Table of Contents

1 Introduction .................................................................................................................................................. 3
   1.1 Remote Laboratories .......................................................................................................................... 3
   1.2 PLC – The Rig Apparatus ................................................................................................................... 3
      1.2.1 Allen-Bradley MicroLogix 1200 PLC ........................................................................................... 3
      1.2.2 NetENI Ethernet Module ............................................................................................................. 3
      1.2.3 Position Sensors ............................................................................................................................ 4
      1.2.4 Control Valves ................................................................................................................................. 4

2 Rig Session ................................................................................................................................................. 5
   2.1 Using the Rig Page ............................................................................................................................. 6
   2.2 Data Acquisition .............................................................................................................................. 6

3 Rig Control Software ................................................................................................................................... 8

4 FAQ & Troubleshooting ............................................................................................................................... 8
1 Introduction

1.1 Remote Laboratories

Remote laboratories enable students to access physical laboratory apparatus through the internet, providing a supplement to their studies and existing hands-on experience. Students carry out experiments using real equipment, but with much greater flexibility since access can occur from anywhere and at any time. Their interaction with the remote equipment is assisted by the use of data acquisition instrumentation and cameras, providing direct feedback to students for better engagement. Traditional engineering laboratories require students to be physically present in order to work with equipment, which may limit student flexibility. Conversely, remote laboratories let students work in their own time and even repeat experiments for better learning outcomes.

Of course students cannot actually touch and feel the equipment in a remote laboratory, but they can still perform most other tasks relevant to their learning. Sometimes, separation from potentially hazardous equipment is preferable from a safety point of view. Due to the increased use of remote operation in industry, where machinery and entire plants are often controlled from a distant location, students may directly benefit from learning how to remotely control equipment. Furthermore, remote laboratories provide the opportunity to access a wider range of experiments as costly or highly specialised equipment may not be locally available. This presents the opportunity to share laboratory facilities between institutions.

Significant research and pilot studies have been undertaken in Australia and by several groups around the world into the educational effectiveness of using remote laboratories. These studies have consistently shown that, if used appropriately in a way that is cognizant of the intended educational outcomes of the laboratory experience, remote laboratories can provide significant benefits. Indeed, multiple research studies have demonstrated that whilst there are some learning outcomes that are achieved more effectively through hands-on experimentation (e.g. identification of assumptions, specific haptic skills), there are other learning outcomes that are achieved more effectively through remotely accessed laboratories (e.g. processing of data, understanding of concepts).

1.2 PLC - The Rig Apparatus

The PLC rig was constructed to allow students to develop programs for the position control of two pistons. The Remote Laboratories’ PLC Rig comprises of the following main components:

- 1 Allen-Bradley MicroLogix 1200 PLC
- 1 NetENI Ethernet Module
- 2 Festo Pneumatic Pistons
- 4 Festo Reed Switch Position Sensors
- 4 Metal Work Control Valves
- Apple iSight web camera for visual feedback
- Rockwell Automation RSLogix 500 Control Software

The pistons, valves and reed sensors are mounted on an aluminum backplane; other modules including PLC, NetENI and power supply are mounted on a DIN rail positioned next to the backplane.

1.2.1 Allen-Bradley MicroLogix 1200 PLC

The Allen-Bradley MicroLogix 1200 PLC is the heart of the rig and allows students to develop ladder-logic programs within Rockwell Automation’s RSLogix 500 and subsequently run them on the PLC. The PLC has 4 control valves and 4 reed position sensors addressed to it as outputs and inputs, respectively.

1.2.2 NetENI Ethernet Module

The ENI provides the MicroLogix 1200 controller with EtherNet/IP connectivity, allowing the MicroLogix 1200 to use a new or existing Ethernet network for program updates, downloads, inter-controller communication and administrative e-mail messages using SMTP.
1.2.3 Position Sensors

The position sensors make use of a reed switch that is activated by a permanent magnet within each pneumatic piston. The sensors have a PNP output/open collector transistor that sources voltage with an external circuit sinking it to ground.

1.2.4 Control Valves

The control valves consist of Metal Work bi-stable double solenoid valves with 24V DC coils with one valve per piston and two coils per valve. The control valves enable quick and reliable response from the pistons when controlled by the PLC.

![Image of PLC Rig in its default state](image)

Figure 1. PLC Rig in its default state.

Ladder logic diagram can be developed in the RSLogix programming environment and then downloaded to the PLC for controlling the movement of the two pistons. PLC Rig is built so that such an apparatus aims to help students develop a simple program and verify the expected outcome against the real-world results coming from the rig by testing the controller design on the rig itself.
2  Rig Session

The following section outlines the procedure for using the PLC Rig, which is similar to other Remote Laboratory Rig types used in the past. The software that runs the Remote Laboratories and provides access to the rigs through a web browser is called Sahara.

For the purpose of using the rig, it is assumed that users have access to a workstation that meets the system requirements. Users should refer to Labshare’s Generic Rig Access Guide for this information.

After logging in with a username and password, the user will be directed to the “Rig Selection” page. Selecting the “PLC” under Rig Types will randomly allocate the user to an available rig. However, if the user wishes to access a particular rig, then this can be selected in the Specific Rigs section. Once the rig is selected, a popup will appear, asking if the user wishes to join in the queue for the chosen rig. By clicking the “Queue” button, the user will be granted access to the selected PLC rig.

Note that if the rig is “In Use” status, the user will be put in waiting list for access to the rig until the current user and any other previously queued users are finished. The user’s position in the queue may be forfeited if the user navigates away from the queue page or logs out of the Remote Labs web page.
2.1 Using the Rig Page

If the rig is free, the user will immediately be taken to the rig page. Each user has a designated session time frame to conduct a desired number of experiments. A countdown timer at the top left of the page shows how much time the user has left on the rig. The rig session time may be automatically extended if no other users are waiting to use the rig. The rig session starts as soon as the user is directed to the “Rig Session” page. If the user does not utilize the rig session within the timeline that is given, the rig session may be forfeited.

In order to use a PLC rig, the user needs to follow the instruction under “Remote Desktop Address” by clicking “Show Help” on the dropdown box as shown on the next screenshot.
If the user has finished using the rig completely back in the PLC Session page, then the user can exit the session by pressing the “Finish Session” button. A popup window will appear asking for a confirmation of exit.

Selecting “Yes” will close the current remote connection to the rig and bring the user back to the Rig Selection page. This will allow the rig to shut itself down and close the control software properly. It is important that the user exits the current rig session properly before logging out of the Remote Labs web page to allow other users to access the rig.

Once successfully logged out, the user will be redirected to the main login page of Remote Labs.
3 Rig Control Software

The Micorlogix 1200 PLCs require the use of Rockwell Automation’s software suite [RSLinx, RSLogix 500, RSView Machine Edition], which is designed to run exclusively under Windows NT and derivative platforms.

4 FAQ & Troubleshooting

Any questions regarding the nature of assessment tasks should initially be directed to the relevant academic. If the user encounters any difficulties using the rigs, the “Contact Support” button should be used to request assistance or report problems. The following popup will appear, allowing the user to enter name and a valid email address. Then the most appropriate category should be selected from the drop down list, and the purpose of the help request should be briefly stated. A more detailed description of the problem, comment or request can be given in the feedback box.

Users are strongly encouraged to leave feedback and comments of their experience with the rigs to help improve the system, as well as to make any suggestions for additional features to be included in the future.

For any enquires or assistance, contact the Labshare helpdesk at:

helpdesk@labshare.edu.au