote laboratory development and conclusions in section V.

Remote Laboratory Architecture

Remote laboratory facility enables students to perform experiments and to control laboratory equipment remotely. Students can access the laboratory [Fig. 1] via internet from anywhere and at any time of the day which is a complemented from real laboratories to remote laboratories [7], [8]. The remote laboratory includes different experimental stations connected with the internet. The experiments exposing students to real-world learning experience in their own time and the remote laboratories give science and engineering students a safe, flexible, high-tech approach to gaining practical knowledge [10], [11].

The real laboratory is equipped with PLCs based different experimental stations which is connected to internet via arduino board and wifi module. A camera which is connected to arduino board and wifi module is used to get a feedback of the experimental stations for remote user. The remote user should connect the laboratory in their schedule time using IOT connectivity protocol like MQTT, Adafruit.

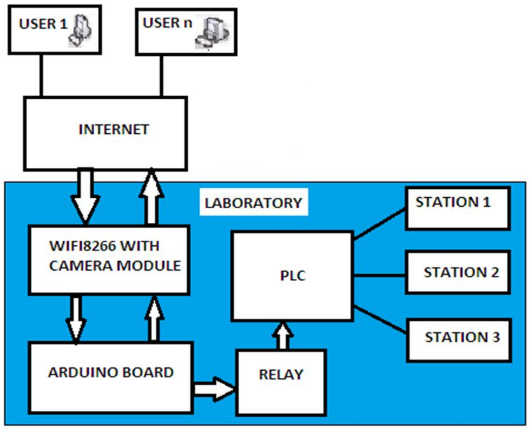

Fig 1. Remote Laboratory Architecture

Remote Laboratory Experiments

Station 1 – Sorting of metal and non-metal elements

This station shows importance of sorting systems in industries. The sorting system [Fig. 2] can speed up the process, gives higher throughput rates and product handling. Here Sorting of metal and non-metal process consists of testing unit [Fig. 3] which is equipped with 3 sensors optical, inductive and capacitive sensors which measures the property of the material. The conveyor is 680mm in length and 50mm in width which consists of DC motor [Fig. 4], DC motors are being used in a variety of industrial motor applications because of its lower cost.

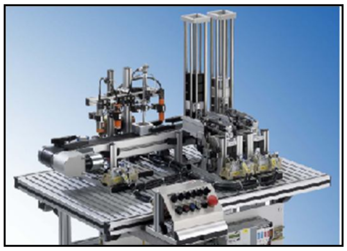

Fig 2. Sorting System

Fig 3. Testing unit (detects metal and non-metal)

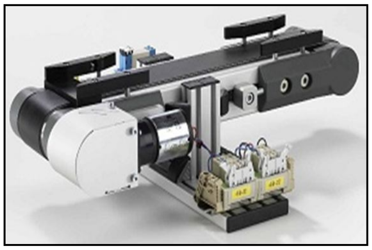

Fig 4. Conveyor consists of DC motor

The station 1 works as follows; one cube is pushed from the storage magazine onto a conveyor belt by a pneumatic cylinder. The conveyor belt moves it pass the testing unit which has three sensors, one optical, one capacitive and one inductive, measure the properties of the materials. A sensor at the end of the conveyor belt senses that a cube has arrived, and if the material is metals the conveyor belt stops. The conveyor belt can change the direction of operation if the material is non-metal.

Station 2 - Conveyor Belt Driven by Induction Motor

Today automation used in every industrial and many other application such as loading, shifting the material in various application point and also transferring the material from one place to another place for saving time ,cost ,labor work and do not cause any damage while shifting the material. Most of the time conveyors are used in the transportation of bulk materials. The principal advantage in using induction motors [Fig. 5] to drive conveyor belts is that force can be applied uniformly to the belt over a wide area without mechanical contact. The drive is therefore independent of the coefficient of friction between belt and rollers and belt stretch is less likely to occur [9]. This station mainly used in material handling and packaging industries and here the station comprises an induction motor that drives a conveyor belt which has metallic or plastic elements.

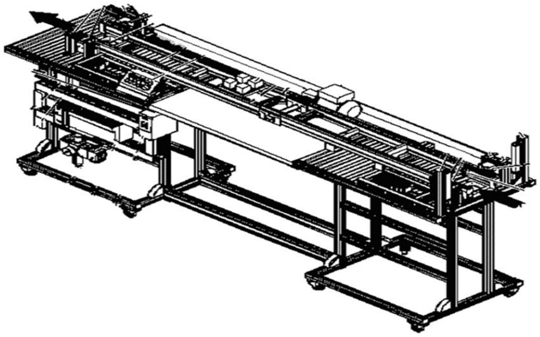

Fig 5. Conveyor Belt Driven by Induction Motor

Station 3 – Stepper Motor

Stepper motor is an electromagnetic actuator. A digital signal is used to drive the motor, when it receives a digital pulse it rotates a specific number of degrees. In this station unipolar stepper motor used [Fig. 6]. The advantage of unipolar stepper motor are, it consist of very simple driver and can be controlled by four outputs of PLC.

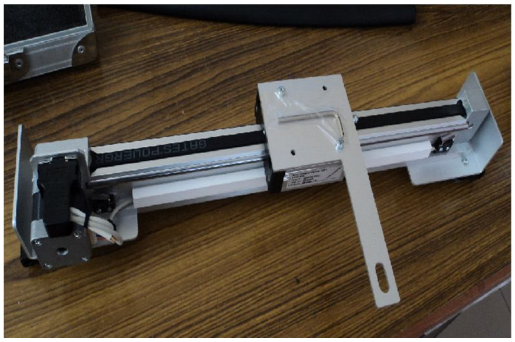

Fig 6. Stepper motor control

Remote Laboratory Development

ESP8266 is an impressive, low cost WiFi module suitable for adding WiFi functionality used for a student to work with the Remote Laboratory. ESP8266 has been designed for achieving the lowest power consumption Major fields of ESP8266 applications to Internet-of-Things include Home Appliances, Home Automation, Industrial Wireless Control, IP Cameras,Sensor Networks and WiFi Location-aware Devices. The ESP8266 module with IP camera modules used to take high quality high resolution photos and videos. Distance learning using remote laboratories consists of visualization device which allows real-world perception for the students.

The Ladder Logic is simple and widely used for programming PLCs. A simple example with one input switch and a timer is used to turn on the output coil [Fig 7]; a timer is programmed for a delay of 10sec. The setup [Fig 8] shows input switch and timer can control by the remote user by connecting to the real laboratory. Remote user will send a controlling signal through the WiFi module and arduino board. The arduino board which is connected to the relay, which provides required voltage for PLCs. The camera connected to arduino and WiFi module gives a feedback of the output signal to the remote user. Hence the remote user will use the real laboratory from any part of the world without any restriction thereby maximizing the use of the laboratories.

Fig 7. PLC ladder logic programming

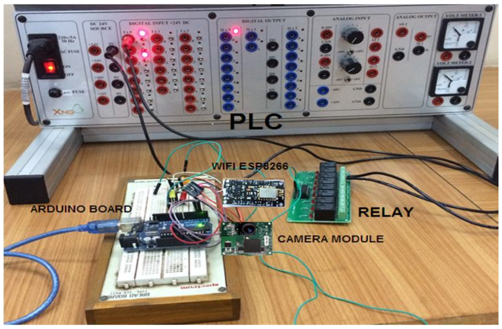

Fig 8. Experimental Setup

Conclusion

The paper introduces a low- cost remote laboratory based platform to learn practical work in the field of drive control with programmable logic controllers. The platform is communicable through the Internet, enables students to perform experiments and to control laboratory equipment remotely. Remote laboratories allows real experiments to be conducted without time and place limitations and emerged as a powerful distance learning environment that effectively supplements students to work in real laboratories. To enable remote laboratory WiFi module is used, which plays an important role to work remotely.

It is important to note that remote laboratory based platform need a fast internet connection, so that the refresh rate of the screen allows the observation of the functioning of the drivers. Remote laboratories are encouraged to develop their own program where students can monitor and control real experiments with programmable logic controllers.

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