XYZ Scanning Rig Software – v1.3 User Manual

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Table of Contents

1.0-Getting Started

1) If not already done, download the GitHub Repository from the following link:

https://github.com/gaetanpans-ucl/LabViewProject---MECH0020_20_21

2) Open the README.md file and follow the steps to set up the software and drivers

2.0-Operating Software

1) Connect the LG Motion LTD scanning rig using an ethernet cable to the computer that is operating the software
2) Turn on the LG Motion LTD scanning rig:
    a. Ensure the emergency button is unclicked/not pushed in
    b. Turn the dial/button 90 degrees
    c. Press the green button for 3 seconds and let go (it should turn green to indicate it is on)
3) Connect the desired LeCroy Oscilloscope using a USB-TMC cable to the computer that is operating the software. If this oscilloscope has not been previously used with this device, see the section on 'Adding a New Oscilloscope Model'.
4) Open up the 'XYZ Ultrasonic Scanning Software v1.3 (Final).vi' file according to the README file in the GitHub repository
5) Start the programme by **clicking the**  **icon** in the top left corner and return to the front panel.
6) Check that you have successfully connected by clicking the '**Check Scanning Rig/Oscilloscope Connection'** button. If so, the LED will turn **Green,** and if unsuccessful it will remain **Red**. Make sure to choose the correct '**VISA Resource Name'** for the model of the oscilloscope.

7) Click on the '**Move to Starting Position Tab**' and enter the relevant distances, directions and click '**Move'** to move from the scanning rig's home position to wherever the scan needs to take place. Note the machine can also be moved physically.
    a. Note the movement distances are relative to wherever the scanning rig is currently (i.e. X distance of 50mm will move it 50mm from that position)
8) Once set, click **'Set Starting Position'**
9) Depending on the scan that aims to be acquired, click the relevant tabs '**A-Scan/B-Scan/C-Scan'**
10) Set the scanning parameters as follows:
    a. **VISA Resource Name**: Model of oscilloscope being used
    b. **Source**: Channel the needle hydrophone is connected to
    c. **Folder to Save:** Desired folder location to save the scan results
    d. **Filename**: Desired filename the scan results
    e. **Click Confirm Scanning Parameters** once everything has been set
11) Specific B-Scan Parameters:
    a. **Length/Width/Height**: The dimensions of the tank that is being scanned
    b. **Select Axis to Scan**: The axis that the B-scan needs to scan along (it will scan the entire length of the corresponding dimension)
    c. **Initial Directions**: Select the direction the scan needs to move in.
    d. Note* Do not need to fill in all the boxes, just the ones corresponding to the axis that will be scanned
    e. The remaining parameters explained in step 9
    f. **Click Confirm Scanning Parameters** once everything has been set
12) Specific C-Scan Parameters:
    a. **Length/Width/Height**: The dimensions of the tank that is being scanned
    b. **Select Plane to Scan**: The plane that the C-scan needs to scan along (it will scan the entire area of the corresponding dimensions)
    c. **Initial Directions**: Select the direction the scan needs to move in both axes.
    d. Note* Do not need to fill in all the boxes, just the ones corresponding to the axes that will be scanned
    e. **C-Scan Build-Up Quality**: Choose the desired value out of 4 options
    f. The remaining parameters explained in step 9
    g. **Click Confirm Scanning Parameters** once everything has been set
13) Click **Acquire A-Scan/B-Scan/C-Scan** accordingly to start the movement and acquisition of data
14) Once completed, the experimental data will be available in the folder selected if chosen to save the results.

3.0-Adding a New Oscilloscope Model

- If the model of the oscilloscope is not an option in the drop-down for **VISA Resource Name**, it means it hasn't been added to the software.
- To check if the model is supported by the driver, check the **README** file of the **LeCroy Drivers** in the **Git Hub Repo.**
- If it is a supported model, perform the following steps:

1) Open up '**NI MAX' software** (figure 1)**.**

a. This should be pre-installed software if LabView 2020 was installed correctly.

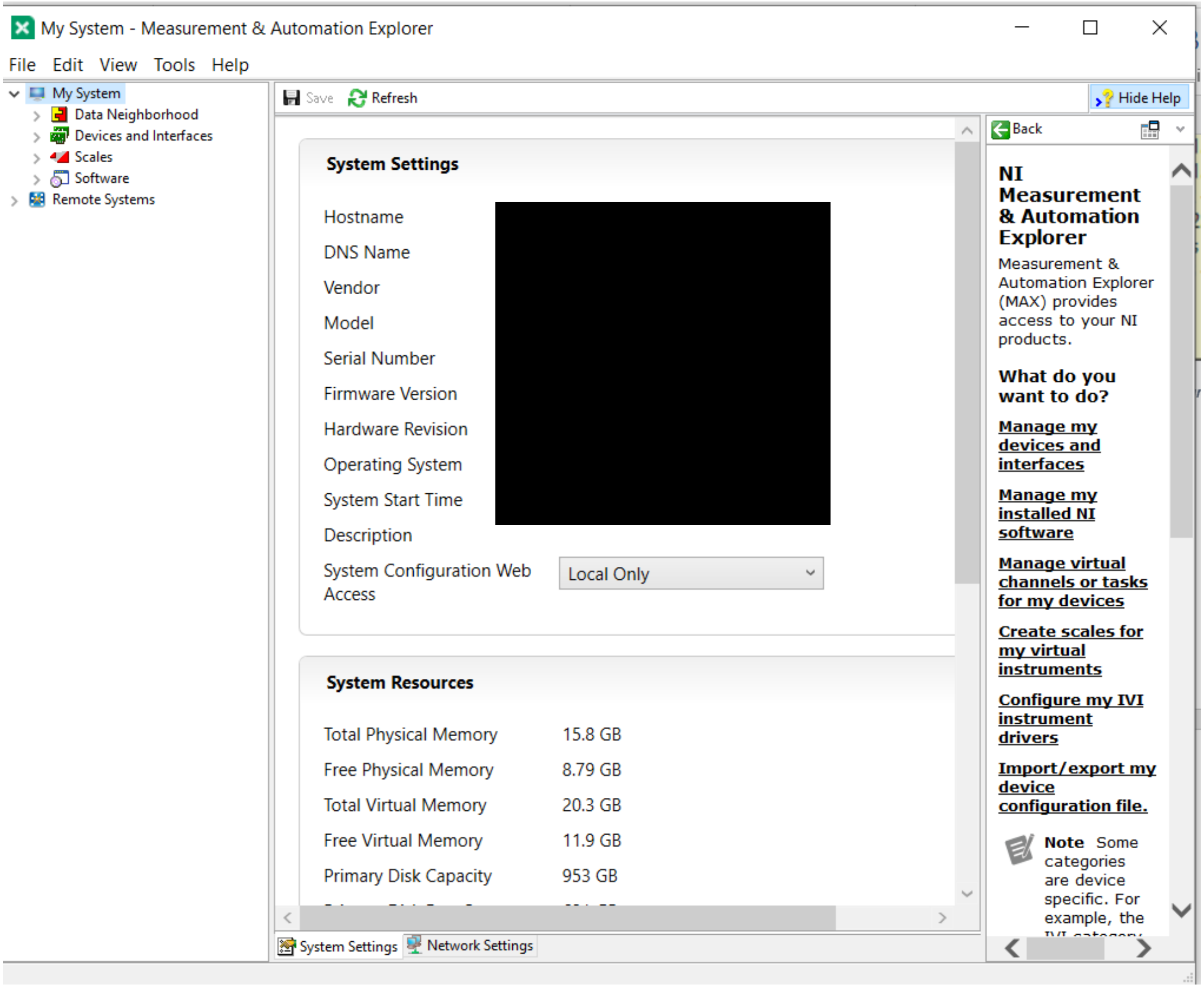


Figure 1 - Interface of the NI MAX software

2) Click **My System/Devices and Interfaces/Network Devices** on the left-hand side and you should see the panel in figure 2.

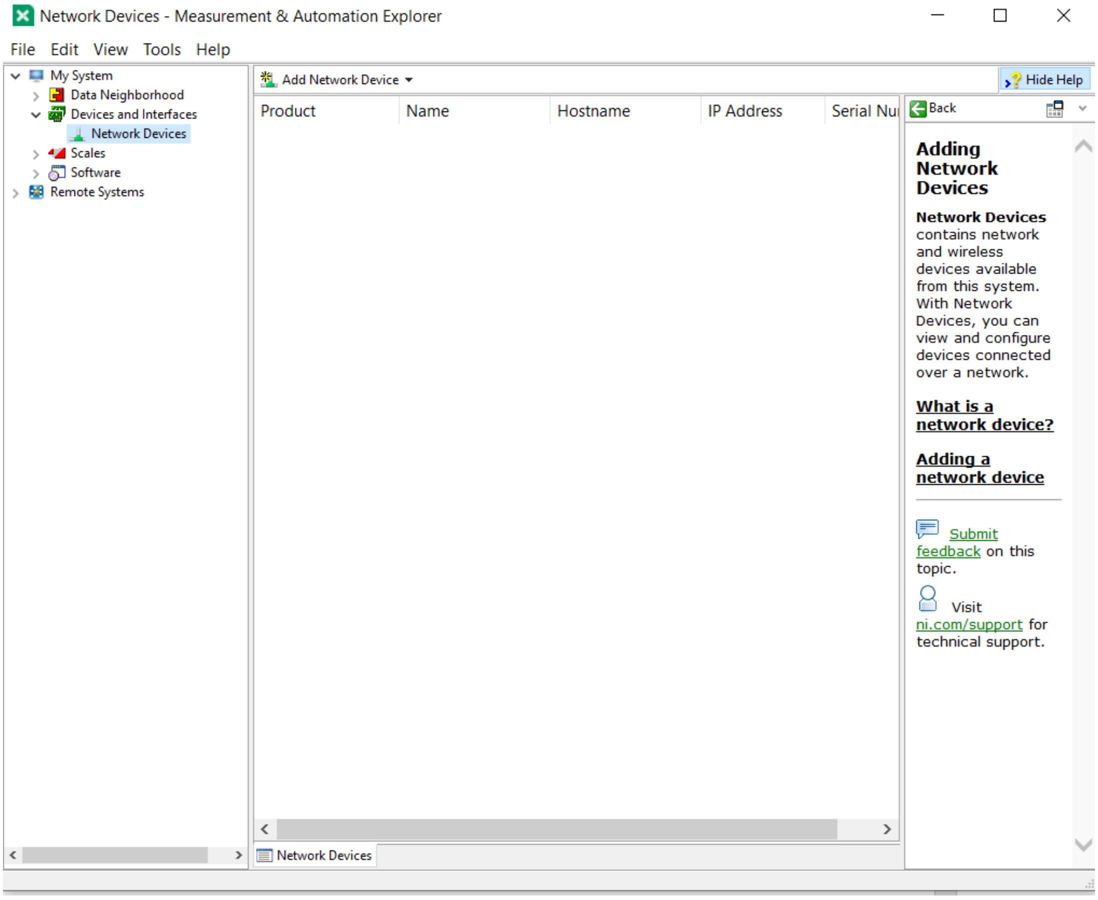


Figure 2 - Interface of the 'Network Devices' Tab

3) Click **Add Network Device** at the top and select the following parameters (make sure your oscilloscope is connected to the system via a USB-TMC cable)

   a. VISA TCP/IP Resource
   b. Auto Detect of LAN Instrument
   c. Select the connected device from the list
   d. Click Finish

4) Return to the LabView software, and refresh the dropdown menu for **VISA Resource Name** on the **Check Connection To Devices** tab.

4.0-Software Structure & Diagnosis

- To view the block diagram, **click** ‘***Window/Show Block Diagram’*** or use the shortcut ‘***Ctrl-E***’
- Once on the block diagram, to find out what each block does, **click the** **icon** in the top right corner and hover over the block that you wish to get more information about.
- Each block (both the custom-designed ones, and built-in ones) will have a description of what it does as well as its inputs and outputs. (example: figure 3)
- If it is a custom block (also known as a Sub-VI), you will be able to ‘***Double Click’*** *the icon in the block diagram to open the programming behind it.*
- On top of the individual descriptions, each block diagram is fully commented (example: figure 4)
- For the specific documentation for the drivers of the scanning rig, open the file ‘**Nippon Pulse PMX-4ET Box Controller Manual**’ in the GitHub Repo and refer to the ASCII Commands section.

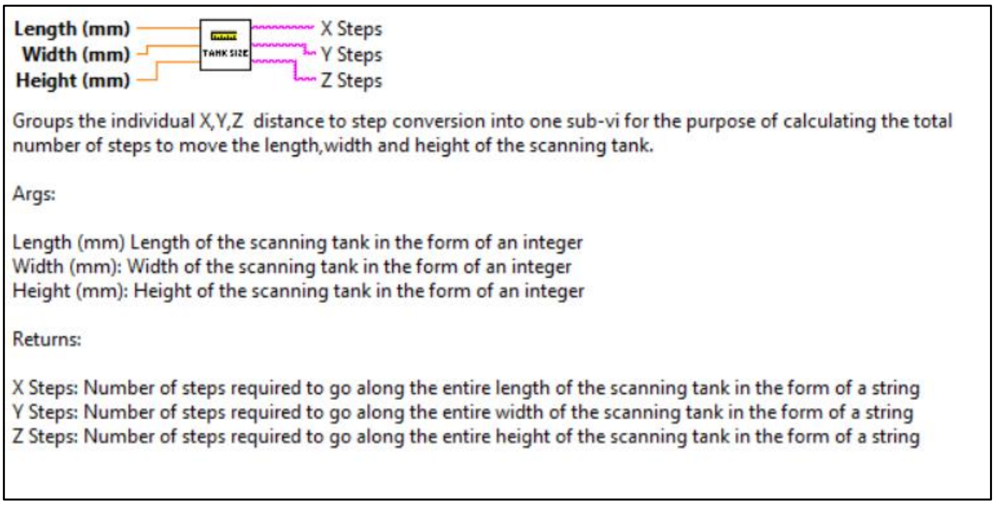


Figure 3 - Example of the description provided with each block/icon/Sub-vi

Commented Code:

1 - Initialises the connection between the software and the scanning rig controller
1.1 - Scanning rig's IP Address
1.2 - Scanning rig's device port
2 - Checks for any incoming errors (as a cluster) with connecting to the controller.
2.1 Unbundles the 'error cluster' to index the Boolean that represents whether or not it is successful
3 - Closes connection between the software and the scanning rig controller.

Figure 4 - Example of the commenting available with every block diagram

5.0-Error Handling

The following mechanisms are tips on fixes certain errors as well as diagnosing general errors if the user comes across a bug in the software or aims to add functionality.

5.1-Confirming Connection with Scanning Rig

If the software's mechanism indicates you are not connected, you can confirm this by checking there is a fault with the ethernet connection.

1) Open up **Command Prompt**
2) Type the following: **ping 192.168.1.250**
    a. Where 192.168.1.250 is the IP Address of the scanning rig
    b. **Current IP Address 192.168.1.250**
    c. **Current Device Port: 5001**
3) **Click Enter** and the response should be as follows (figure 5):

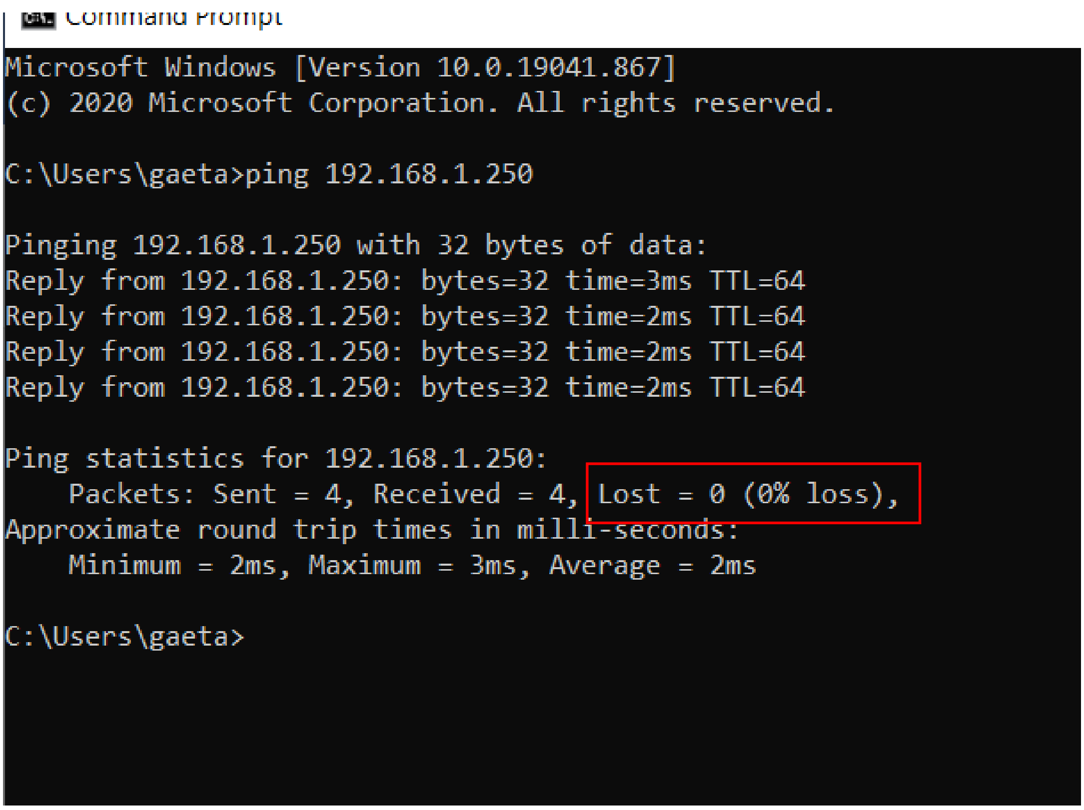


Figure 5 - Response for successful connection with the scanning rig

4) If the percentage lost (figure 5) is anything but 0%, it means the connection is not secure meaning the following possible errors
    a. Faulty Cable
    b. Wrong IP Address

5.2-Debugging Technique 1 – Highlight Execution

If LabView raises an error or the program is not doing what is expected, the root of the problem can be found using LabView's **Highlight Execution** mechanism.

1) Before running the software, open the block diagram and click the  icon in the top right corner.
2) Then run the software as usual by **clicking the**  **icon**
3) LabView will then visualise the data flowing through the wires on the block diagram and will display the inputs and outputs. This way the developer can check exactly which block is causing the error
4) **Note** – This slows down the speed of the software massively and should only be used for debugging purposes.

5.3-Debugging Technique 2 – Running Individual Systems or Sub-VI's

<u>Running Individual Systems</u>

In the **Git Hub Repo,** 2 additional files of the latest version of the software were added as follows:
XYZ Ultrasonic Scanning Software v1.3 (Data-Acq-Osc) – Operates just the oscilloscope functionalities

XYZ Ultrasonic Scanning Software v1.3 (Movement) – Operates just the movement for the scanning rig functionalities

By running these files, systems can be tested individually which may help diagnose the issue of the more complicated software with the combined systems. Previous versions of the software uploaded to the **Git Hub Repo** consist of a similar structure.

<u>Running Individual Sub-VI's</u>

If it is an individual Sub-VI causing the error, it is possible to run just that Sub-VI to confirm it is doing what it is supposed to. If you wish to run an individual Sub-VI, the following changes need to occur if it is a file that connects to the scanning rig.

1 – Replace figure 7 with figure 6

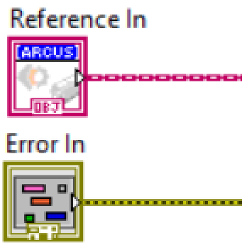


Figure 7 - Connection between Sub-Vi's

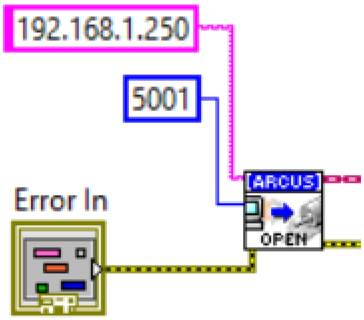


Figure 6 - Connection straight to scanning rig

2 – Replace figure 9 with figure 8

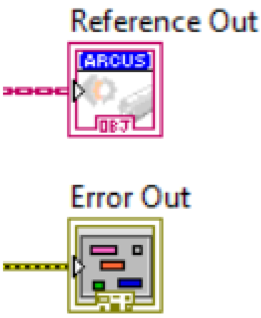


Figure 9 - Connection to the next Sub-VI

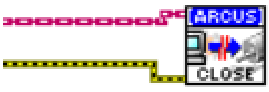


Figure 8 - Closing connection straight to the scanning rig

3 – Run the Sub-VI on its own to help with debugging

6.0-Further Development-Proposed Verasonics Addition

The Verasonics system is not yet incorporated in v1.3 due to a lack of testing. For future developers aiming to add this to the software, the following steps are the proposed structure to do so.

1) Obtain the relevant MATLAB File that is used to operate the Verasonics.
2) In a new LabView file, click **Ctrl-Space** to open quick search and type **MATLAB Script**
    a. If it is not found, click the following link to install the correct module https://knowledge.ni.com/KnowledgeArticleDetails?id=kA00Z0000019XaYSAU&l=en-GB
3) This allows MATLAB code to be run inside a LabView script (figure 10)

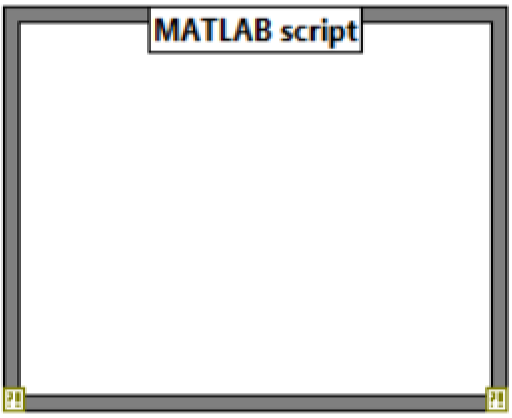
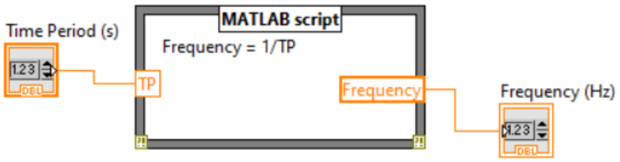


Figure 10 - MATLAB Script node

4) Copy and paste the relevant Verasonics MATLAB code into this MATLAB script box
5) To interact with the inputs and output variables of this code, **right-click** on the structure and **add input** or **add output** accordingly (figure 11).



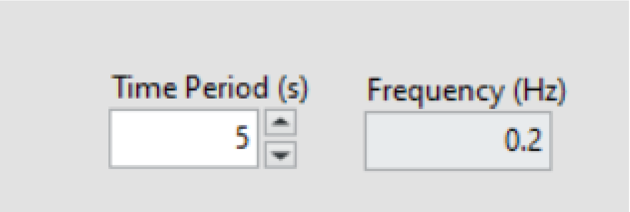


Figure 11 - Example MATLAB Script node demonstrating inputs and outputs

6) Given the MATLAB script triggers the HIFU transducer, this LabView code can then be packaged as its own Sub-VI and added relevant for loops responsible for A/B/C-Scan so that the transducer is triggered with each 'for loop'.
7) The relevant inputs can then be added to the front panel so the user can change the parameters of the file to change the HIFU parameters (e.g. frequency)