Operator Manual: Align DUT

Graham Greig

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Overview

This manual is for the use of the LabVIEW software AlignDUT.vi. It is a stand-alone application for determining the position and angle of rotation of a sensor loaded on the Semiprobe robot. When opened, the GUI looks as below:

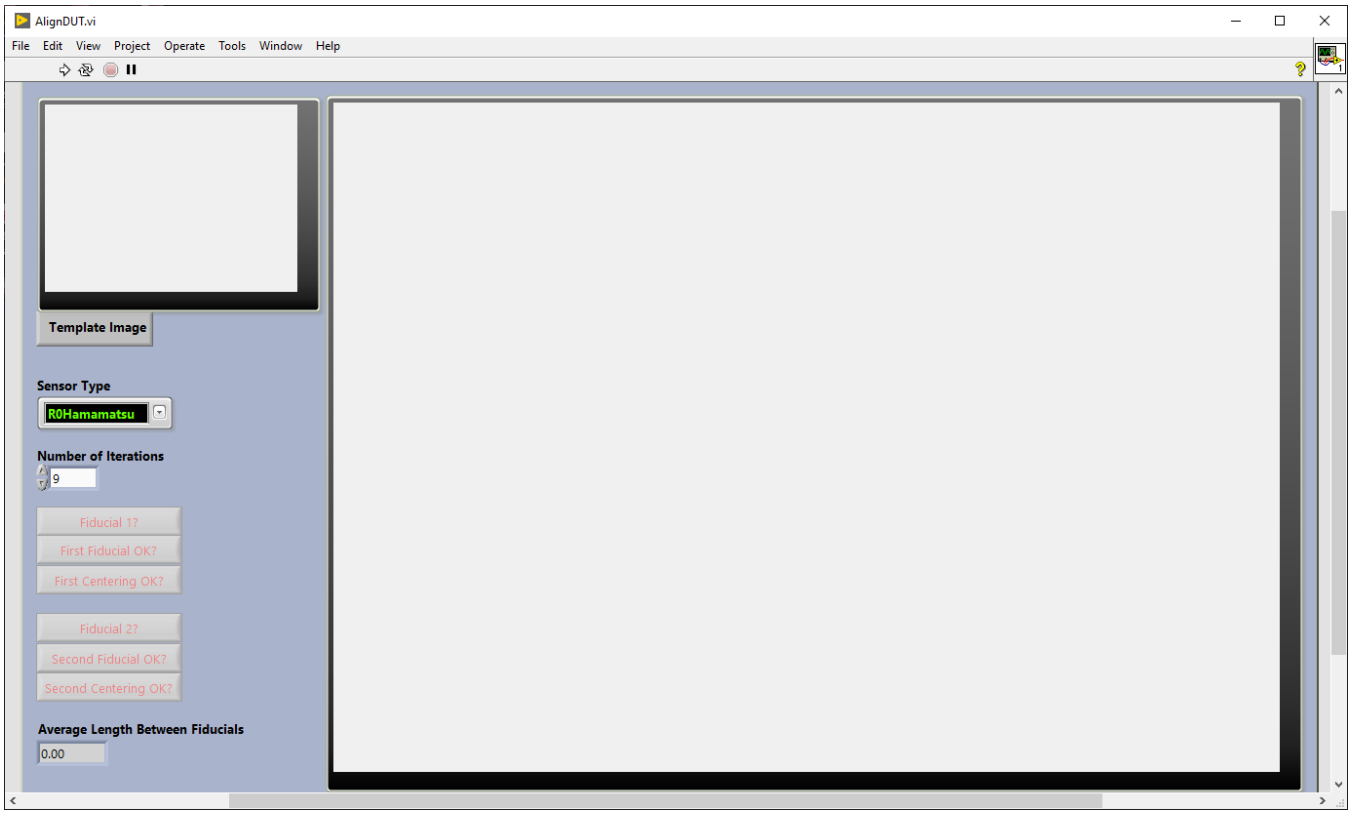

Figure 1: The Align DUT GUI

The various aspects of the GUI are as follows:

1.) **Template Image window** – This displays the template image which is to be searched for. It corresponds to the fiducials which form a straight line through the center of the sensor.

2.) **Sensor Type** – A selection box for the type of sensor which has been loaded onto the chuck.

3.) **Number of Iterations** – The number of times each fiducial will be found after manual location. For accuracy a recommendation is 9 or greater.

4.) **Process Buttons** – These buttons will become available during the manual fiducial finding procedure. They are checks for the operator to ensure that the recognition of the fiducial is satisfactory and that the robot is receiving automated move commands properly.

5.) **Average Length Between Fiducials** – Used as a check that the X and Y axes of the prober are within calibration. If after a test this value is off by more than 5 um for the current sensor being tested, a recalibration of the axes should be performed.

6.) **Live Feed Window** – This window displays a live view from the gantry camera. It displays pattern recognition results and is used for locating the fiducials.

Setup

The steps for setting up a test are as follows:

1.) **Open all Critical Software** – The software to be opened is: SemiServer, ProberInterface, CommunicationsController, Navigator and AlignDUT.vi. All the former software can be found on the desktop except AlignDUT. It is in a file folder of the same name. Ensure the software is opened in the order above as it will throw an error otherwise. If the ProberInterface throws an error when opened, the SemiServer was not setup fully. Close both in task manager and wait a several seconds between opening. When fully setup the software should look as follows:

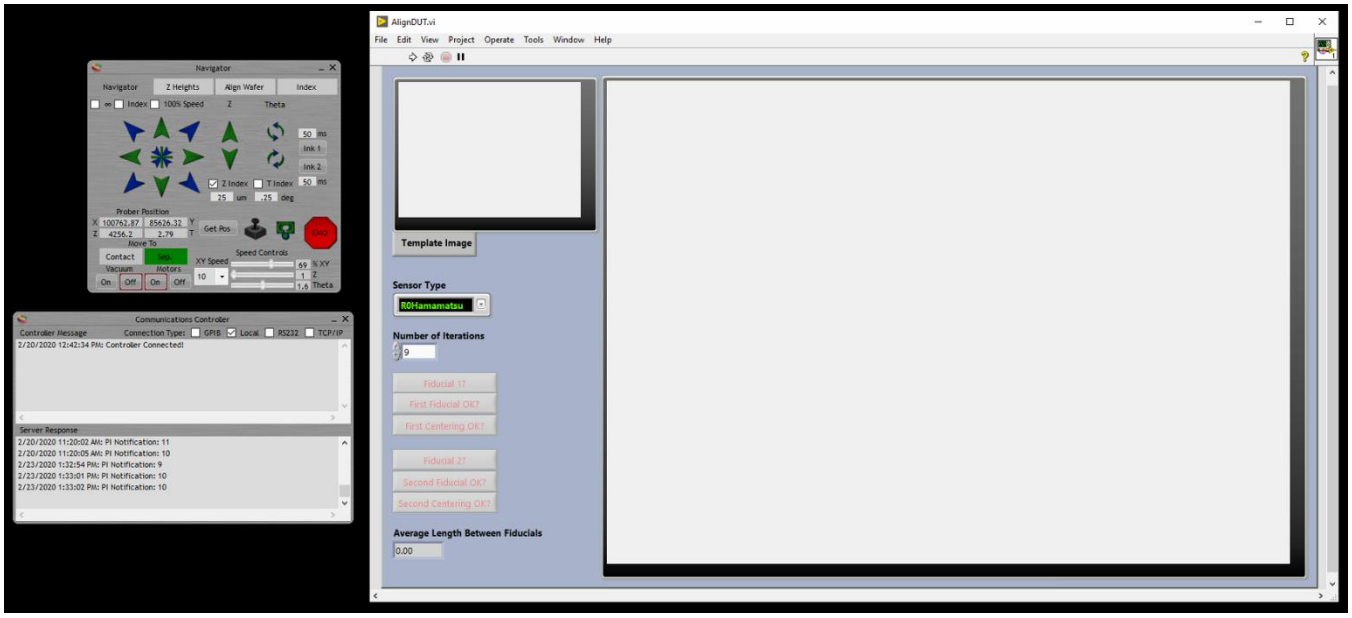

Figure 2: All relevant user interfaces opened.

2.) **Set Communications Controller to Local** – Check the box at the top of the communications controller for Local.

3.) **Turn on the Light Source** – Upon loading a sensor, the coaxial light must be turned on. It is a manual control knob underneath the probe station box. Set the light intensity to a maximum of 50 else the bulb lifetime will decrease dramatically.

4.) **Load a Sensor** – Load a sensor onto the chuck of the Semiprobe robot and turn on the vacuum with the Navigator GUI. Best results have been observed if the angle of rotation from the GDS file is minimized. This alignment is convex side to the right and concave left as seen in figure 3.

5.) **Start the Program** – Press the run arrow in the upper left corner of the AlignDUT software to initiate a test. Upon initiation, the communications controller should state "Controller Connected!" if it does not, it was not shut down properly in a previous

test. If this is the case, commands will not be received by the robot. Stop the Vi, uncheck and recheck the box to refresh and restart the Vi.

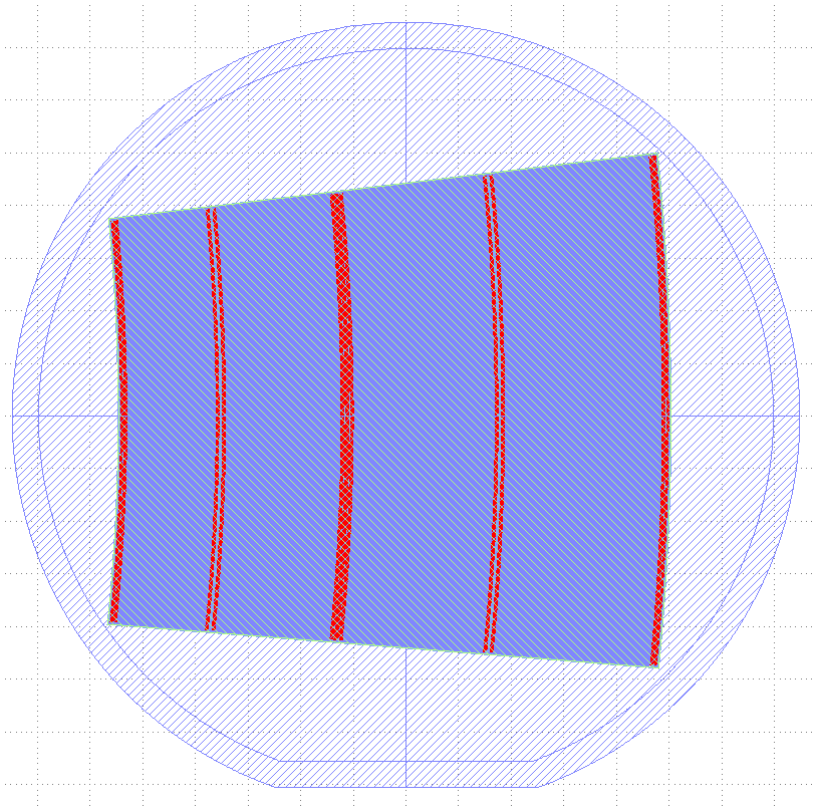

Figure 3: Desired sensor orientation for best accuracy.

Aligning a Sensor

1.) Upon starting the software, there will be a delay while the camera is accessed. Following this delay, the template fiducial and live feed will populate. Now, choose the **Sensor Type** and **Number of Iterations.**

2.) The arrow keys of the navigator will now be used to move to the first fiducial. If the

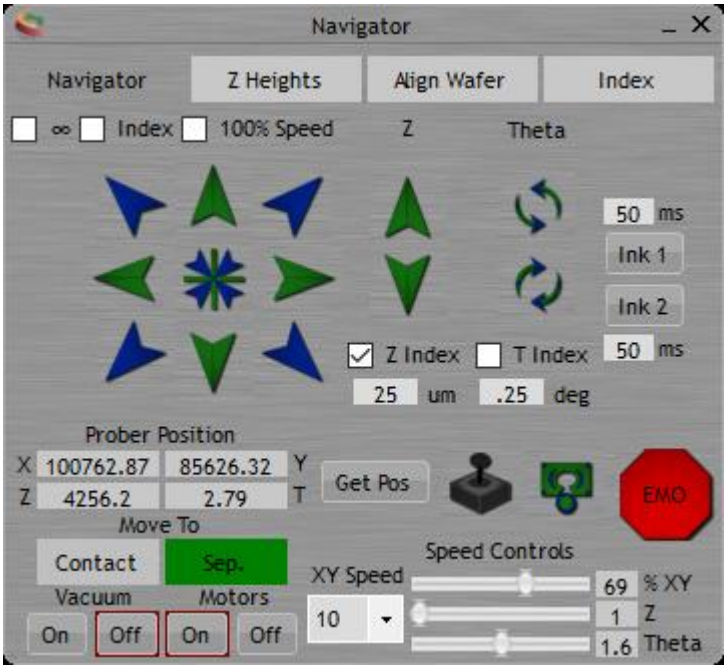

Figure 4: Navigation software GIU. Use the arrow keys to move the stage in the corresponding direction, set the speed controls and adjust the focus.

image is out of focus, adjust the Z height by moving the stage up or down until a crisp image comes into view. Drive to the first fiducial on the convex side of the sensor. When the fiducial of interest comes into view press the **Fiducial 1?** button to start the pattern recognition process. A fiducial will only be recognised when it is in the bounding ROI box else a line to the upper left corner of the live feed will appear indicating no pattern has been matched. When a fiducial is matched, a bounding box will appear around the match as will a vector from the center of the image to the center

of the match. Table 1 gives the strip indicators between which the first and second fiducials can be found.

Sensor Type	Concave Side	Convex Side
R0	450 & 500	550 & 600
R1	600 & 650	700 & 750
R2	750 & 800	750 & 800
R3	400 & 450	450 & 500
R4	450 & 500	500 & 550
R5	550 & 600	550 & 600

Table 1: Approximate locations of fiducials depending on sensor type.

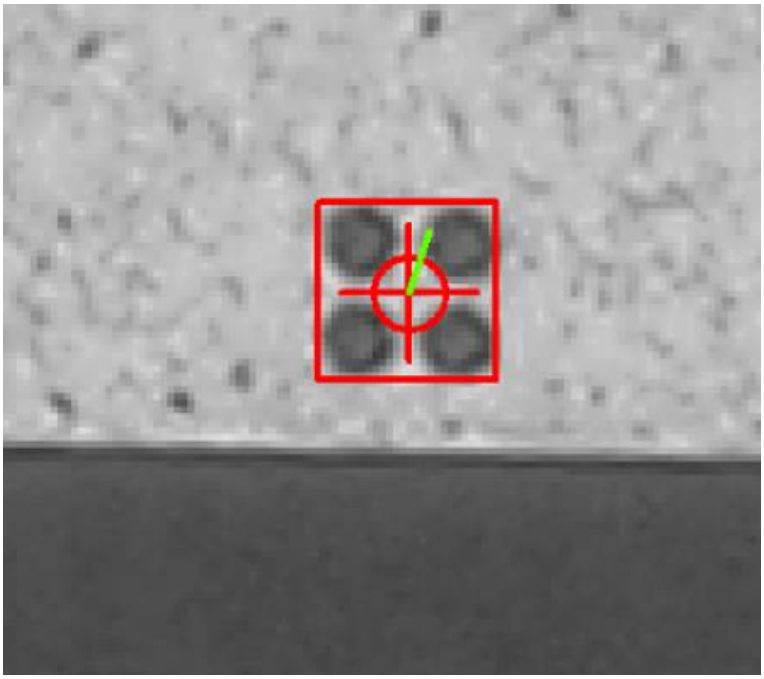

Figure 5: A zoomed image of pattern recognised fiducial. The green line is a vector from the center of the image to the center of the red match box.

3.) Once a match has been made press the **First Fiducial Ok?** button. This will center the camera onto the fiducial and start the match process again. This is to minimize the error which could be caused by a slightly inaccurate pixel to distance calculation or by

a rotation of the camera. At this point, if the image does not center on the fiducial the camera has been jarred and should be re-aligned.

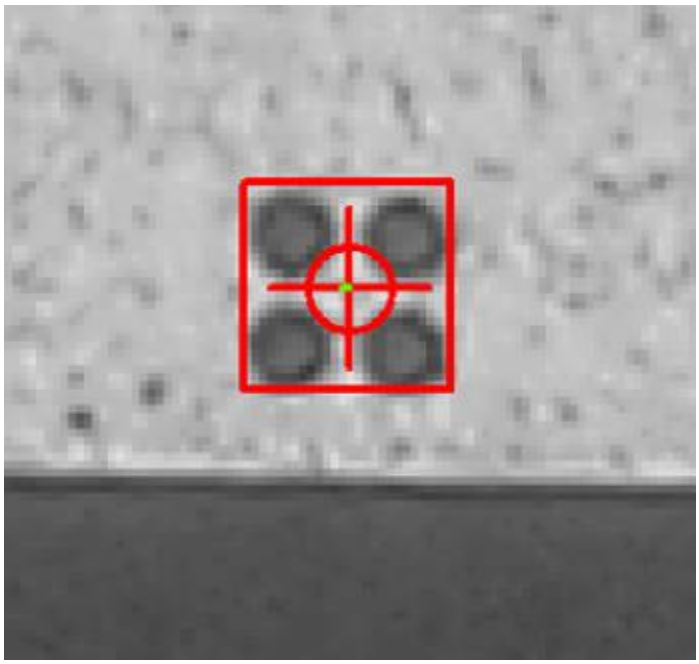

Figure 6: A zoomed image of the fiducial after the automated centering.

4.) To save the current fiducial position, press the **First Centering OK?** button. This will remove the bounding box and match from the image.

5.) Drive to the concave side of the sensor and repeat steps 2-4 for the second fiducial.

6.) Upon completion, the chuck will automatically start driving back and forth between the two found fiducials for the specified number of iterations. The program will then close its connection to the robot writing "Controller Disconected" to the communications controller. Once this process is completed, the file **CurrentDUT.txt** will contain a list of positions to be probed. This list can be used to manually investigate positions or automatically in the striptest code. It also updates the files **Fiducial1ErrorTest.txt** and **Fiducial2ErrorTest.txt** which contain lists of the co-ordinates where the fiducials were found at each iteration for error checking.

Calibrating the X and Y Axes

1.) The AlignDUT software is also used for calibration of the X and Y steps-to-um ratios for the stepper motors. The same procedure above is performed except now the sensor must be aligned precisely to the axis of interest. Perform steps 1 and 2 of *Aligning a Sensor* while looking at fiducial 1, using the theta controls, align the fiducial such that there is a straight green line from the center of the fiducial to the center of the image.

2.) In the navigator, go to the *index* tab and enter the distance between fiducials in the index column then press set index. Use the table provided depending on the sensor you are using.

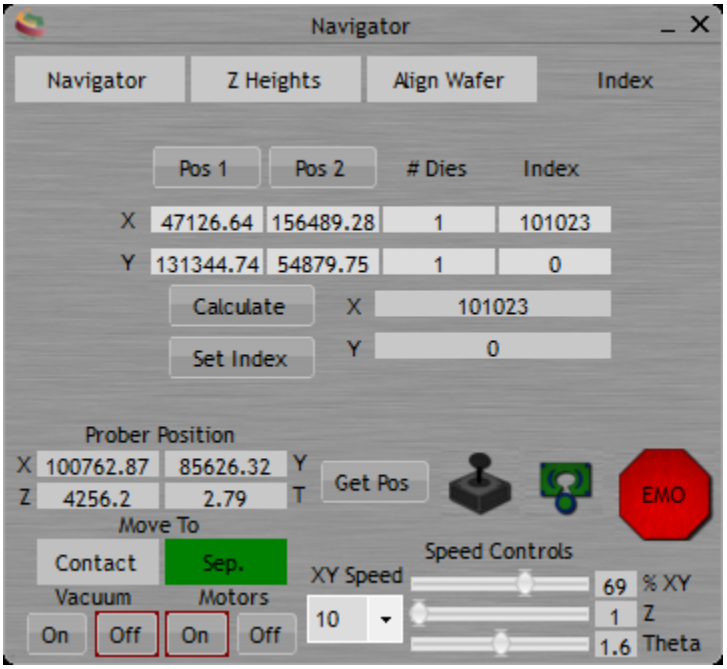

Figure 7: The GUI tab for index move.

3.) Go back to the Navigator tab and check the box for **Index**. Press the arrow once to move in the direction of the second fiducial. Adjust the angle of the stage until the distance between the fiducial and the original move to position is halved. Now, uncheck the index box and move the stage until the green line is aligned with the axis

of interest again. Turn **index** back on and move back to the first fiducial. Repeat this step until the two fiducials are aligned along the X or Y axis of the motor.

Sensor Type	Center to Center Distance (um)
R0	104623
R1	85071
R2	62315
R3	117592
R4	109861
R5	101023

Table 2: Inter fiducial distances by sensor type.

4.) When the sensor is aligned to a motor axis, continue the steps of the aligning a sensor. When completed, compare the expected center to center distance with the computed distance. Open the settings menu of the navigator by clicking the icon in the upper left corner. Navigate to **Stage** and open the **Stage Settings** menu. Increase the value if the distance is short and decrease it if there is an overshoot. An estimate of the change is 0.0001 per um of correction when using an R5 sensor for calibration.

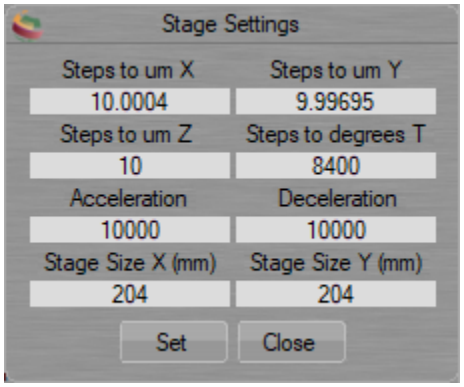

Figure 8: Stage settings for steps to um calibration.

5.) Repeat step 4 until the distance is within 3 um of the expected value.

Accuracy Testing

If the stage is seeing a large amount of error during absolute moves, during testing or the alignment procedure, there could be an underlying mechanical issue. To check, run AlignDUT with at least 50 iterations. Then, run the software Accuracy.m in MATLAB with the inputs **Fiducial1ErrorTest.txt** and **Fiducial2ErrorTest.txt.** This will produce histograms of the error from the manual move and, if large, indicates a floating reference frame. Shown are images of the expected accuracy and accuracy when a problem is present. If the latter is seen, contact the lead engineer for the machine.