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PROJECT TITLE : REMOTE ACCESS LABORATORY FOR CONDITION MONITORING

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Contents

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1 Abstract

This report contains all the work that has been put into the project as of June to August 2016.

2 Hardware

i Camera

One of the feature of the remote access laboratory is the ability to stream live video feed on the front panel of labview. It allows the student to observe the experimental set up in real time. The students will also be able to relate the experimental results with changes made according to the laboratory procedures. Through the video feed, students will be able to see the motor spinning and a little bit of displacement caused by the linear actuator on the shaft.

The camera used in this project is Logitech's Orbit MP Sphere as shown in Figure 1. It is capable of taking image or video resolution of up to 960x720 (HD) and a maximum of 30 frame per second at lowered resolutions. It also has a built-in pan-tilt-zoom(PTZ) mechanism that allows the camera to rotate around. The camera is connected using a USB 2.0 directly to computer.

Figure 1: Logitech Orbit MP Sphere

Using Labview's IMAQdx module, the images from the camera can be streamed and displayed on the front panel of the main programme. Noted that programmer need to choose the right camera channel, in this case it is "cam4" as shown in Figure 2. This code can be accessed from "Remote Front Panel.vi". However, the control of PTZ of the camera can only be managed through Logitech's Quickcam software.

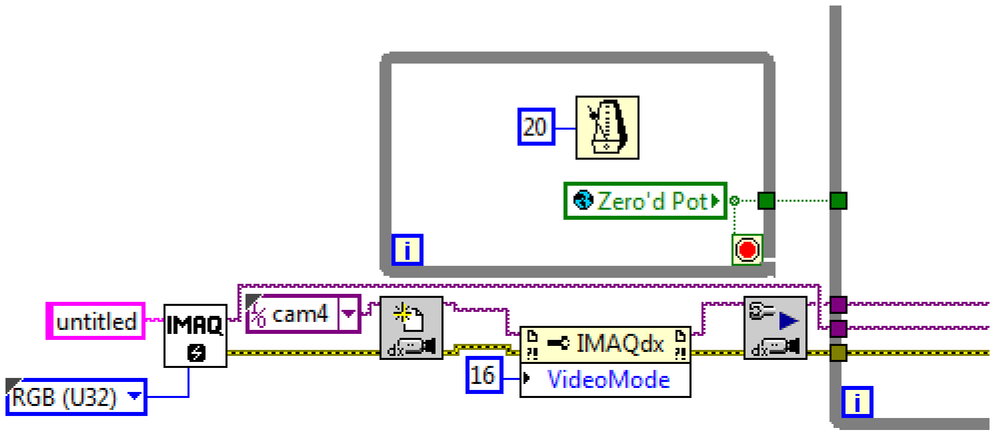

Figure 2: Labview's IMAQdx code

Without the Quickcam software, user may not be able to benefit from the PTZ movement of the camera. Other camera controlling software by Logitech i.e. Logitech Webcam Software(LWS) will not work on this camera. When configuring the camera in the first place, programmer need to ensure that the camera does not install it's latest driver automatically. A little bit of tweaking is needed by updating the camera driver to vista version for it to work with Quickcam. More detailed steps can be referred from the youtube video in this link. https://www.youtube.com/watch?v=j_iEEsIXPAk

It should be noted that the camera tend to automatically update its driver automatically if the usb connection is being unplugged and plugged again. Hence the previous steps of installing the vista version driver need to be followed again. As a suggestion, the programming of the main programmed can be improved by adapting Labview's VISA method to control the camera PTZ motors instead. Hence this will eliminate the problem associated with the Quickcam software and driver.

ii SIEMENS Inverter

A frequency inverter is used for controlling the speed of three phase AC motors (ABB). The model used in this set up is SIEMENS' SINAMICS G110 and enclosed in a case as shown in Figure 3. This inverter with its default factory settings is ideal for a large range of simple V/f motor control applications. Using the comprehensive range of programmable parameters provided with the inverter, the unit can be adapted for a wide range of applications. Parameters can be changed using either USS communications or the Basic Operator Panel (BOP).

The SINAMICS G110 is available in two variants; the Analog controlled variant and the USS controlled variant utilizing RS485 protocol. The Analog controlled variant is straightforward but the USS controlled variant on the other hand requires advanced commissioning. In addition, the latter requires a specific software "STARTER" to communicate with the inverter, hence complicating the programming with LabVIEW.

For this experimental set up, the inverter is controlled using the analog variant. Only basic commissioning is deployed i.e. using the inverter with its factory default settings by connecting analogue and digital inputs. The connection between inverter and relay is shown in Figure 4. When 5v signal is sent from the NI DAQ into the relay, the switch closes and the relay would transmit 24v from pin 3 of relay into pin 3 of inverter (DIN0) to activate the inverter. The frequency of the motor is controlled by varying 0-5v signal into pin 9(ADC1) of the inverter using NI DAQ.

The motor can be activated through the front panel of the main programme by clicking the "Motor On" button. The speed can be varied by keying in between 0-1500 rpm into the box. These rpm is relative to 0-5v voltage. A light sensor is placed at the end of the shaft to measure the speed of the motor. The data from the sensor is analysed and displayed on the front panel.

Figure 3: SIEMENS' SINAMICS G110

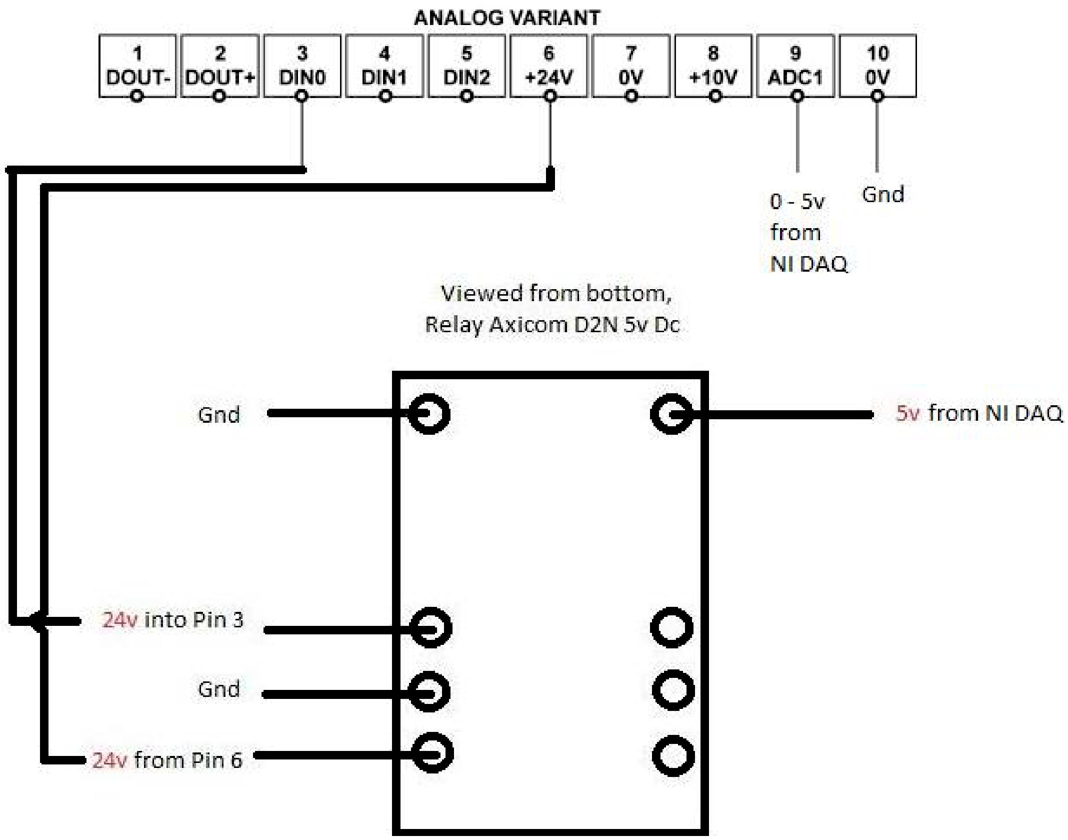

Figure 4: Connection Inverter and Relay

iii Linear Actuator

A linear actuator is used in this experimental set up to protrude a linear force onto the shaft. It is connected to the NI DAQ via an actuator box. The actuator box contains several relays to allow the actuator to move in forward and reversed direction by changing the polarity of the dc voltage source. It is controlled by a digital signal from the NI DAQ. There is also a button on the actuator box to change the operating mode of either automatic or manual control. In manual control, user is able to control the movement of actuator via buttons on the actuator box.

The linear actuator is also equipped with fail-safe mechanism. Two micro switches are equipped as shown in orange boxes in Figure 5. They prevent the linear actuator to extend and retract beyond safe distance. A linear potentiometer is also included as shown in blue box in Figure 5 to measure the displacement of the shaft caused by the linear actuator. The reading of potentiometer is displayed on the front panel of the main programme.

When the linear actuator moves forward it pushes the shaft sideways slightly however when the actuator retracts it does not pull the shaft along. Hence the shaft is left with a little displacement. This needs to be fixed manually by pushing the middle shaft holder inward. As a suggestion, the linear actuator can be replaced with a stepper motor and attached directly on the middle shaft holder.

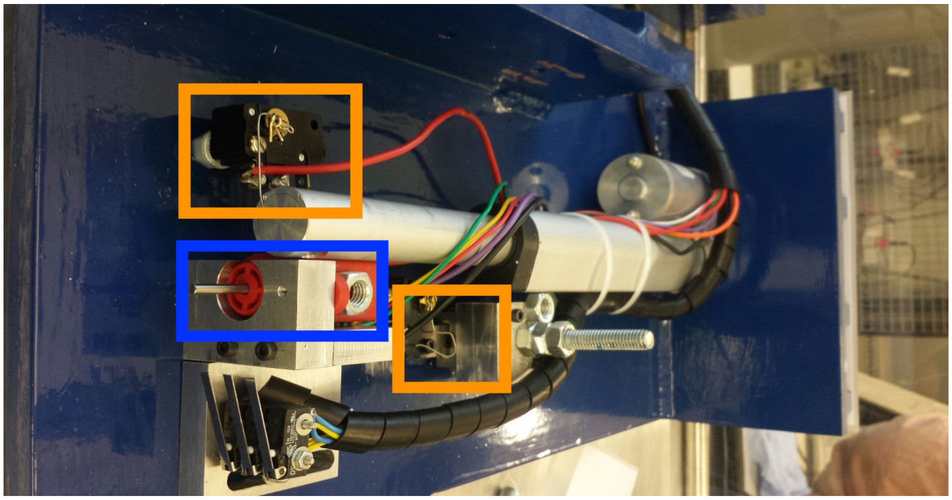

Figure 5: Linear Actuator

iv Linear Actuator Box

The electronics and connection from the linear actuator to NI DAQ are housed in a box as shown in Figure . It also contains the connection from light sensor which acts as a tachometer to measure the speed of the shaft. Gentle care should be taken when handling the box because there is a tendency for the wires to be disconnected. No documentation has been recorded for the connection inside the box.

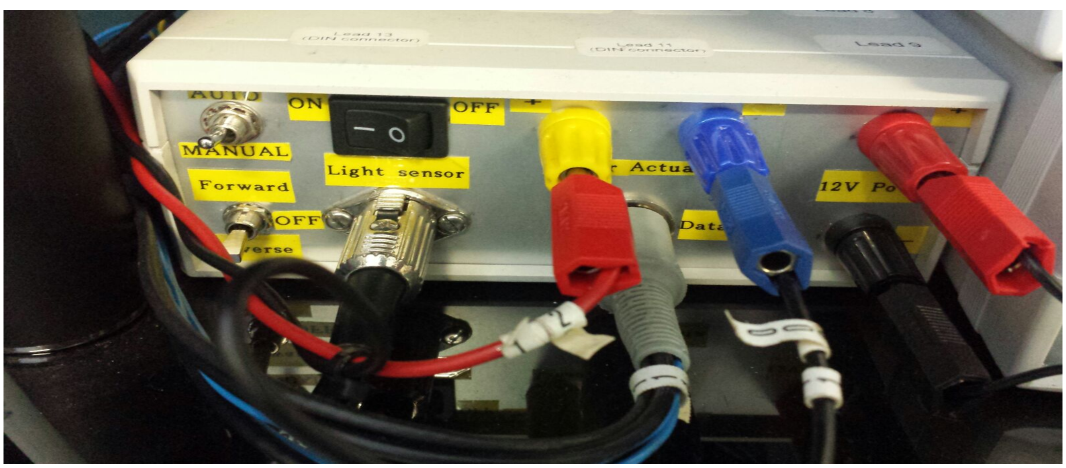

Figure 6: Linear Actuator electronic box

v Cleaning up Hardware and Wiring

Figure 7: Before

Figure 8: After

3 Front Panel

Figure 9: Front Panel of the Programme

4 Remote Access

Another objective laid out for this project is to have the experiment accessible by students via the web. Based on previous reports written by Adam Wright and Chang Kai Ming, this project was heavily influenced by success of University of Leed's very own remote access lab called Remote Labs Operated at a Distance(ReLOAD). They created their own server to hosts several experiments across their university for students use.

i ReLOAD Server

This project is initially an effort by Adam Wright's supervisor, Dr Jonathan Swingler after being in contact with Dr Martin Levesley at University of Leeds and learning how they have developed and implemented ReLOAD. This project was supposed to be in parallel with ReLOAD due to the fact that they will be supplying parts as well as to host two of our projects. However, there are no documentations showing if this experiment has ever been uploaded to ReLOAD server in the past.

The system architecture of ReLOAD server is shown in figure 11. The webpage can be accessed through here http://www.reload.leeds.ac.uk. Students are required to login to access the experiment. There is a queue system in place to manage traffic. Once logged in, the students are able to change experimental parameters which are then passed to the central web server (ReLOAD web server) using a standard web interface(also called as request page).

The ReLOAD web server interprets the request and redirects this request via a LAN to one of several Experiment Server computers physically connected to either single or multiple pieces of experimental equipment. The request is then converted into a series of commands appropriate for the specific equipment being run by the Experiment Server. When the experiment requested is completed the Experiment Server computer sends results in the form of data images and video clips back to the user on the client computer via the ReLOAD web server.

LabVIEW allows two alternative methods to communicate the required information between computers to perform remote experiments i.e. LabVIEW HTTP Server with Common Gateway Interface (CGI) Scripts or embedded ActiveX control panels. The ReLOAD server benefits from the HTTP Server with CGI scripts. The latter will be discussed later in the Web Publishing Tool section. The system architecture of this method is shown in Figure 10

a Limitations ReLOAD

Despite the great success by the ReLOAD system, there are a number of limitations that should be considered for this project. First of all, a great deal of understanding about setting up a webpage is required. Building a similar service similar to ReLOAD server will consume time and require expert advice regarding the use of University's server. Student should consult iSolutions and may need their extensive help.

Security will the main concern by iSolutions. Since the page will be published online, there is a risk of malware or hackers attacking the university network. Students and iSolutions need to work together on ways to mitigate the risk. Creating a static pages will definitely help, however the project includes a number of dynamics item such as buttons, live video feed and graphs.

The way ReLOAD system is designed is that the web pages are created as statics, in which there are no continuous streaming of data unlike this project. The student will need to click a button to generate a result which will then be displayed in the next page. This method perhaps make the server more secure. The programmer should be well versed in website creating as well as Labview HTTP Server and CGI Script.

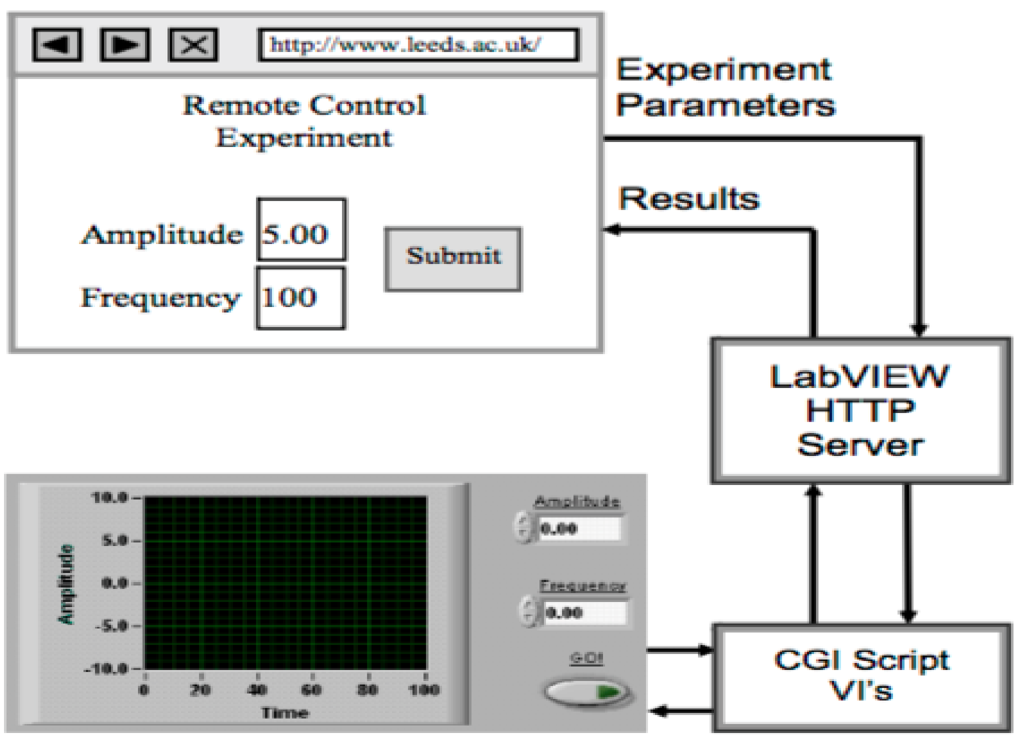

Figure 10: Labview HTTP server with CGI script' method

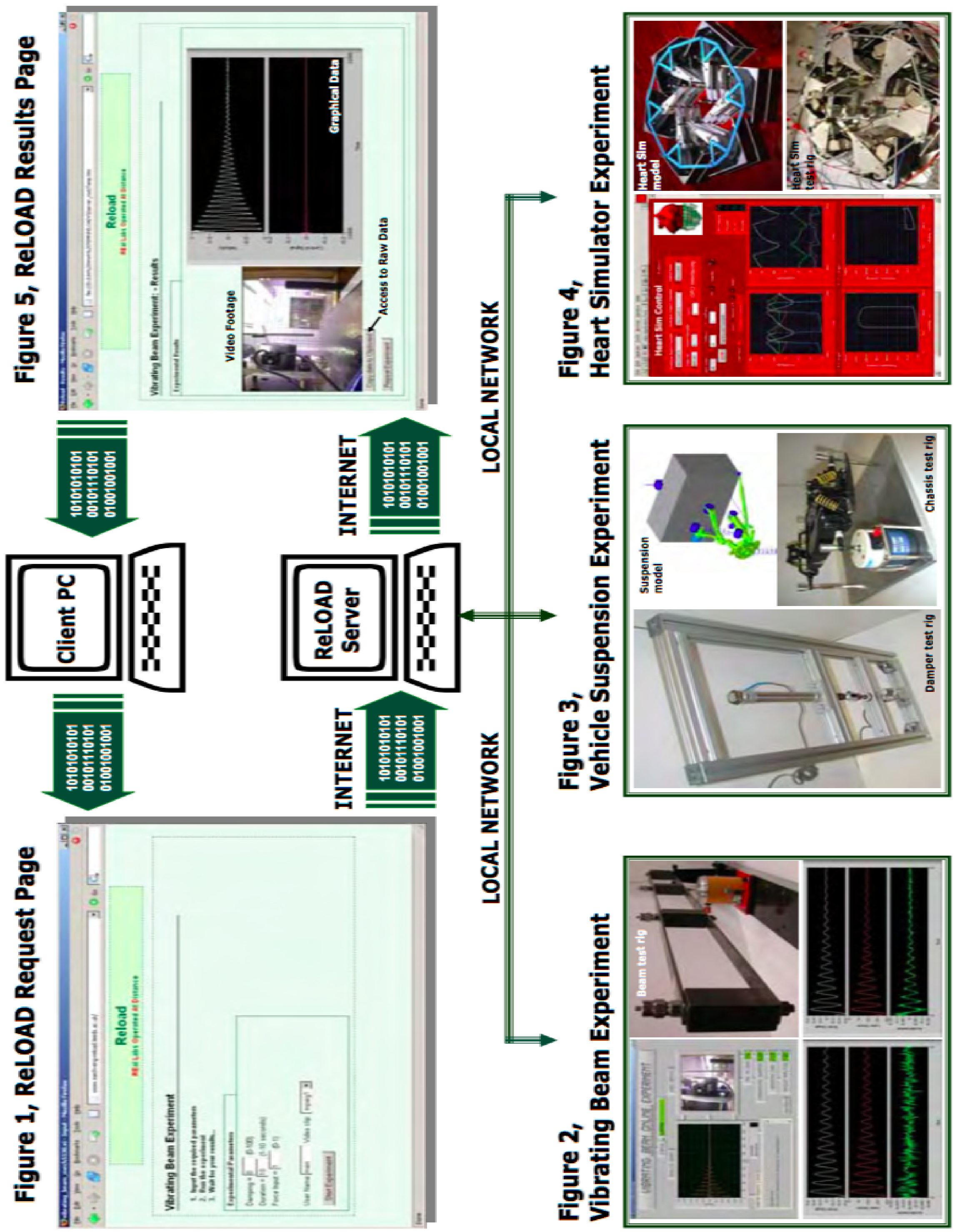

Figure 11: System Architecture of ReLOAD server, Uni. of Leeds

ii TeamViewer

TeamViewer has been used all across the globe for businesses and general use. It comes in free version as well as paid packages. TeamViewer was used in the past for this project to give lecturers access to this laboratory during class demonstration. However it was reported that there are problems caused by TeamViewer such as disconnection while demonstration is taking place.

When tested recently, it can be seen that the recent version of TeamViewer provides more stable connection to the experiment computer. Using computer ID and password, user will be able to log in the experiment computer easily. A standalone application of the experiment is created and located on the desktop and can be launched straight away. This method is relevant for experimental procedures since data can be transferred across computers easily through teamviewer using "File Transfer" option.

a Limitation TeamViewer

TeamViewer does not only gives client access to the experiment. Client may also open other folders on the experiment computer consequently damaging the computer internally. It is a great concern that students might open unnecessary programmes besides the laboratory programme on the experiment computer. A damage on the machine will cause delays to fix, and students may complain for not being able to conduct their experiment sessions on time.

TeamViewer might be ideal for lecturer's use during class demonstration i.e. single use. However if the access were given to students, complexities will arise. TeamViewer doesn't have queue systems to manage users. With the free version, only

iii LabVIEW Web Publishing Tool

As been discussed before, LabVIEW allows two alternative methods to communicate information between computers particularly for remote experiments. Whilst ReLOAD benefit from LabVIEW HTTP Server with CGI Scripts, this section will describe more about the second method that is embedded ActiveX control panels. LabVIEW Web Publishing Tool is very easy to use and transforms the front panel of the VI almost instantly to a html page. Clients do not need to install the full version of LabVIEW, only several plugins are required. Note that the version of plugins should be installed based on the version of LabVIEW used for the VI. In this case LabVIEW 2015.

The experiment VI should first be loaded on the memory of experiment computer. The page can then be accessed easily by opening the link on a web browser given that appropriate plugins have been installed. It has a queue system built in. Clients may easily request and give up control of the experiment by right clicking on the main page. Graphs and video feed are streamed continuously unlike ReLOAD system. Another advantage of this method is that it is very easy to be deployed. There are no additional coding required. The list of steps are shown in the next section.

The saving function is added on the main programme so that students are able to save their data and graphs. Since students are expected to write a report about the outcome of the project, they will be able to attach the data from the experiment they conducted themselves. Raw sampling data will also be provided in which they can do their own analysis to help with their learning.

a Required Plugins for Clients

Download the following plugins(for windows):

LabVIEW Run Time Engine 2015 :
http://www.ni.com/download/labview-run-time-engine-2015/5507/en/

DAQmx Run Time 2015 driver :
http://www.ni.com/download/ni-daqmx-run-time-engine-15.1.1/5667/en/

b Limitation Web Publishing Tool

Eventhough this is the most ideal method for remote access, there are a number of limitations that should be considered. Firstly, the published web has managed to only work locally i.e. within the same network. Since we are utilising the university network, the port cant be opened to public to prevent malware, viruses and even hackers. As advised before, programmer should work hand in hand with iSolutions department on the best way to benefit from the university network.

Besides that, when accessing the experiment remotely there are chances that the experiment will be stopped due to acquisition and sampling rate problem. This might be due to transmission delay from the client to server. Continuous data stream and live video feed impose heavy data transmission thus affecting the sampling rate and data traffic on LabVIEW. It is unknown to how much data can be handled by LabVIEW Web Publishing Tool.

Other than that, once the webpage is published anyone with the link can open the page. Refer Figure 12. Problem might occur in the future involves heavy traffic, when too much students log in at one time. Students might also obtain control easily and messes the experiment other student is conducting. Following this, other students might also choose to skip the experiment and copy the result of their friend's as lecturer is not able to track who has and hasn't do the experiment.

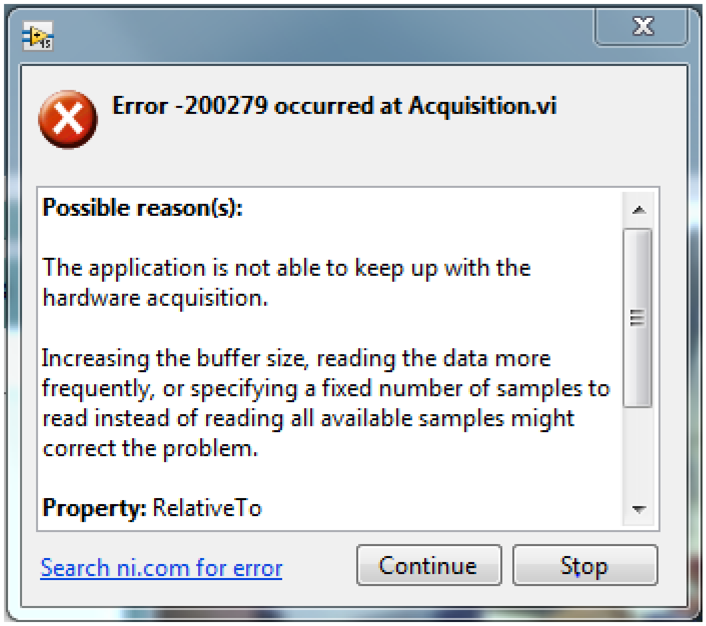

Figure 12: Error Message Generated by LabVIEW during Remote Control

5 Future Works and Recommendation

1. LabVIEW Web Publishing Tool has been pursued and seems to have little advantage to disadvantage. It has been unsuccessful as to date. Therefore it is advised for the next programmer to take on different approach i.e. LabVIEW Web Services as well as LabVIEW HTTP Server and CGI Script. Intermediate knowledge in HTML is required. Connection with Dr Martin Levesley should be reestablished to learn about how they set up ReLOAD server.

2. Programmer should work closely with a member of iSolutions in devising a secure website since day 1. The last contacted iSolution member was Ed Rayner. He is very interested to push this technology through. Integrate the students log in page for lecturers to track who has been doing the experiment.

3. The programming can be cleaned up and be made more effective in reducing the data load on the front page. This perhaps mitigates the problem related to sampling rate and data acquisition.

4. LabVIEW VISA should be used to control the webcam camera to prevent complications in the future with the QuickCam software.