In-Sight 3D Standard Lab Manual

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Lab Exercise 1.1 – Hardware & Connections

At the end of this lab exercise, Participants will be able to:

- Connect their In-Sight 3D L4000 camera to the network

The Participant will utilize the following In-Sight Functions to successfully complete this exercise:

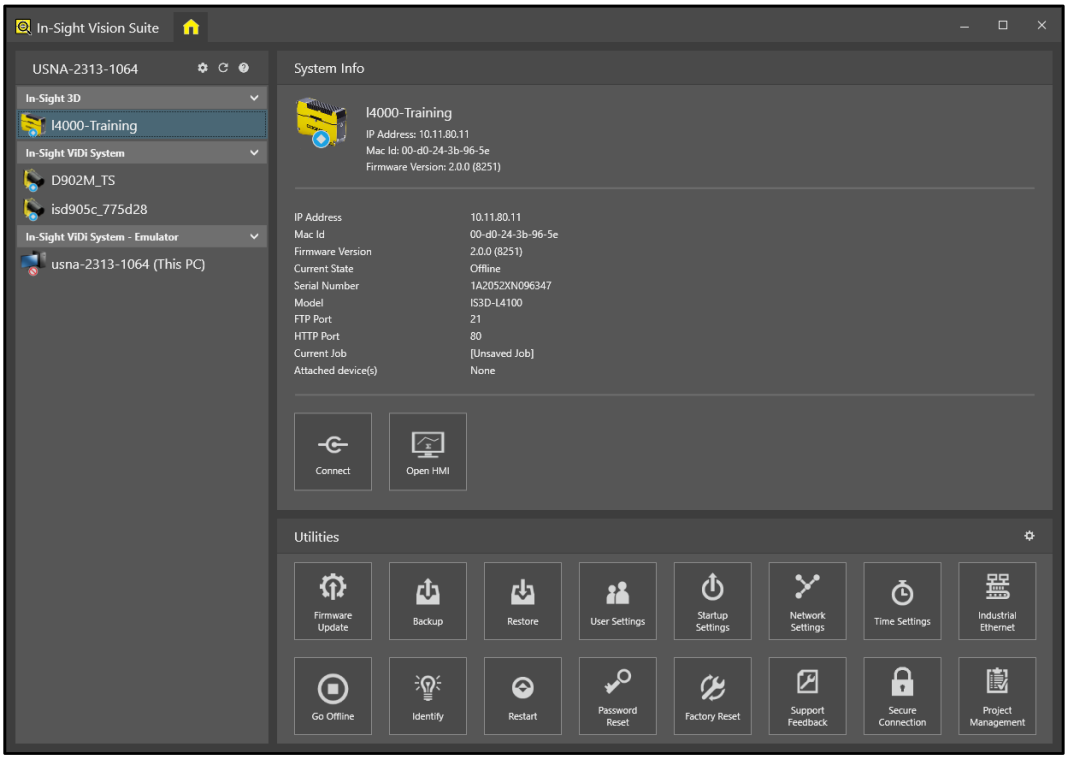
- In-Sight Vision Suite
- Connect button

Follow the steps below to connect to the In-Sight 3D Camera:

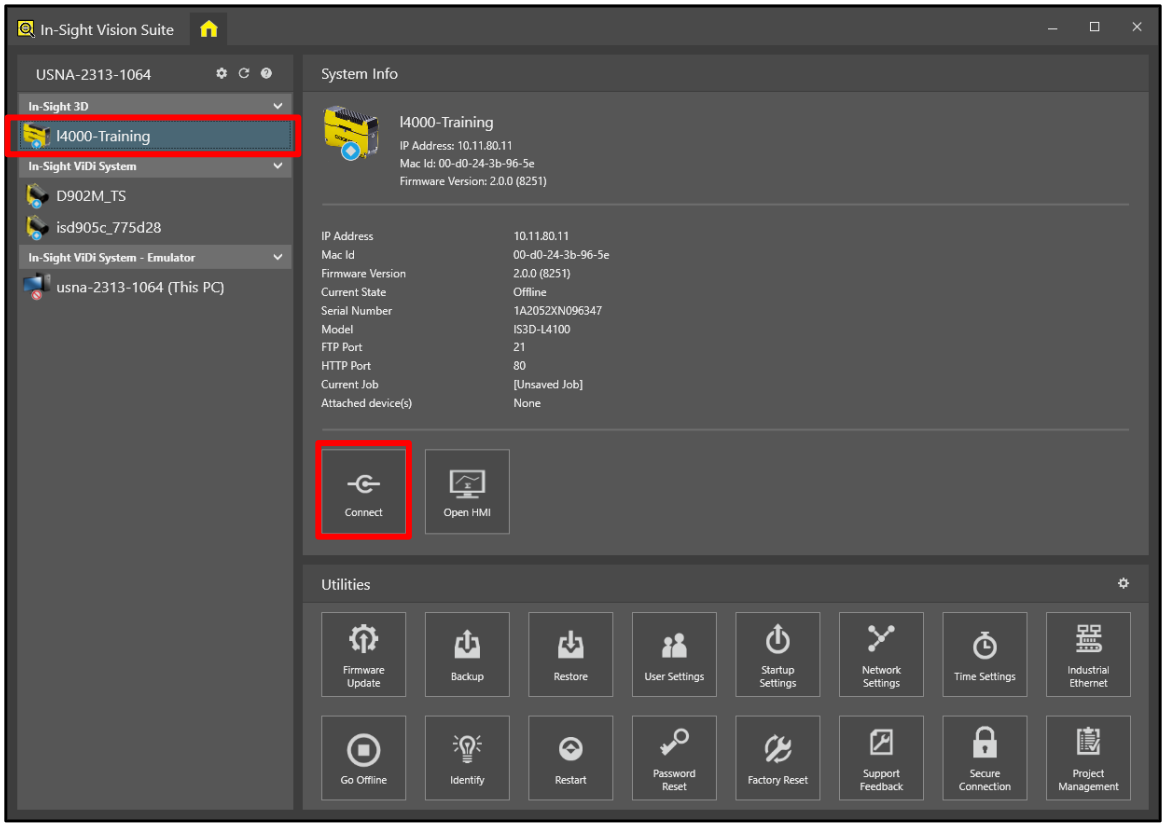
1. Create a folder on your desktop named **IS3DClass** with the date appended, e.g., **IS3DClass021721.** This is where you will save the jobs you will develop in the lab exercises.
2. Double click the **In-Sight Vision Suite** shortcut icon on your desktop.

The In-Sight Vision Suite Launcher will display. The In-Sight Vision Device Pane displays the host names of the discovered devices, as well as the icons that indicate the model and status of the devices.

NOTE: *When the launcher first starts, it will discover and enumerate all the In-Sight Vision Systems on the local subnet network in the In-Sight Device Pane.*

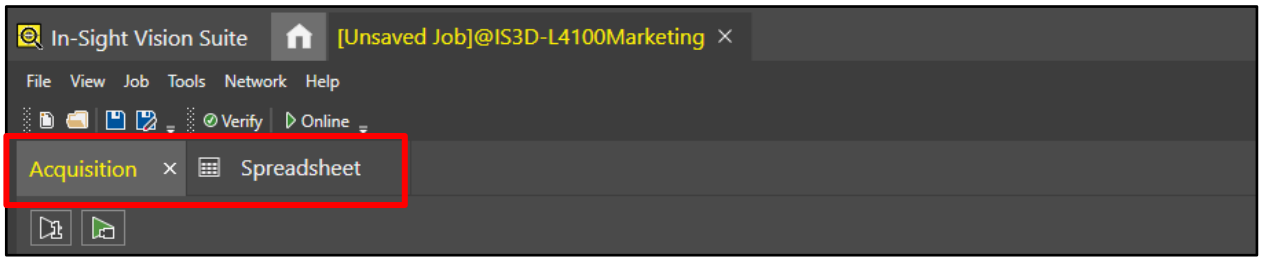


3. Click the name of your In-Sight 3D L4000 camera and click the **Connect** button.



The **Loading Window** displays.

The **Development Environment** displays. The *Acquisition* tab is active, notice that there is a second tab representing the blank *Spreadsheet*.



Lab Exercise 2.1 – Software and Image Acquisition

At the end of this lab exercise, Participants will be able to:

- Utilize the Acquisition Wizard to configure and control the acquisition settings
- Acquire an image using an In-Sight 3D-L4000 series camera

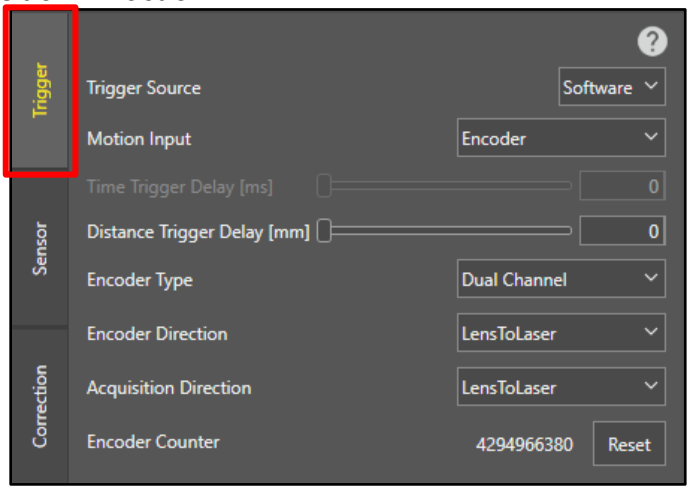
The Participant will utilize the following In-Sight Functions to successfully complete this exercise:

- Acquisition Wizard
- In-Sight Spreadsheet

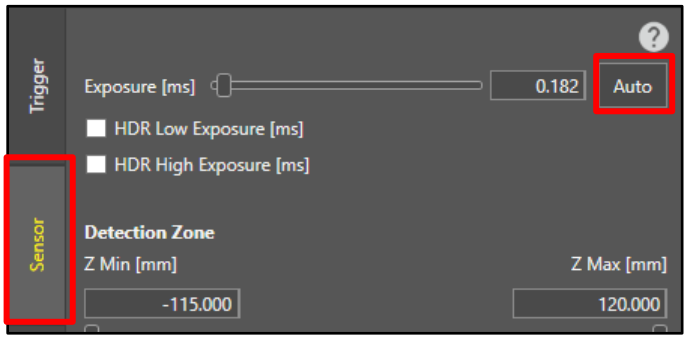
Follow the steps below to acquire an image:

1. Connect to your camera.
2. Double click cell **A0** to open the Acquisition Wizard.

   The **Acquisition Wizard** displays.
3. On the **Trigger** Tab set the parameters as follows:
   - *Trigger Source* = Software
   - *Motion Input* = Encoder
   - *Encoder Direction* = LensToLaser
   - *Acquisition Direction* = LensToLaser

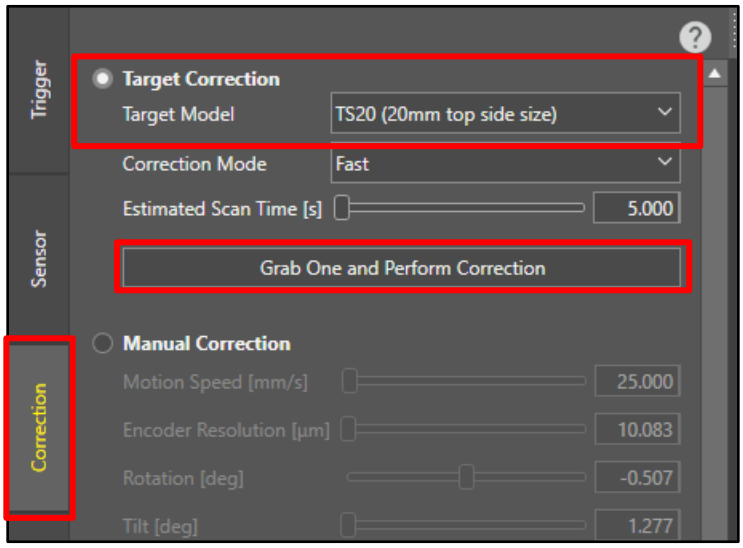


4. On the **Sensor** tab set the parameters as follows:
   - *Exposure* = Click the **Auto** button

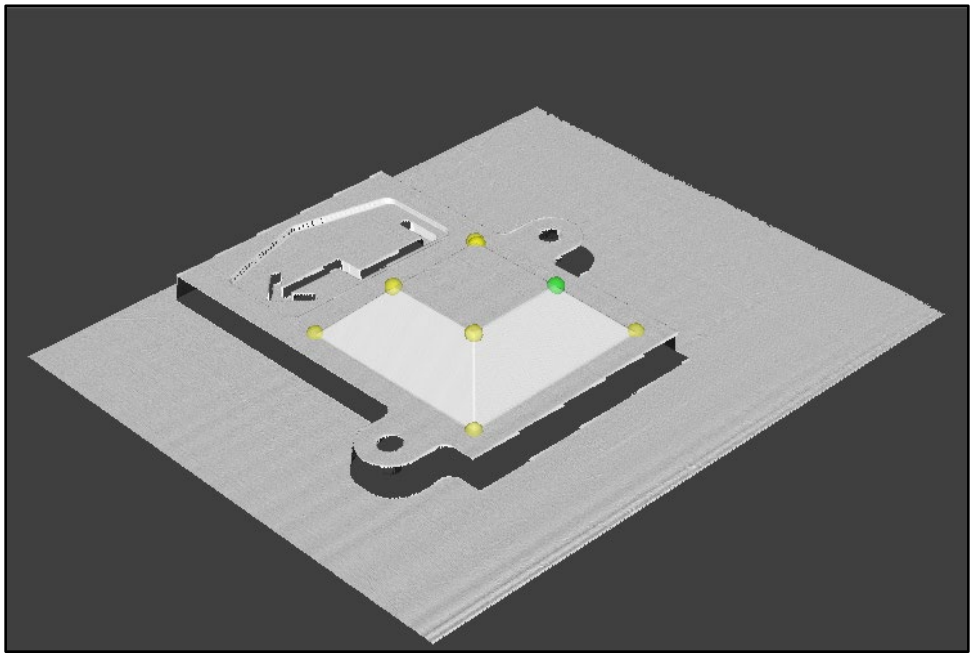


5. On the **Correction** tab set the parameters as follows:
   Target Correction
   - *Target Model* = TS20

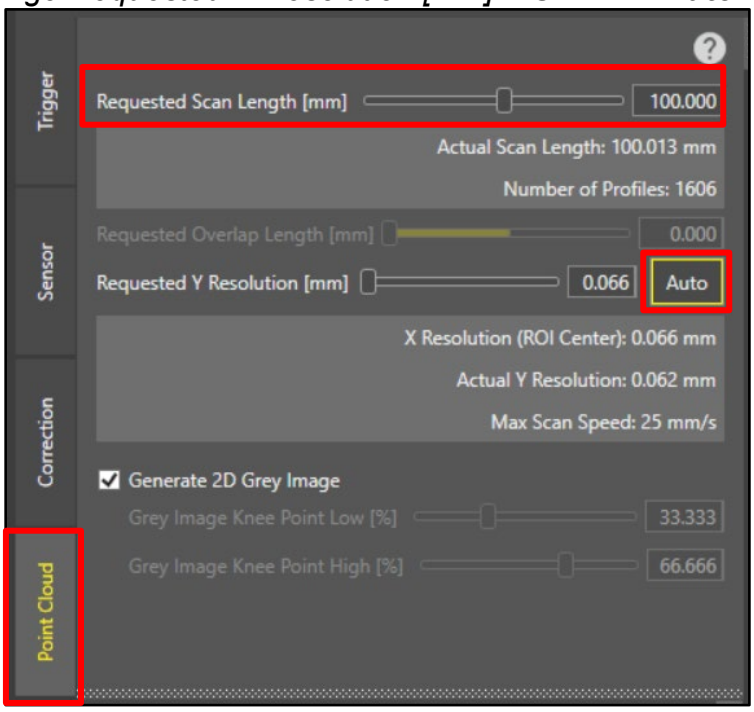
   Click the **Grab One and Perform Correction** button.



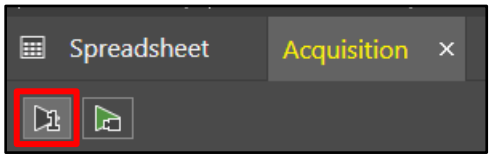
6. Move your slider from left to right to acquire an image.
   The camera processes the parameters for motion state and performs field calibration.



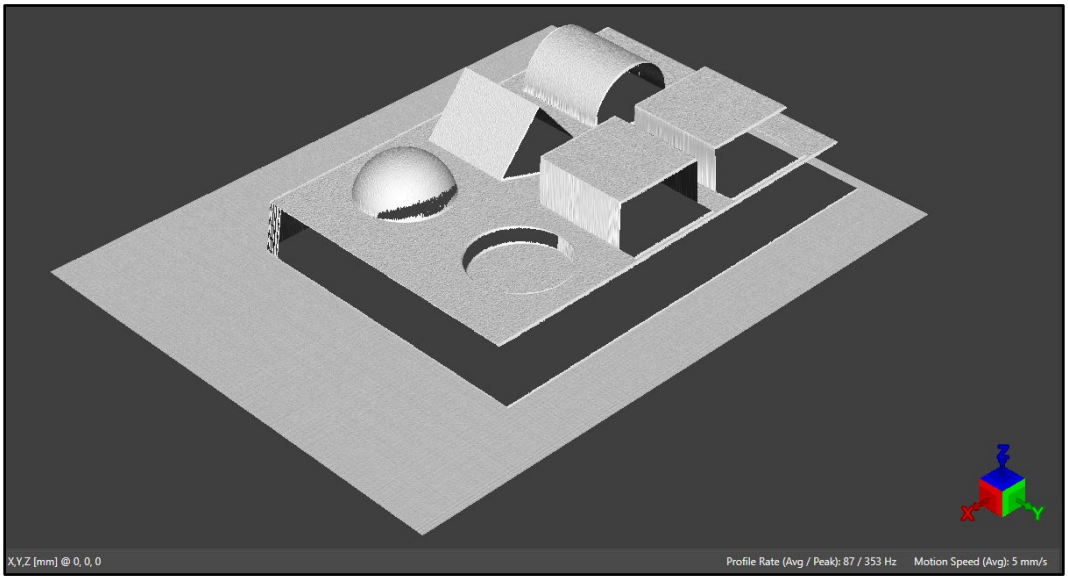
7. On the Point Cloud tab set the parameters as follows:
   - *Requested Scan Length* = 100 mm
   - *Change Requested Y Resolution [mm]* = Click the **Auto** button



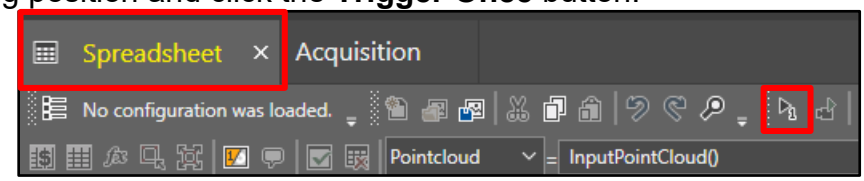
8. Place the good Demo Part on the demo station slider and click the **Trigger Once** button.



9. Move the demo station slider from left to right to acquire an image. Review the image.

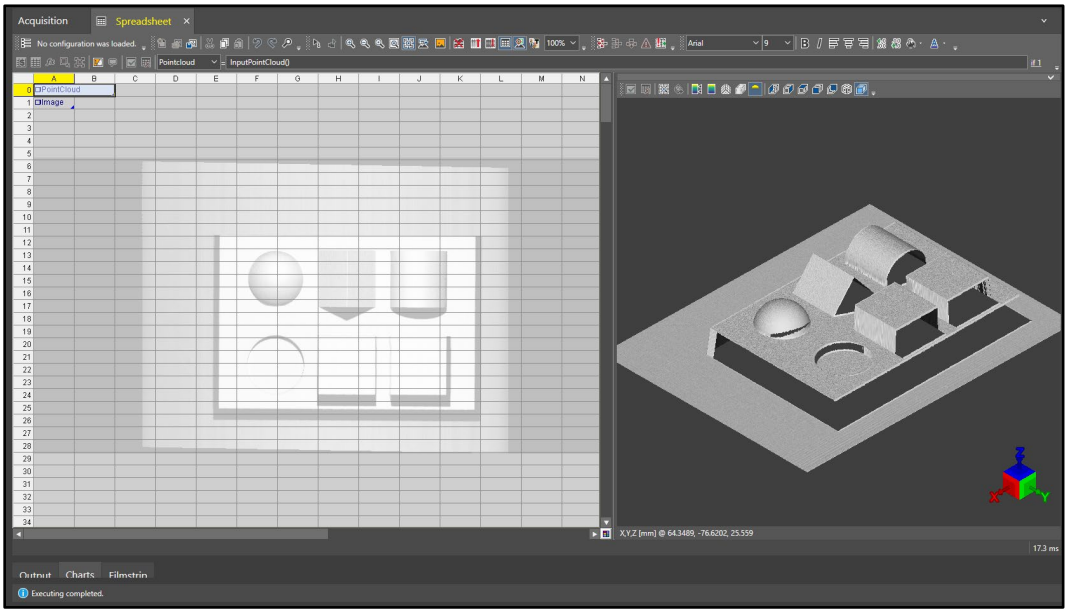


10. Click the **Spreadsheet** tab to return to the spreadsheet, return the slider to the starting position and click the **Trigger Once** button.



11. Move the demo station slider from left to right to acquire an image.

    A new **Point Cloud** image displays in the 3D display and behind the spreadsheet.



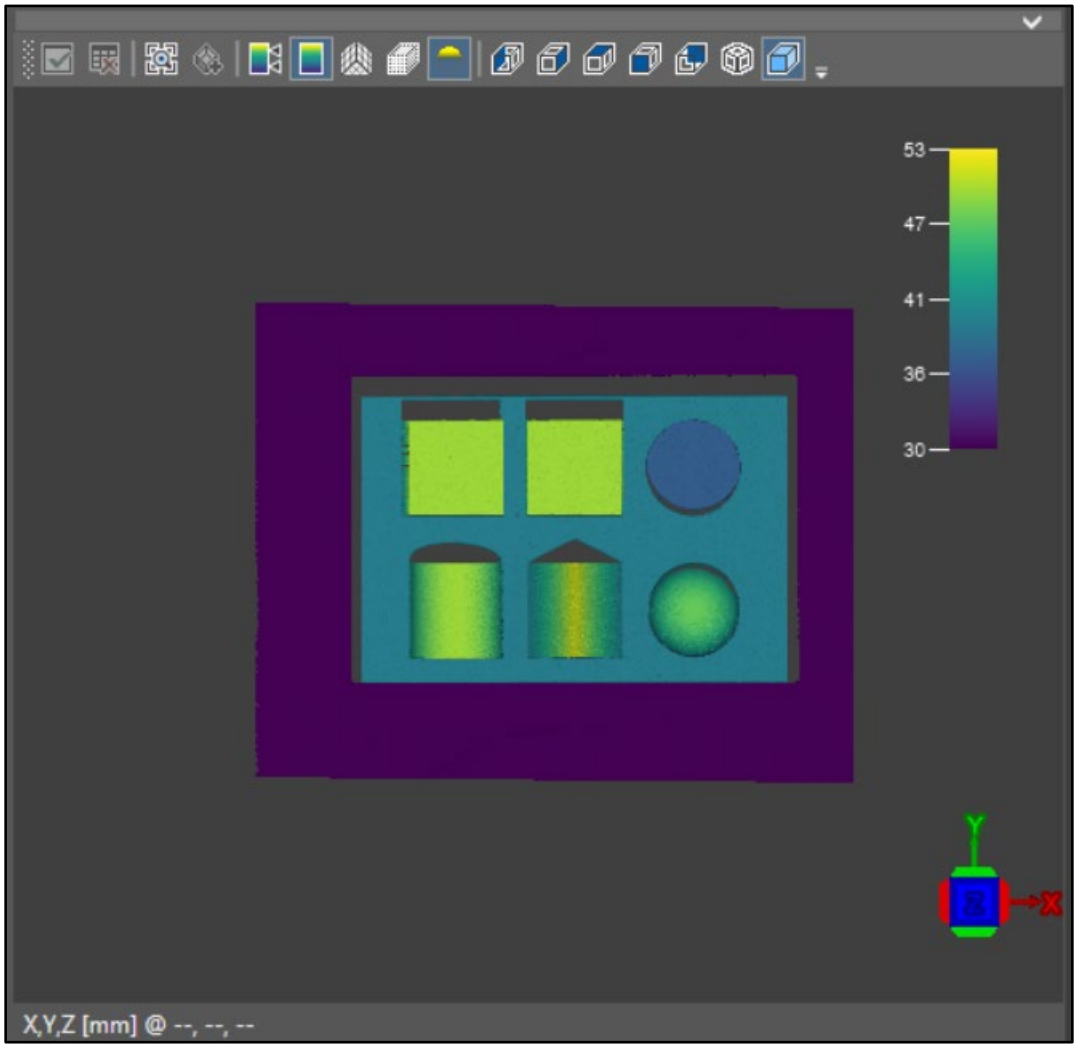
12. Click the **Show 3D Image from** buttons to view the 3D image from the different perspectives.

13. Click the **Change Height Coloring** button and move the color display bars to view the change in colors.

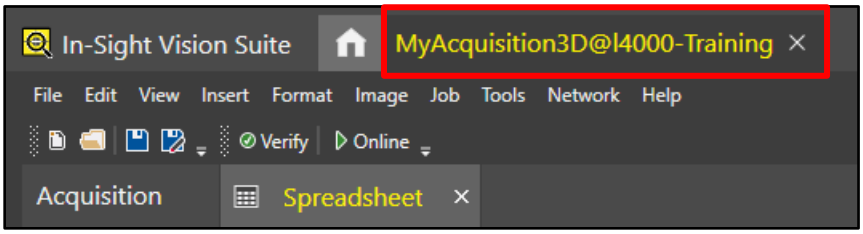
14. When you are happy with the colors, click the **Change Height Coloring** button again.

Color mapping is added to the 3D image.

NOTE: *In the color mapping of the demo part, the base plane is a dark purple.*



15. Save the job as **MyAcquisition3D** in the folder on the desktop created in Lab #1.



Lab Exercise 3.1 – Pattern Location using PatMax 3D

At the end of this lab exercise, Participants will be able to:

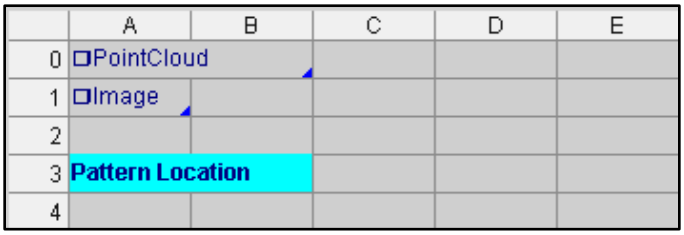
- Utilize the PatMax3D tools to locate a cuboid on the demo part

The Participant will utilize the following In-Sight 3D Functions to successfully complete this exercise:

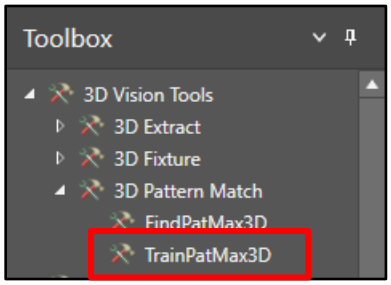
- TrainPatMax3D
- FindPatMax3D
- Quick Drop Box

Follow the steps below to acquire an image:

1. Continue with the **MyAcqusition3D** job from the last lab exercise.
2. Save the job as **MyPatMax3D** in the folder that you created in Lab #1.
3. Enter the comment **Pattern Location** in cell A3. Be sure to start with an apostrophe (‘). Format the cell so that the comments are noticeable in the spreadsheet.



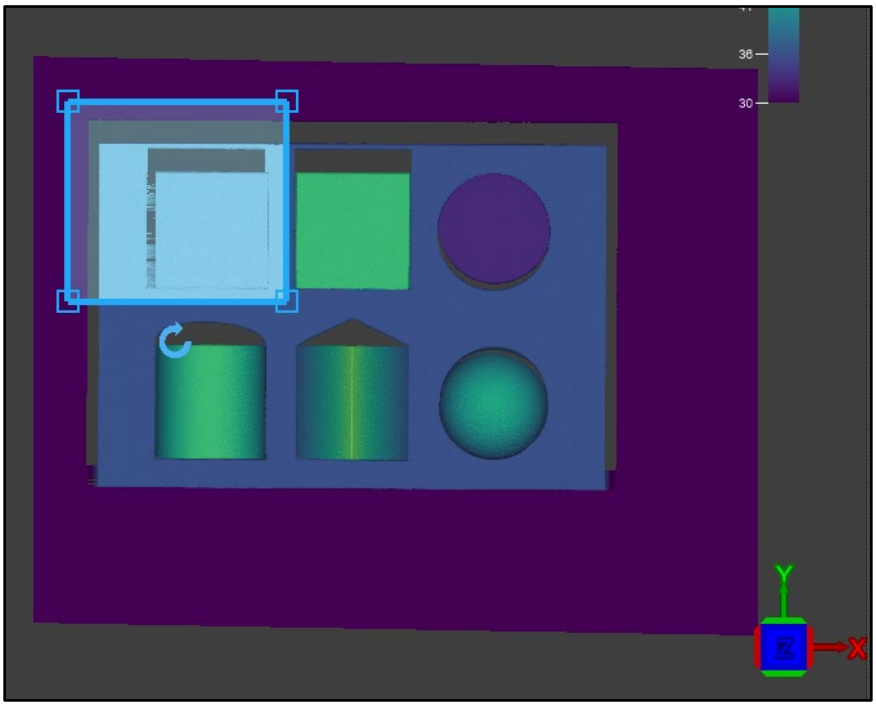
4. Insert a **TrainPatMax3D** tool into cell **B5** of the spreadsheet.



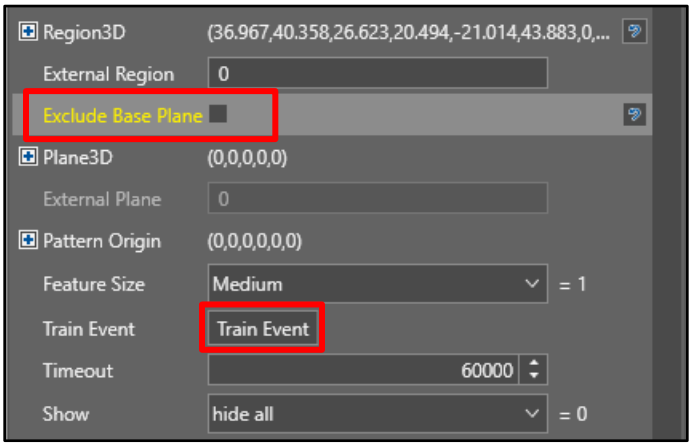
5. Double-click the **Region3D** parameter.
   The region displays on the 3D image window.
6. Click the **Show 3D Image from Top** button.

7. Click the **Quick Drop Box** button.

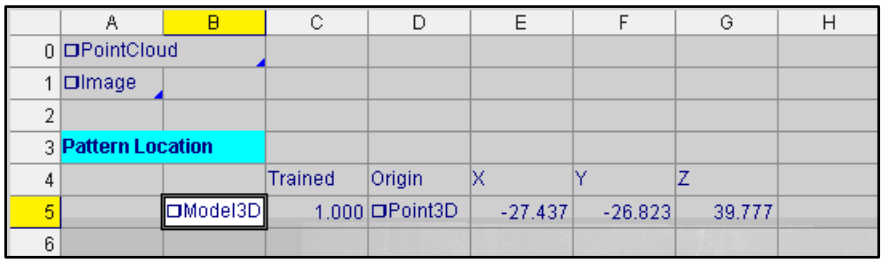
8. Draw a region over the corner cuboid and the corresponding corner and press the **<Enter>** key.



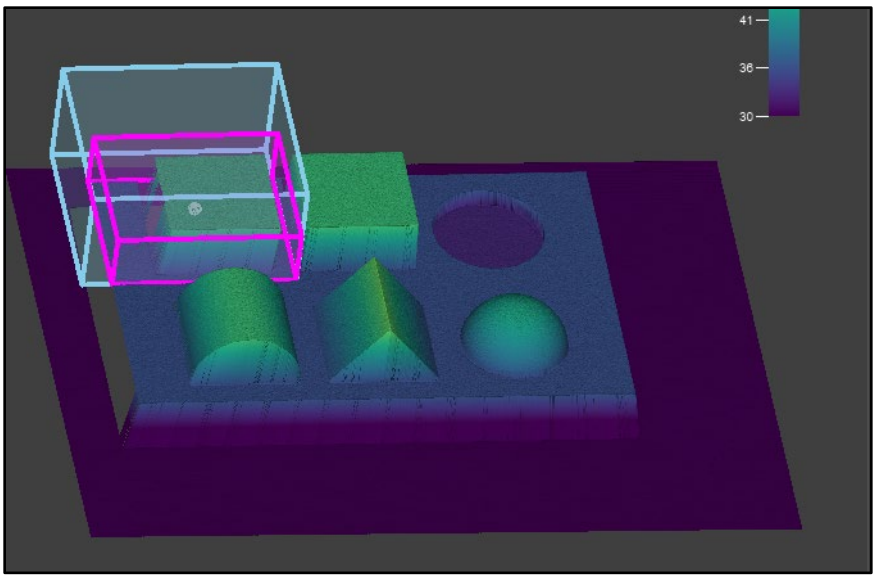
9. Uncheck the **Exclude Base Plane** checkbox and click the **Train Event** button.



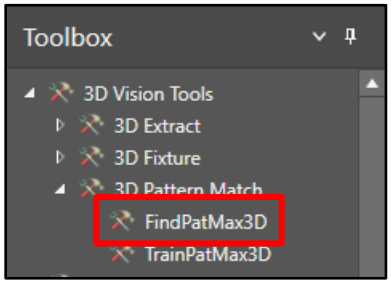
10. Click the **OK** button to close the TrainPatMax3D Property Sheet.
    The **Model3D** Structure is added to the spreadsheet.



	A	B	C	D	E	F	G	H
0	PointCloud							
1	Image							
2								
3	**Pattern Location**							
4			Trained	Origin	X	Y	Z	
5		Model3D	1.000	Point3D	-27.437	-26.823	39.777	
6								



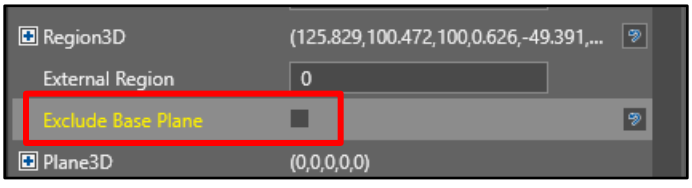
11. Insert a **FindPatMax3D** tool into cell **B7** in the spreadsheet.



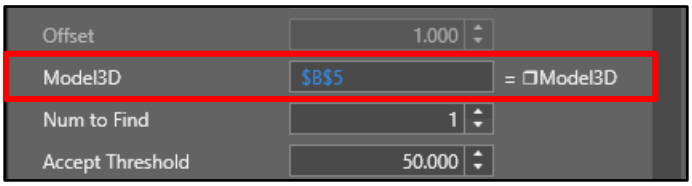
12. Double-click the **Region3D** parameter.
    The region displays on the 3D image window. View the Demo Part from the Top.

13. Click the **Quick Drop Box** button.

14. Draw a region over the entire part and press the **<Enter>** key.
    NOTE: *The green checkmark (Accept Changes) button can also be used.*
15. Uncheck the **Exclude Base Plane** checkbox.



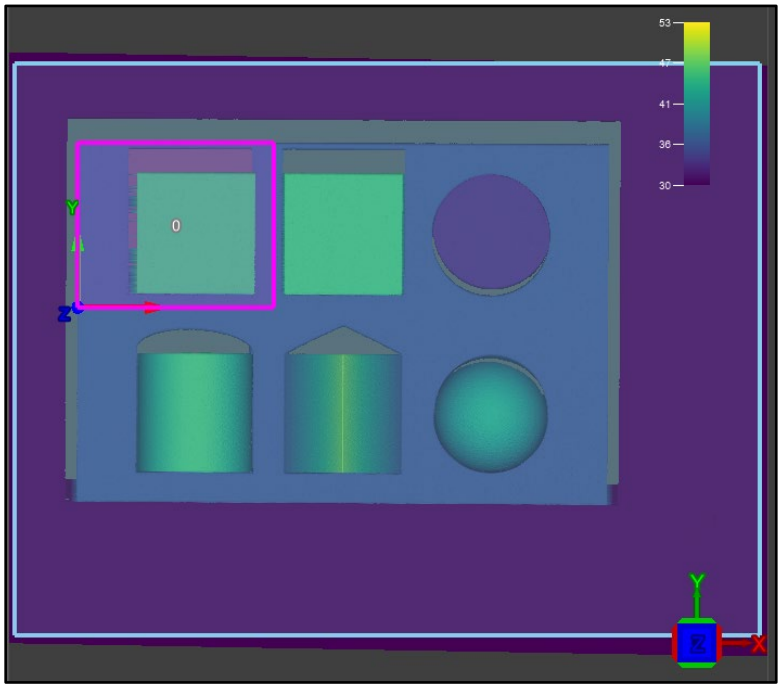
16. Double-click the **Model3D** parameter to open – reference the **TrainPatMax3D** cell (B5) and press the **<Enter>** key.



17. Allow all default settings to remain and click the **OK** button to close the FindPatMax3D Property Sheet.

    The **Patterns3D** Structure is added to the spreadsheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M
0	PointCloud												
1	Image												
2													
3	**Pattern Location**												
4			Trained	Origin	X	Y	Z						
5		Model3D	1.000	Point3D	-27.437	-26.823	39.777						
6			Num Found	Index	Score	Fixture	X	Y	Z	Rotation	Tilt	Tilt Direction	
7		Patterns3D	1.000	0.000	93.377	Fixture3D	-27.428	-26.824	39.776	0.009	0.003	94.049	
8													

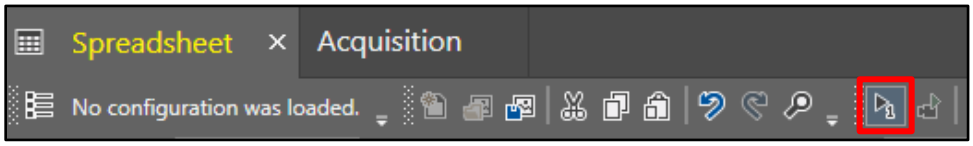


NOTE: *The X, Y, Z, Rotation, Tilt and Tilt Direction parameters show the location of the found features.*

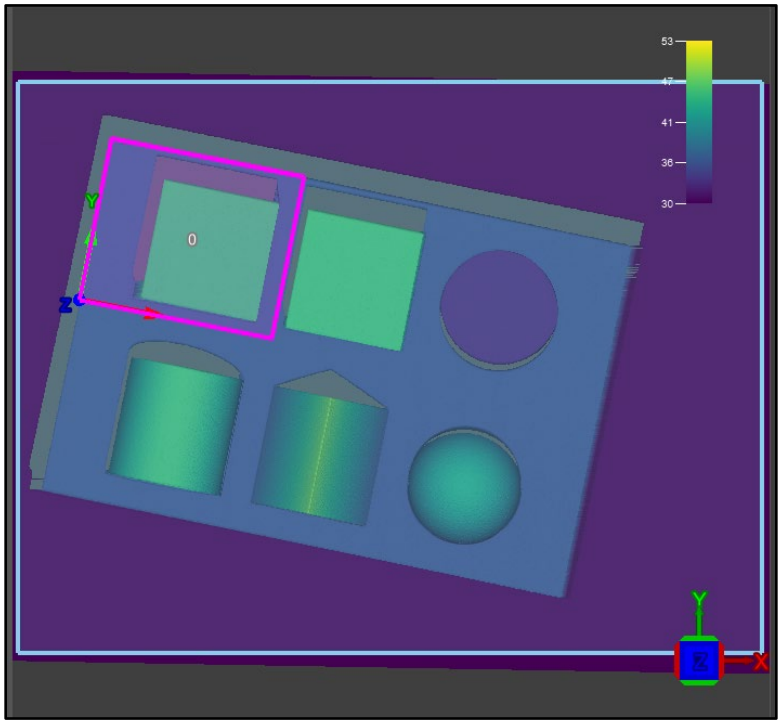
18. Highlight the **Fixture3D** structure in cell **F7**.

3	**Pattern Location**											
4		Trained	Origin	X	Y	Z						
5	Model3D	1.000	Point3D	-27.437	-26.823	39.777						
6		Num Found	Index	Score	Fixture	X	Y	Z	Rotation	Tilt	Tilt Direction	
7	Patterns3D	1.000	0.000	93.377	Fixture3D	-27.428	-26.824	39.776	0.009	0.003	94.049	

19. Move the part and click the **Trigger Once** button to acquire a new image.



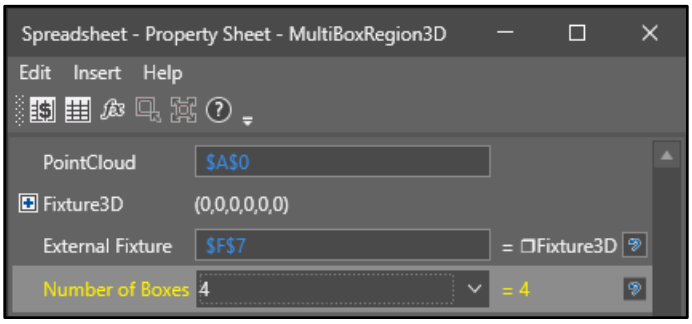
20. Review the results.



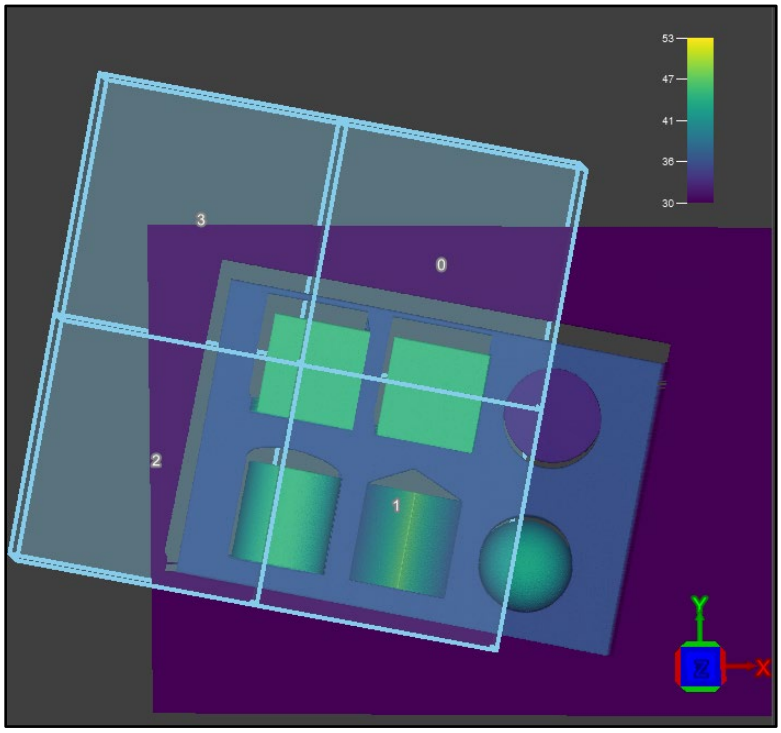
21. Enter the comment **Find Corners** in cell **A8**. Be sure to start with an apostrophe (‘). Format the cell so that the comments are noticeable in the spreadsheet.
22. Enter a **MultiBoxRegion3D** tool into cell **B9**.

    NOTE: *The MultiBoxRegion3D tool is found under Toolbox → 3D Structures.*

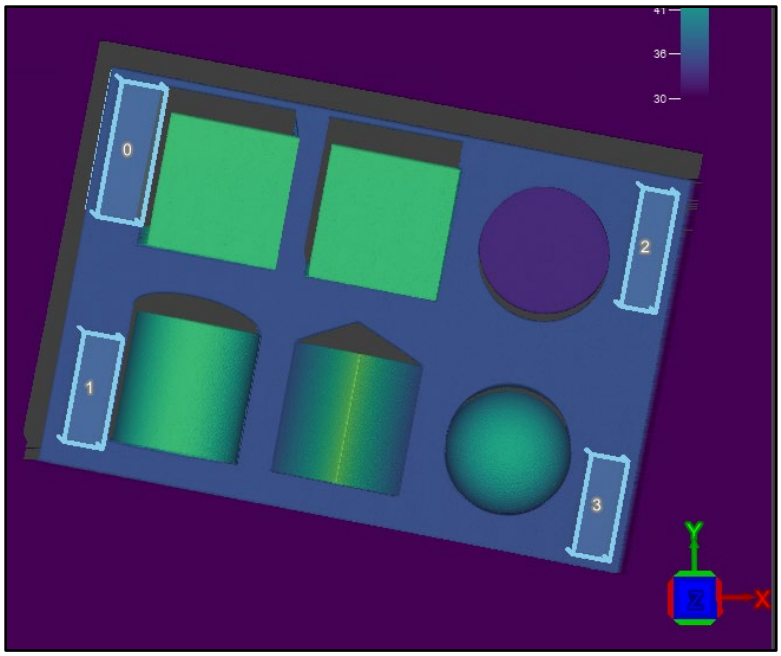
    The **MultiBoxRegion3D Property Sheet** displays.
23. Double-click the **External Fixture** parameter to open – reference the **Fixture3D** cell (F7) and press the **<Enter>** key.
24. Change the **Number of Boxes** parameter to *4*.



25. Click the **Show 3D Image from Top** button.

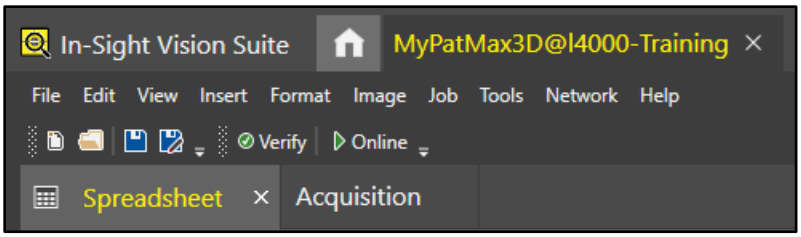


26. Double-click the **Box3D 0** parameter and position the region on the corner next to the cuboid and press the **<Enter>** key.
27. Repeat for the remaining Box3D parameters, placing each one in a corner of the demo part as shown below.



28. Click the **OK** button to close the MultiBoxRegion3D Property Sheet.

29. Save the job.



	A	B	C	D	E	F	G	H	I	J	K	L	M
0	PointCloud												
1	Image												
2													
3	**Pattern Location**												
4			Trained	Origin	X	Y	Z						
5		Model3D	1.000	Point3D	-27.437	-26.823	39.777						
6			Num Found	Index	Score	Fixture	X	Y	Z	Rotation	Tilt	Tilt Direction	
7		Patterns3D	1.000	0.000	92.990	Fixture3D	-27.648	-33.759	39.790	359.907	0.267	131.139	
8	**Find Corners**												
9		Region3D											

Lab Exercise 4.1 – 3D Extract Tools

At the end of this lab exercise, Participants will be able to:

- Use the ExtractPlane3D function to extract one of more planes from the point cloud
- Find blobs that are both positive (above the plane) and negative (below the plane)
- Extract edges from the specified region of the point cloud

The Participant will utilize the following In-Sight Functions to successfully complete this exercise:

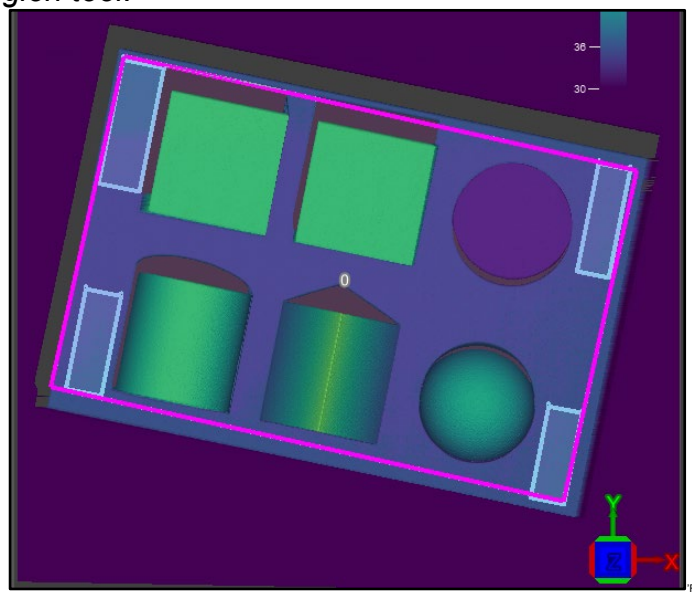
ExtractPlane3D
ExtractEdge3D
ExtractCylinder3D
ExtractBlob3D
ExtractSphere3D

Follow the steps below to complete the lab exercise:

ExtractPlane3D

1. Continue with the **MyPatMax3D** job from the last lab exercise.
2. Save the job as **MyExtractTools3D** in the folder created in lab #1.
3. Enter the comment **Base Plane** in cell **A10**.
4. Insert an **ExtractPlane3D** tool in cell **B12**.
   NOTE: *The ExtractPlane3D tool is found in the Toolbox → 3D Vision Tools → 3D Extract → ExtractPlane3D.*
   The **ExtractPlane3D Property Sheet** displays.
5. Set the property sheet parameters as follows:
   - *External Region* = Region3D Structure of the MultiBoxRegion tool (B9)

   Allow all other defaults to remain and click the **OK** button to close the property sheet.
   NOTE: *The ExtractPlane3D tool will use the region that was used in the MultiBoxRegion tool.*



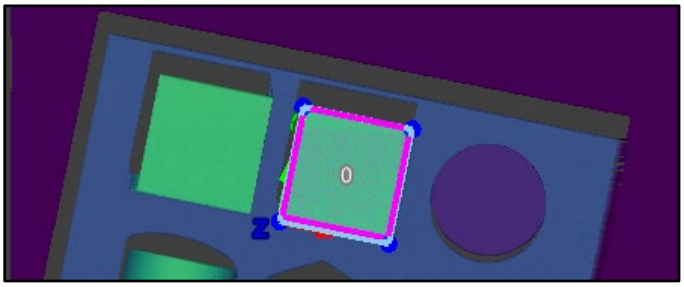
6. Enter the comment **Block Plane** in cell **A13**.
7. Enter the comment **Middle Cube** in cell **B14**.
8. Insert an **ExtractPlane3D** tool in cell **B16**.
9. Set the property sheet parameters as follows:
   - *External Fixture* = Fixture3D Structure of the FindPatMax3D tool (F7)

   Press the **<Enter>** key.
10. Double-click the **Region3D** parameter.

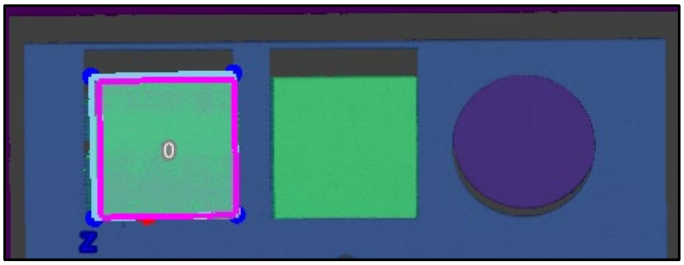
    The region displays on the 3D image window.
11. Click the **Show 3D Image from Top** button.

12. Click the **Quick Drop Box** button.

13. Draw a region over the middle cuboid and press the **<Enter>** key.
14. Click the **OK** button to close the ExtractPlane3D Property Sheet.



15. Enter the comment **Corner Cube** in cell **B17.**
16. Insert an **ExtractPlane3D** tool in cell **B19** and repeat steps 9 – 14 to find the corner cube.



10	Base Plane												
11			Num Found	Index	Score	Relative Tilt	Rectangle	Center	X	Y	Z	Tilt	Tilt Direction
12		Planes3D	1.000	0.000	89.835	0.042	Rectangle3D	Point3D	-5.665	-47.750	36.954	0.042	112.138
13	Block Plane												
14		Middle Cube											
15			Num Found	Index	Score	Relative Tilt	Rectangle	Center	X	Y	Z	Tilt	Tilt Direction
16		Planes3D	1.000	0.000	80.580	1.737	Rectangle3D	Point3D	-4.680	-32.493	46.813	0.064	101.250
17		Corner Cube											
18			Num Found	Index	Score	Relative Tilt	Rectangle	Center	X	Y	Z	Tilt	Tilt Direction
19		Planes3D	1.000	0.000	80.761	0.248	Rectangle3D	Point3D	-29.540	-31.283	46.818	0.083	47.846

17. Save the job.

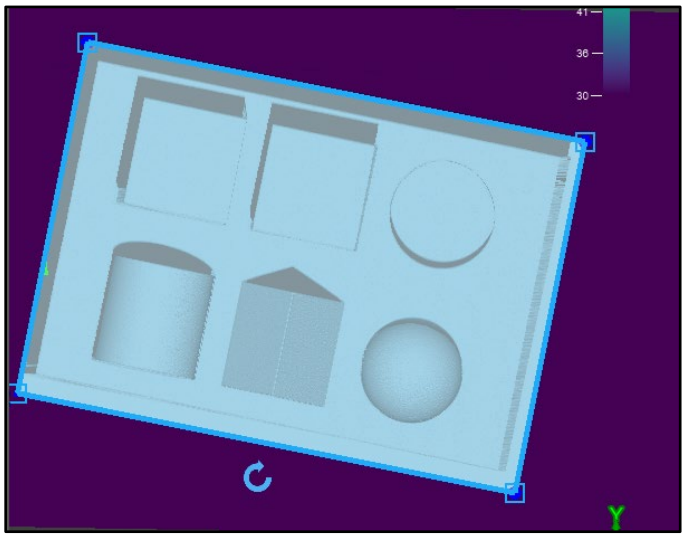
ExtractBlob3D

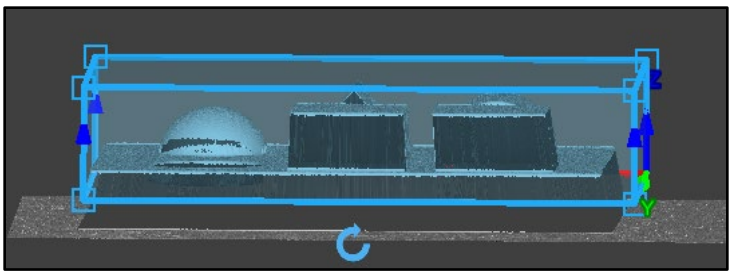
1. Enter the comment **Blob Count** in cell **A20**.
2. Insert an **ExtractBlob3D** tool in cell **B22**.

   NOTE: *The ExtractBlob3D tool is found in the Toolbox → 3D Vision Tools → 3D Extract → ExtractBlob3D.*

   The **ExtractBlob3D** Property Sheet displays.
3. Set the property sheet parameters as follows:
   - *External Fixture* = Fixture3D structure from FindPatMax3D tool (F7)
   - *Plane from Region checkbox* = Unchecked
   - *External Plane* = Rectangle3D structure from Base Plane (G12)
   - *Number to Extract* = 6
4. Double-click the **Region3D** parameter.

   The region displays on the 3D image window.
5. Click the **Show 3D Image from Top** button.
6. Click the **Quick Drop Box** button.
7. Draw a region over the base plane, rotate the demo part and reduce the size of the region from the top and bottom, and press the **<Enter>** key.

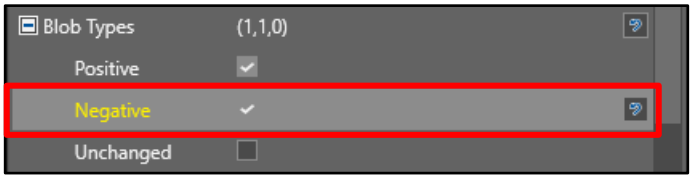




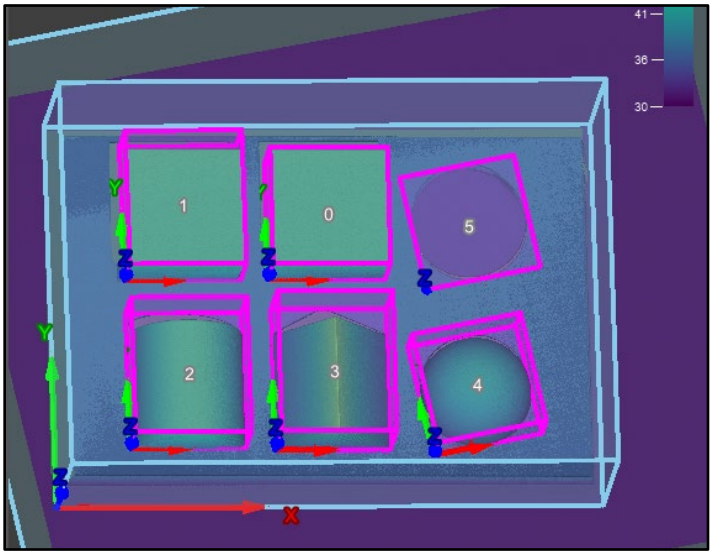
8. Click the **OK** button to close the ExtractBlob3D Property Sheet.
9. Rotate the part and review the results. Notice the ExtractBlob3D tool found 5 of the 6 blobs that we were looking for.

Blob Count							
		Num Found	Index	Volume	Height	Type	Bounding E
	Blobs3D	5.000	0.000	4043.177	10.111	Positive	Box3D
			1.000	4028.628	10.140	Positive	Box3D
			2.000	3157.237	10.174	Positive	Box3D
			3.000	2440.768	12.048	Positive	Box3D
			4.000	1459.605	7.961	Positive	Box3D
			5.000	#ERR	#ERR	#ERR	#ERR

10. Open the ExtractBlob3D Property Sheet and expand the **Blob Types** parameter.
    NOTE: *The ExtractBlobs3D tool is only searching for the blobs that are positive (above the base plane), notice that the 6th blob is under the base plane.*
11. Check the **Negative** checkbox and click the **OK** button to close the property sheet.



12. Review the results. Notice now all 6 blobs (above and below the base plane) have now been found.



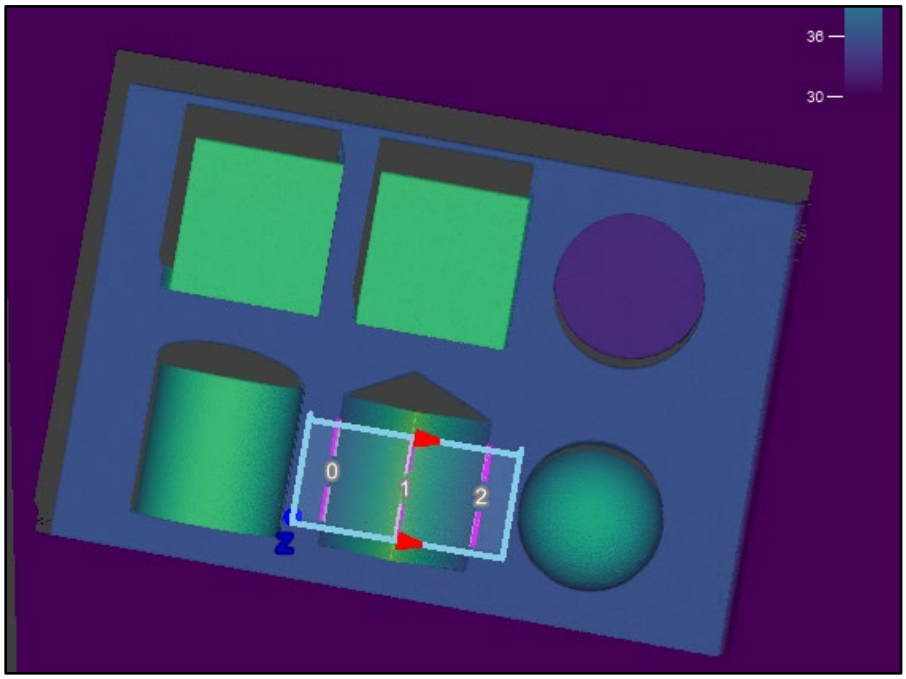
13. Save the job.

ExtractEdge3D

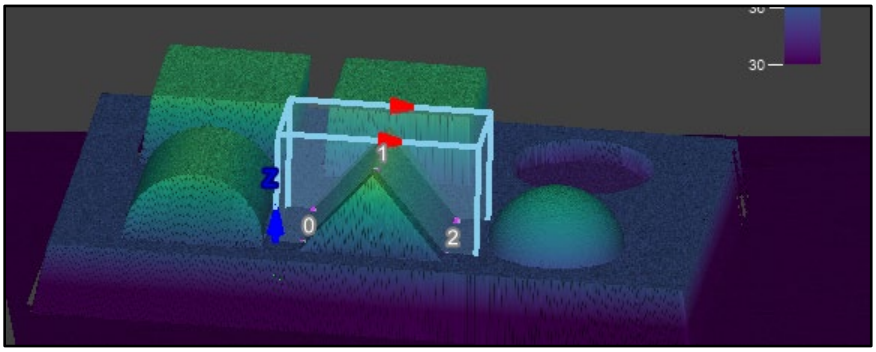
1. Enter the comment **Find Edges** in cell **A28**.
2. Insert an **ExtractEdge3D** tool in cell **B30**.
   NOTE: *The ExtractEdge3D tool is found in the Toolbox → 3D Vision Tools → 3D Extract → ExtractEdge3D.*
   The ExtractEdge3D Property Sheet displays.
3. Set the property sheet parameters as follows:
   - *External Fixture* = Fixture3D Structure of the FindPatMax3D tool (F7)
   - *Number to Extract* = 3
   - *Feature Size* = Medium
   - *Allow all other defaults to remain*
4. Double-click the **Region3D** parameter.
   The region displays on the 3D image window.
5. Click the **Show 3D Image from Top** button.

6. Click the **Quick Drop Box** button.

7. Draw a region over the pyramid and press the **<Enter>** key.
8. Click the **OK** button to close the ExtractEdge3D Property Sheet.



9. Rotate the part and review the results.



Find Edges

		Num Found	Index	Transition	Score	Coverage	Sharpness	Vertical Ang	Horizontal A	Line	Midpoint	X0	Y0	Z0	X1
	Edges3D	3.000	0.000	Concave	95.098	100.000	45.237	0.044	1.255	Line3D	Point3D	-15.473	-54.394	36.998	-
			1.000	Convex	93.217	100.000	91.142	0.033	1.958	Line3D	Point3D	-5.375	-54.394	48.644	
			2.000	Concave	95.323	100.000	45.669	0.051	0.955	Line3D	Point3D	4.509	-54.394	37.025	

10. Save the job.

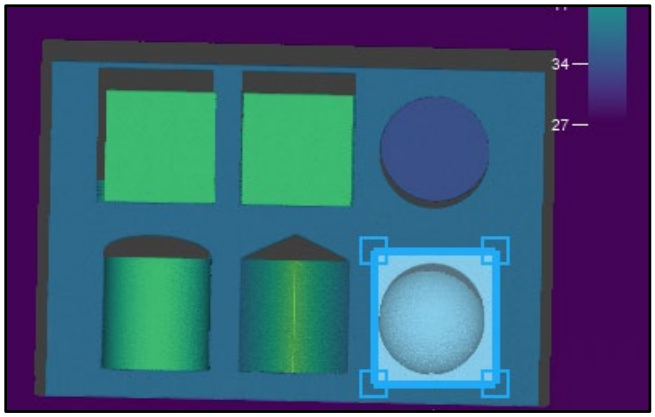
ExtractSphere3D

1. Enter the comment **Find Sphere** in cell **A33**.
2. Insert an **ExtractSphere3D** tool in cell **B35**.

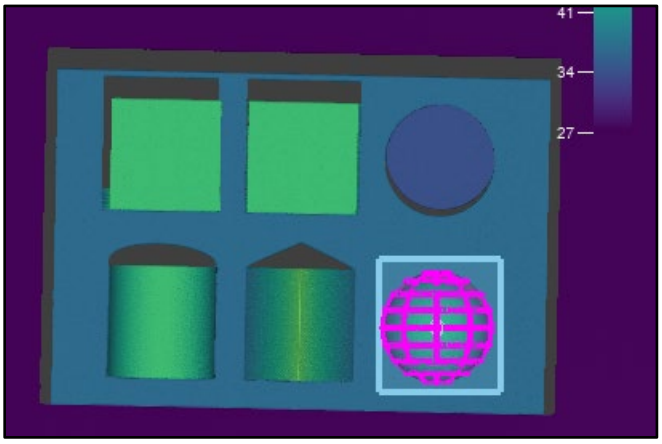
   NOTE: *The ExtractSphere3D tool is found in the Toolbox → 3D Vision Tools → 3D Extract → ExtractSphere3D.*

   The ExtractSphere3D Property Sheet displays.
3. Set the property sheet parameters as follows:
   - *External Fixture* = Fixture3D Structure of the FindPatMax3D tool (F7)
   - *Mode* = Robust
   - *Feature Size* = Medium
4. Double-click the **Region3D** parameter.

   The region displays on the 3D image window.
5. Click the **Show 3D Image from Top** button.
6. Click the **Quick Drop Box** button.
7. Draw a region over the sphere and press the **<Enter>** key.



8. Click the **OK** button to close the ExtractSphere3D Property Sheet.

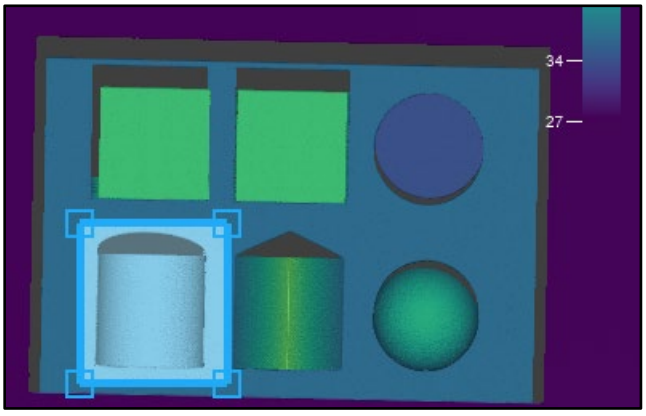


Find Sphere										
		Num Found	Index	Score	Sphere	Center	Radius	X	Y	Z
	Spheres3D	1.000	0.000	90.028	Sphere3D	Point3D	10.253	19.335	-63.932	34.629

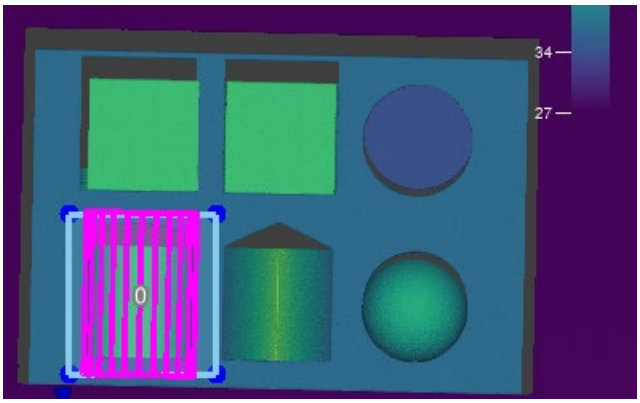
9. Save the job.

ExtractCylinder3D

1. Enter the comment **Find Cylinder** in cell **A36**.
2. Insert an **ExtractCylinder3D** tool in cell **B38**.
   NOTE: *The ExtractCylinder3D tool is found in the Toolbox → 3D Vision Tools → 3D Extract → ExtractCylinder3D.*
   The ExtractCylinder3D Property Sheet displays.
3. Set the property sheet parameters as follows:
   - *External Fixture* = Fixture3D Structure of the FindPatMax3D tool (F7)
4. Double-click the **Region3D** parameter.
   The region displays on the 3D image window.
5. Click the **Show 3D Image from Top** button.
6. Click the **Quick Drop Box** button.
7. Draw a region over the cylinder and press the **<Enter>** key.



8. Click the **OK** button to close the ExtractCylinder3D Property Sheet.



Find Cylinder														
		Num Found	Index	Score	Cylinder	Axis	Center	Radius	Length	X	Y	Z	Tilt	Tilt Direction
	Cylinders3D	1.000	0.000	93.017	Cylinder3I	Line3D	Point3D	10.017	29.498	-30.541	-61.508	36.851	89.882	268.822

9. Save the job.

Spreadsheet:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
0	PointCloud															
1	Image															
2																
3	**Pattern Location**															
4			Trained	Origin	X	Y	Z									
5		Model3D	1.000	Point3D	8.598	-22.819	36.952									
6			Num Found	Index	Score	Fixture	X	Y	Z	Rotation	Tilt	Tilt Direction				
7		Patterns3D	1.000	0.000	81.328	Fixture3D	-36.007	-28.231	36.953	87.510	0.125	245.872				
8	**Find Corners**															
9		Region3D														
10	**Base Plane**															
11			Num Found	Index	Score	Relative Tilt	Rectangle	Center	X	Y	Z	Tilt	Tilt Direction			
12		Planes3D	1.000	0.000	89.835	0.042	Rectangle3D	Point3D	-5.665	-47.750	36.954	0.042	112.138			
13	**Block Plane**															
14		**Middle Cube**														
15			Num Found	Index	Score	Relative Tilt	Rectangle	Center	X	Y	Z	Tilt	Tilt Direction			
16		Planes3D	1.000	0.000	80.580	1.737	Rectangle3D	Point3D	-4.680	-32.493	46.813	0.064	101.250			
17		**Corner Cube**														
18			Num Found	Index	Score	Relative Tilt	Rectangle	Center	X	Y	Z	Tilt	Tilt Direction			
19		Planes3D	1.000	0.000	80.761	0.248	Rectangle3D	Point3D	-29.540	-31.283	46.818	0.083	47.846			
20	**Blob Count**															
21			Num Found	Index	Volume	Height	Type	Bounding Box								
22		Blobs3D	6.000	0.000	4013.956	10.102	Positive	Box3D								
23				1.000	3997.406	10.068	Positive	Box3D								
24				2.000	3154.911	10.120	Positive	Box3D								
25				3.000	2421.354	11.902	Positive	Box3D								
26				4.000	1459.861	7.990	Positive	Box3D								
27				5.000	903.482	3.480	Negative	Box3D								
28	**Find Edges**															
29			Num Found	Index	Transition	Score	Coverage	Sharpness	Vertical Ang	Horizontal Angle	Line	Midpoint	X0	Y0	Z0	X1
30		Edges3D	3.000	0.000	Concave	95.098	100.000	45.237	0.044	1.255	Line3D	Point3D	-15.473	-54.394	36.998	
31				1.000	Convex	93.217	100.000	91.142	0.033	1.958	Line3D	Point3D	-5.375	-54.394	48.644	
32				2.000	Concave	95.323	100.000	45.669	0.051	0.955	Line3D	Point3D	4.509	-54.394	37.025	
33	**Find Sphere**															
34			Num Found	Index	Score	Sphere	Center	Radius	X	Y	Z					
35		Spheres3D	1.000	0.000	90.028	Sphere3D	Point3D	10.253	19.335	-63.932	34.629					
36	**Find Cylinder**															
37			Num Found	Index	Score	Cylinder	Axis	Center	Radius	Length	X	Y	Z	Tilt	Tilt Direction	
38		Cylinders3D	1.000	0.000	93.017	Cylinder3D	Line3D	Point3D	10.017	29.498	-30.541	-61.508	36.851	89.882	268.822	

Lab Exercise 5.1 – 3D Measure Tools

At the end of this lab exercise, Participants will be able to:

- Find the height of the cuboid and angle of the pyramid on the demo part

The Participant will utilize the following In-Sight Functions to successfully complete this exercise:

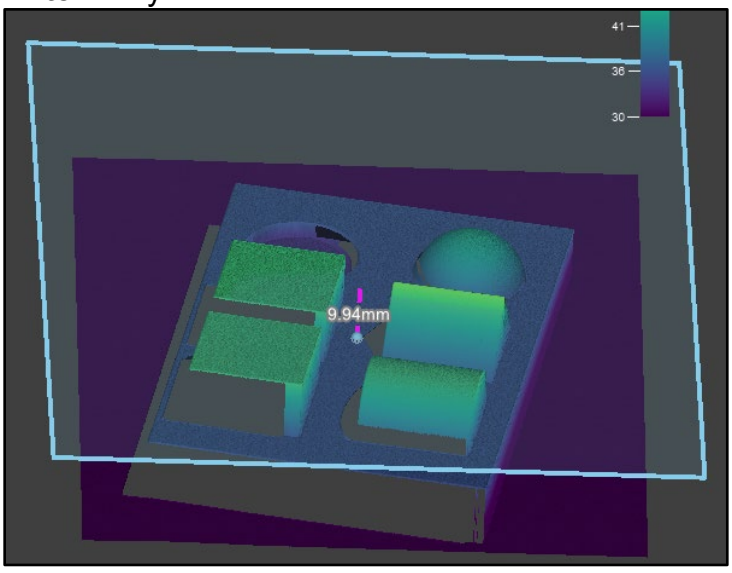
- PointToPlane3D
- PlaneToPlaneAngle3D

Follow the steps below to complete the lab exercise:

1. Continue with the **MyExtractTools3D** job from the last lab exercise.
2. Save the job as **MyMeasureTools3D** in the folder created in lab #1.
3. Enter the comment **Height Measure** in cell **A39**.
4. Enter the comment **Middle Cube** in cell **B40**.
5. Insert a **PointToPlane3D** tool in cell **B42**.
   NOTE: *The PointToPlane3D tool is found in the Toolbox → 3D Measure → PointToPlane3D.*
6. Set the property sheet parameters as follows:
   - *External Point* = Point3D Structure of the Base Plane (H12)
   - *External Plane* = Rectangle3D Structure of the Block Plane (G16)

   Press the **<Enter>** key.
7. Enter the comment **Corner Cube** in cell **B43**.
8. Insert a **PointToPlane3D** tool in cell **B45**.
9. Set the property sheet parameters as follows:
   - *External Point* = Point3D Structure of the Base Plane (H12)
   - *External Plane* = Rectangle3D Structure of the Block Plane (G19)

   Press the **<Enter>** key.

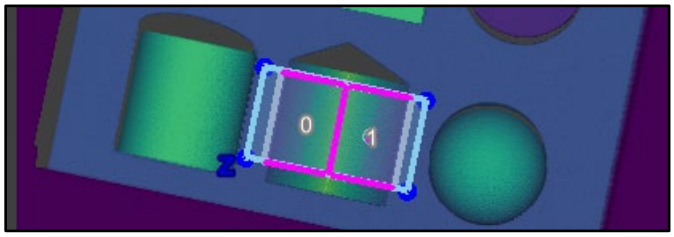


10. Rotate the part and review the results.
11. Enter the comment **Pyramid** in cell **B46**.
12. Insert an **ExtractPlane3D** tool in cell **B48**.
13. Set the property sheet parameters as follows:
    - *External Fixture* = Fixture3D Structure of the FindPatMax3D tool (F7)
    - *Mode* = Robust
    - *Number to Extract* = 2
14. Double-click the **Region3D** parameter.

    The region displays on the 3D image window.
15. Click the **Show 3D Image from Top** button.

16. Click the **Quick Drop Box** button.

17. Draw a region over the pyramid and press the **<Enter>** key.
18. Click the **OK** button to close the ExtractPlane3D Property Sheet.



39	Height Measure												
40		Middle Cube											
41			X0	Y0	Z0	X1	Y1	Z1	Tilt	Tilt Direction	Distance		
42		Dist3D	-5.665	-47.750	36.954	-5.667	-47.739	46.829	0.064	101.250	9.876		
43		Corner Cube											
44			X0	Y0	Z0	X1	Y1	Z1	Tilt	Tilt Direction	Distance		
45		Dist3D	-5.665	-47.750	36.954	-5.655	-47.739	46.812	0.083	47.846	9.859		
46		Pyramid											
47			Num Found	Index	Score	Relative Tilt	Rectangle	Center	X	Y	Z	Tilt	Tilt Direction
48		Planes3D	2.000	0.000	78.890	48.744	Rectangle3D	Point3D	-0.308	-62.779	42.537	48.744	358.856
49				1.000	71.926	48.250	Rectangle3D	Point3D	-11.071	-63.139	42.410	48.251	178.836

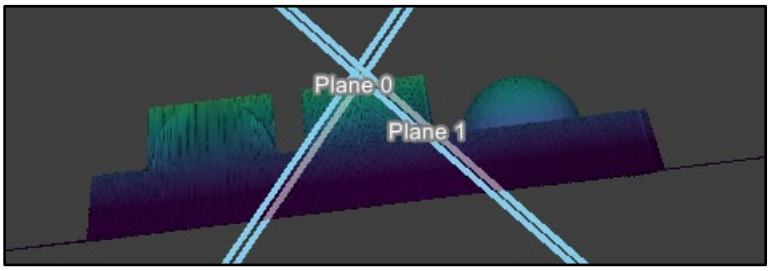
19. Enter the comment **Angle Measure** in cell **A50**.
20. Insert a **PlaneToPlaneAngle3D** tool in cell **B51**.

    NOTE: *The PlaneToPlaneAngle3D tool is found in the Toolbox → 3D Measure → PlaneToPlane3D.*

21. Set the property sheet parameters as follows:
    - *External Plane 0* = Rectangle3D Structure of Height Measure Plane 0 (G48)

    Press the **<Enter>** key.
    - *External Plane 1* = Rectangle3D Structure of Height Measure Plane 1 (G49)

    Press the **<Enter>** key.
22. Click the **OK** button to close the PlaneToPlaneAngle3D Property Sheet.



50	Angle Measure	
51		83.005

23. Review the results.
24. Save the job.

Spreadsheet:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
0	PointCloud															
1	Image															
2																
3	Pattern Location															
4			Trained	Origin	X	Y	Z									
5		Model3D	1.000	Point3D	8.598	-22.819	36.952									
6			Num Found	Index	Score	Fixture	X	Y	Z	Rotation	Tilt	Tilt Direction				
7		Patterns3D	1.000	0.000	81.328	Fixture3D	-36.007	-28.231	36.953	87.510	0.125	245.872				
8	Find Corners															
9		Region3D														
10	Base Plane															
11			Num Found	Index	Score	Relative Tilt	Rectangle	Center	X	Y	Z	Tilt	Tilt Direction			
12		Planes3D	1.000	0.000	89.835	0.042	Rectangle3D	Point3D	-5.665	-47.750	36.954	0.042	112.138			
13	Block Plane															
14		Middle Cube														
15			Num Found	Index	Score	Relative Tilt	Rectangle	Center	X	Y	Z	Tilt	Tilt Direction			
16		Planes3D	1.000	0.000	80.580	1.737	Rectangle3D	Point3D	-4.680	-32.493	46.813	0.064	101.250			
17		Corner Cube														
18			Num Found	Index	Score	Relative Tilt	Rectangle	Center	X	Y	Z	Tilt	Tilt Direction			
19		Planes3D	1.000	0.000	80.761	0.248	Rectangle3D	Point3D	-29.540	-31.283	46.818	0.083	47.846			
20	Blob Count															
21			Num Found	Index	Volume	Height	Type	Bounding Box								
22		Blobs3D	6.000	0.000	4013.956	10.102	Positive	Box3D								
23				1.000	3997.406	10.068	Positive	Box3D								
24				2.000	3154.911	10.120	Positive	Box3D								
25				3.000	2421.354	11.902	Positive	Box3D								
26				4.000	1459.861	7.990	Positive	Box3D								
27				5.000	903.482	3.480	Negative	Box3D								
28	Find Edges															
29			Num Found	Index	Transition	Score	Coverage	Sharpness	Vertical Ang	Horizontal Angle	Line	Midpoint	X0	Y0	Z0	X1
30		Edges3D	3.000	0.000	Concave	95.098	100.000	45.237	0.044	1.255	Line3D	Point3D	-15.473	-54.394	36.998	
31				1.000	Convex	93.217	100.000	91.142	0.033	1.958	Line3D	Point3D	-5.375	-54.394	48.644	
32				2.000	Concave	95.323	100.000	45.669	0.051	0.955	Line3D	Point3D	4.509	-54.394	37.025	
33	Find Sphere															
34			Num Found	Index	Score	Sphere	Center	Radius	X	Y	Z					
35		Spheres3D	1.000	0.000	90.028	Sphere3D	Point3D	10.253	19.335	-63.932	34.629					
36	Find Cylinder															
37			Num Found	Index	Score	Cylinder	Axis	Center	Radius	Length	X	Y	Z	Tilt	Tilt Direction	
38		Cylinders3D	1.000	0.000	93.017	Cylinder3D	Line3D	Point3D	10.017	29.498	-30.541	-61.508	36.851	89.882	268.822	
39	Height Measure															
40		Middle Cube														
41			X0	Y0	Z0	X1	Y1	Z1	Tilt	Tilt Direction	Distance					
42		Dist3D	-5.665	-47.750	36.954	-5.667	-47.739	46.829	0.064	101.250	9.876					
43		Corner Cube														
44			X0	Y0	Z0	X1	Y1	Z1	Tilt	Tilt Direction	Distance					
45		Dist3D	-5.665	-47.750	36.954	-5.655	-47.739	46.812	0.083	47.846	9.859					
46		Pyramid														
47			Num Found	Index	Score	Relative Tilt	Rectangle	Center	X	Y	Z	Tilt	Tilt Direction			
48		Planes3D	2.000	0.000	78.890	48.744	Rectangle3D	Point3D	-0.308	-62.779	42.537	48.744	358.856			
49				1.000	71.926	48.250	Rectangle3D	Point3D	-11.071	-63.139	42.410	48.251	178.836			
50	Angle Measure															
51		83.005														

Lab Exercise 6.1 – Inputs/Outputs & Network Functions

At the end of this lab exercise, Participants will be able to:

- Use the TCPClient to define a spreadsheet cell as a TCP/IP client, initiating the communication with another TCP/IP device for sharing data over the network

The Participant will utilize the following In-Sight Vision Suite tools to successfully complete this exercise:

- TCPClient
- Format String
- Hercules

Follow the steps below to complete the lab exercise:

1. Continue with the **MyMeasureTools3D** job from the last lab exercise.
2. Save the job as **MyCommunication3D** in the folder created in lab #1.
3. Enter the comment **TCP/IP Inspection Output** in cell **A53**.
4. Enter the following comments in the spreadsheet to create the columns of your table:
   - **Label** in cell **A54**
   - **Value** in cell **B54**
   - **Delimiter** in cell **C54**

   NOTE: *Label describes the quantity we are going to output (strings must be entered after the comment character ‘ (apostrophe))*
   Value contains a string or a floating-point number representing the quantity to be sent as the output
   Delimiter column has the string for the string for the Value field (strings must be entered after the comment character ‘ (apostrophe))’,
5. Enter the following comments in the spreadsheet to create the rows of your table:
   - **Inspection:** in cell **A55**
   - **# of 3D Blobs:** in cell **A56**
   - **Middle Cube:** in cell **A57**
   - **Corner Cube:** in cell **A58**

53	TCP/IP Inspection Output		
54	Label	Value	Delimiter
55	Inspection:		
56	# of 3D Blobs:		
57	Middle Cube:		
58	Corner Cube:		

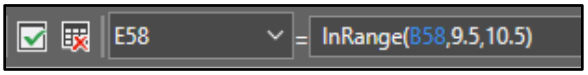
6. Insert the following comments in the spreadsheet for your logic columns:
   - **Height Check (Pass/Fail)** in cell **E54**
   - **Global Pass/Fail** in cell **G54**
7. Insert the following comments in the spreadsheet in the *Delimiter* column:
   - , (comma) in cell **C55**
   - , (comma) in cell **C56**
   - *mm,* in cell **C57**
   - *mm* in cell **C58,**
8. Enter a **GetNFound** function in cell **B56**, the formula will reference the Blobs3D structure in cell **B22**.

9. Cell **B57** will reference the *Middle Cube* Distance result in cell **K42**.

10. Cell **B58** will reference the *Corner Cube* Distance result in cell **K45**.

11. Enter the logic statement in cell **E57** to confirm the height of the *Middle Cube*:
    - InRange(B57,9.5,10.5)

12. Enter the logic statement in cell **E58** to confirm the height of the *Corner Cube*:
    - InRange(B58,9.5,10.5)

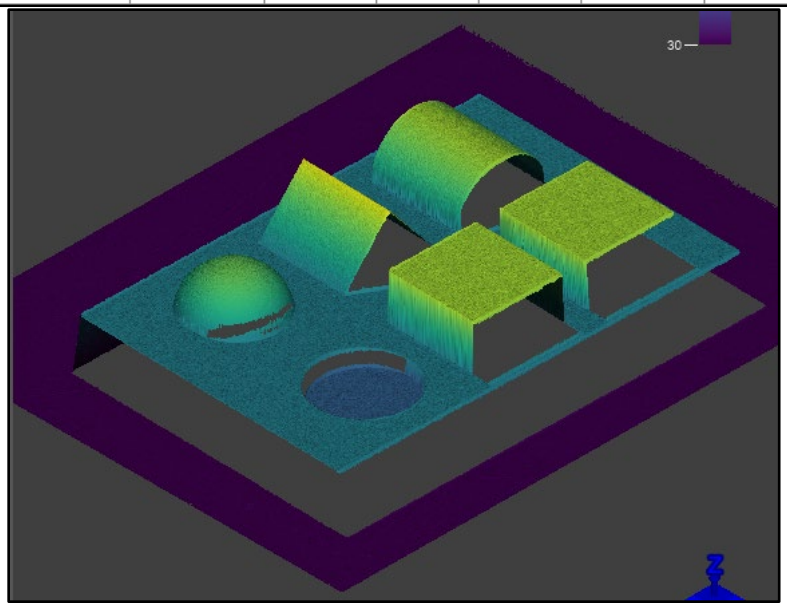


13. Next, enter the logic statement in cell **G57** for the *Global Pass/Fail* of the demo part:
    - And(E57:E58)

14. Enter the logic statement in cell **B55** for the *Inspection:* of the demo part:
    - If(G57=1,”Pass”,”Fail”)

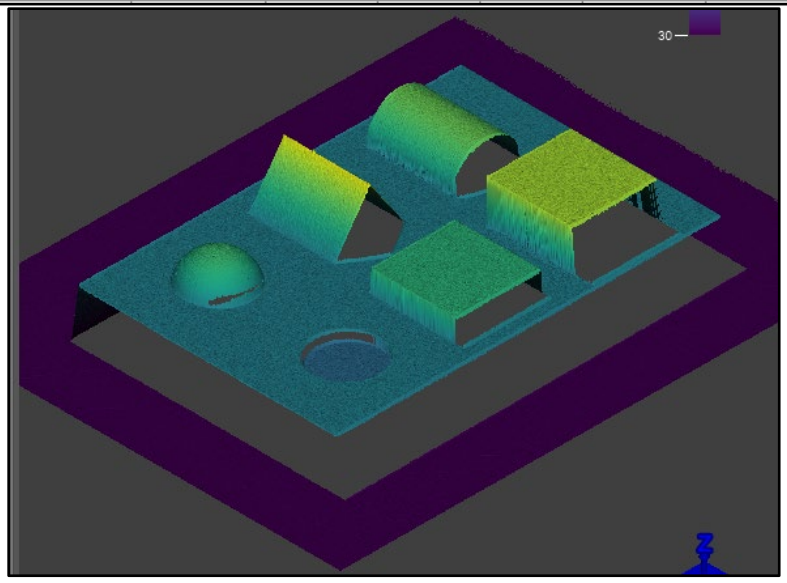
Good Part:

53	TCP/IP Inspection Output						
54	Label	Value	Delimiter		Height Check (Pass/Fail)		Global Pass/Fail
55	Inspection:	Pass	,				
56	# of 3D Blobs:	6.000	,				
57	Middle Cube:	9.876	mm,		1.000		1.000
58	Corner Cube:	9.859	mm		1.000		

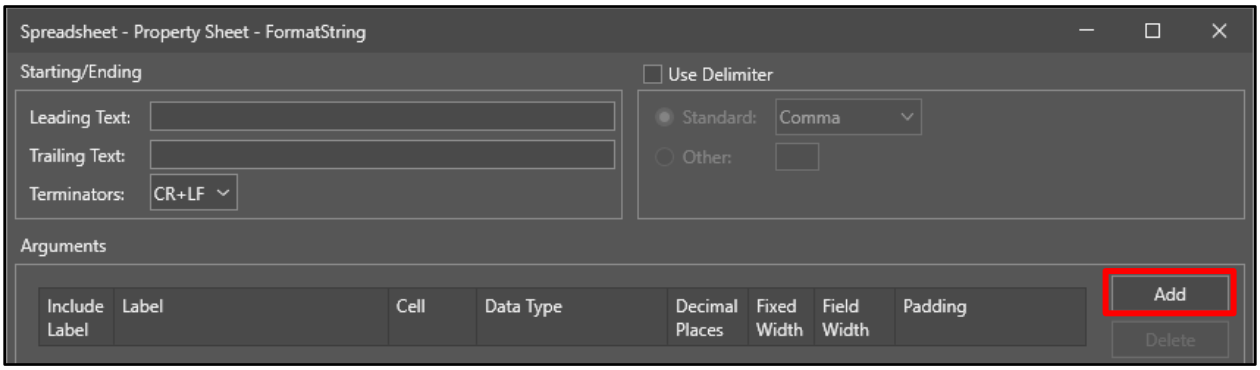


Bad Part:

53	TCP/IP Inspection Output						
54	Label	Value	Delimiter		Height Check (Pass/Fail)		Global Pass/Fail
55	Inspection:	Fail	,				
56	# of 3D Blobs:	6.000	,				
57	Middle Cube:	4.946	mm,		0.000		0.000
58	Corner Cube:	9.892	mm		1.000		



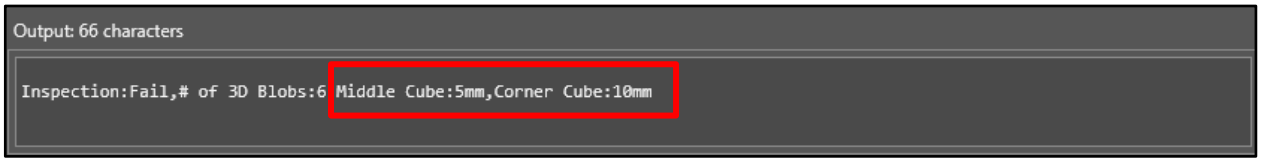
15. Insert the comment *Format String* in cell **A60**.
16. Enter a **FormatString** function into cell **A61**.
    NOTE: *The FormatString function is found in the Toolbox → Text → String → FormatString.*
    The **FormatString Property Sheet** displays.



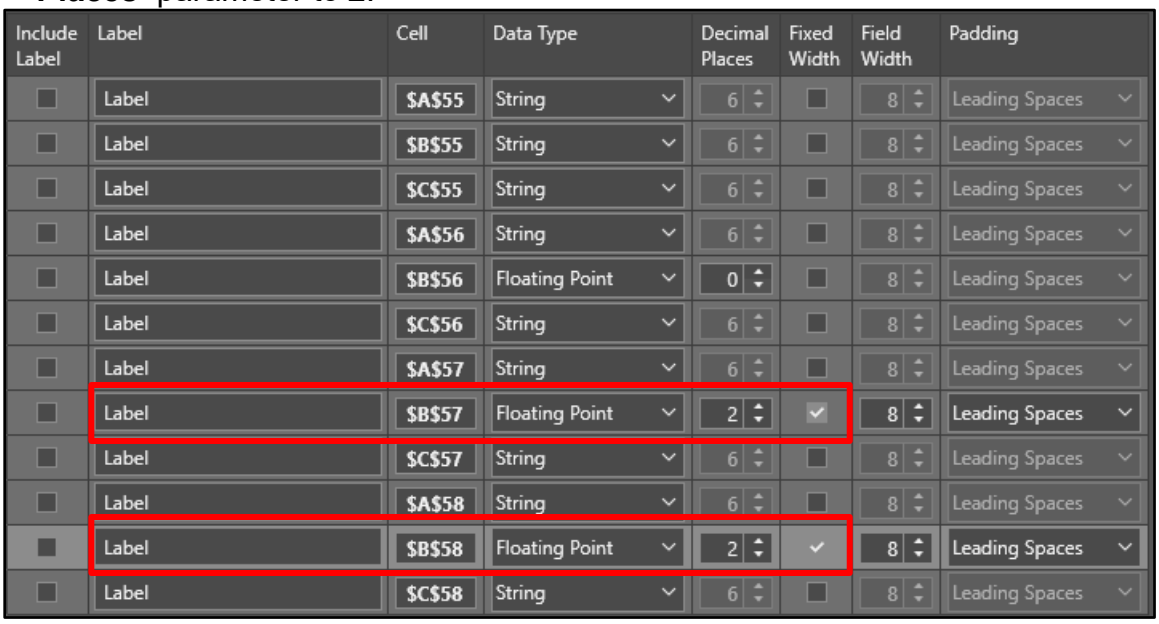
17. Select *CR+LF* from the **Terminators** drop-down list.
    NOTE: *CR+LF = Carriage Return + Line Feed.*
18. Click the **Add** button.
    NOTE: *You will add in all the cells in the table – they are entered one at a time. Do this in a logical way to ensure that no cells are missed. There should be 12-line items added.*

Include Label	Label	Cell	Data Type	Decimal Places	Fixed Width	Field Width	Padding
☐	Label	A55	String	0	☐	8	Leading Spaces
☐	Label	B55	String	0	☐	8	Leading Spaces
☐	Label	C55	String	0	☐	8	Leading Spaces
☐	Label	A56	String	0	☐	8	Leading Spaces
☐	Label	B56	Floating Point	0	☐	8	Leading Spaces
☐	Label	C56	String	0	☐	8	Leading Spaces
☐	Label	A57	String	0	☐	8	Leading Spaces
☐	Label	B57	Floating Point	0	☐	8	Leading Spaces
☐	Label	C57	String	0	☐	8	Leading Spaces
☐	Label	A58	String	0	☐	8	Leading Spaces
☐	Label	B58	Floating Point	0	☐	8	Leading Spaces
☐	Label	C58	String	0	☐	8	Leading Spaces

19. Review the string output at the bottom of the property sheet.

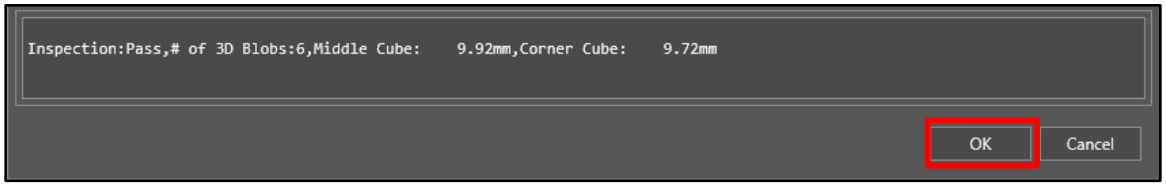


20. The cube heights are showing as a whole number – check the **Fixed Width** checkbox for the Floating Points in cells **B57** and **B58** and change the **Decimal Places** parameter to **2**.

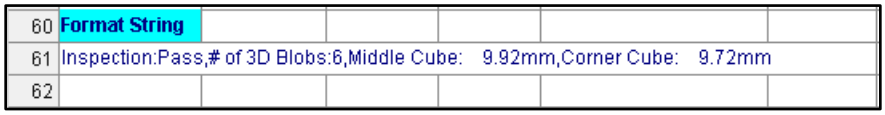


21. Review the string output at the bottom of the property sheet and click the **OK** button.

NOTE: *If label appears in the string delete the word from the Label column.*



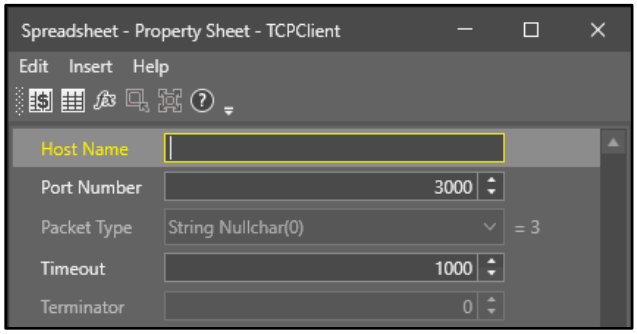
The string displays in cell A61.



22. Insert the comment *TCP Client* in cell **A62**.
23. Enter a **TCPClient** function in to cell **A63**.

NOTE: *The TCPClient function is found in the Toolbox → Input/Output → Network → TCPClient.*

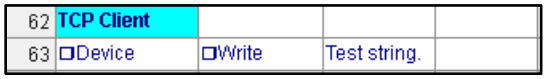
The **TCPClient Property Sheet** displays.



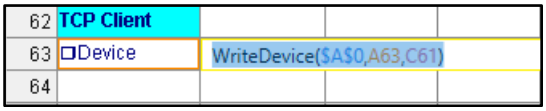
24. Set the property sheet parameters as follows:
    - Host Name = IP address of the computer (ex. 192.168.0.1)
    - Port Number = 3000

    Click the **OK** button.

    TCPClient and **WriteDevice** are inserted into the spreadsheet.



25. Double-click the WriteDevice function in cell **B63** to open. Change the 3rd reference (cell C63) to the FormatString function (cell A61).



26. Delete the Test string function in cell C63 as it is not needed any longer.

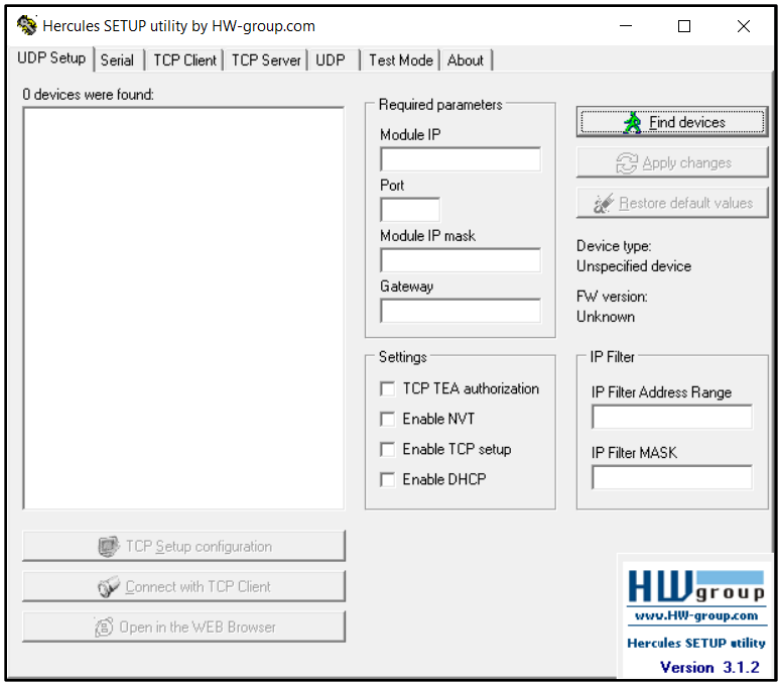
27. Save the job.

Setting up Hercules

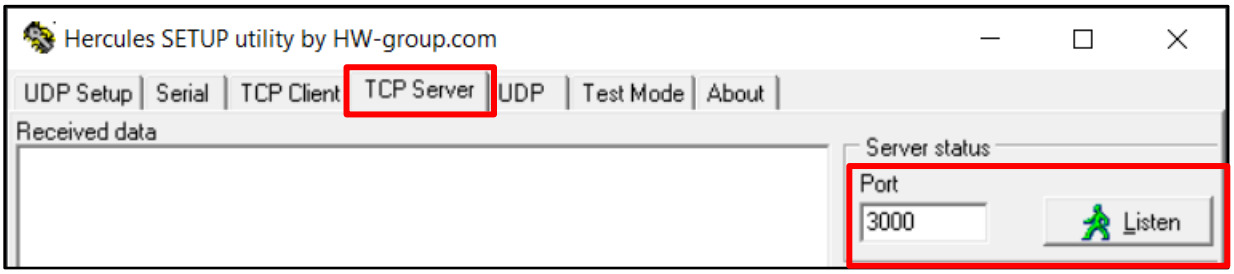
Note: *Going forward if working with the software trigger the system can stay offline. If working with the hardware trigger the system must be put online by clicking the Online button.*
When working with the hardware trigger, the trigger pulse is provided to the L4000 by clicking on the silver button located on the slider.

1. Start **Hercules**. There should be a shortcut on the computer's desktop.

The **Hercules SETUP utility** displays.

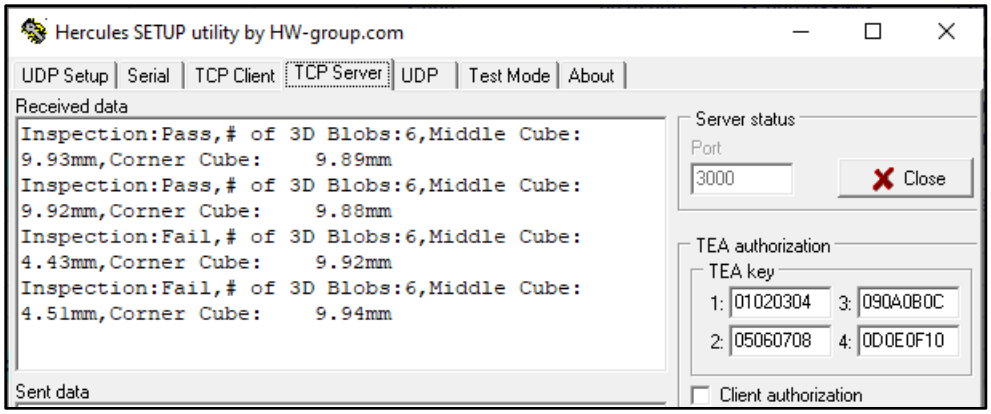


2. Select the **TCP Server** tab.



3. Enter *3000* in the **Port** field and click the **Listen** button.
4. Trigger your camera.

5. Repeat using both the good and the bad part.
   Review the results.



6. Click the **Close** button to end the connection.
7. Save the job.

Lab Exercise 7.1 – Operator Interface (HMI)

At the end of this lab exercise, Participants will be able to:

- Create a custom interface accessible from other devices, including status indicators, inspection results and interactive controls to view and affect the vision application

The Participant will utilize the following In-Sight Vision Suite tools to successfully complete this exercise:

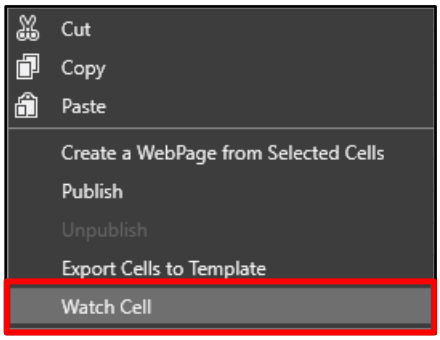
- Tags
- WebPages
- User Inputs

Follow the steps below to complete the lab exercise:

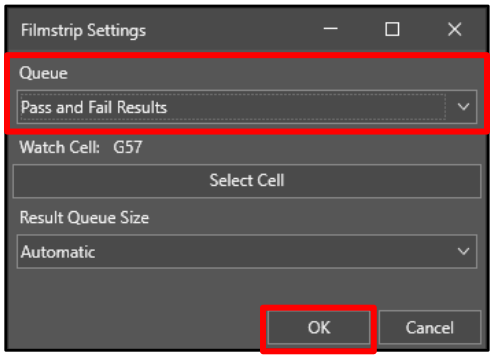
1. Continue with the **MyCommunication3D** job from the last lab exercise.
2. Save the job as **MyHMI3D** in the folder created in lab #1.

Add a Pass/Fail display on the WebHMI:

3. Right-click on the **Global Pass/Fail** logic cell (G57) and select **Watch Cell** from the fly-out list.

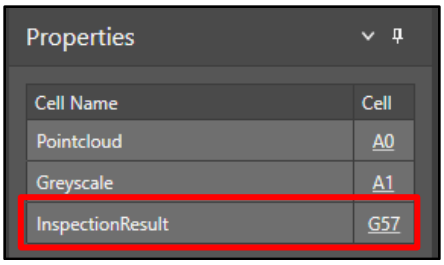


The **Filmstrip Settings** dialog displays.

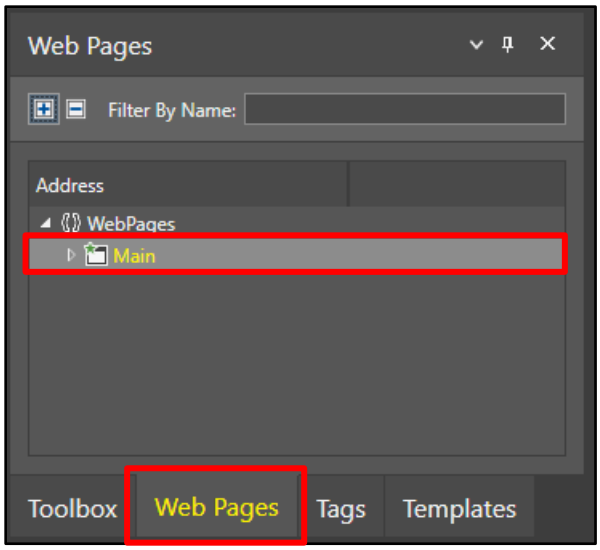


4. Select *Pass and Fail Results* for the **Queue** parameter and click the **OK** button.

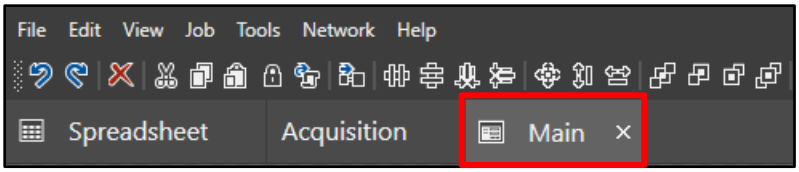
A new tag named **InspectionResult** displays in the Properties window.



5. Click the **Web Pages** tab and double-click on **Main** to open the Web Page.

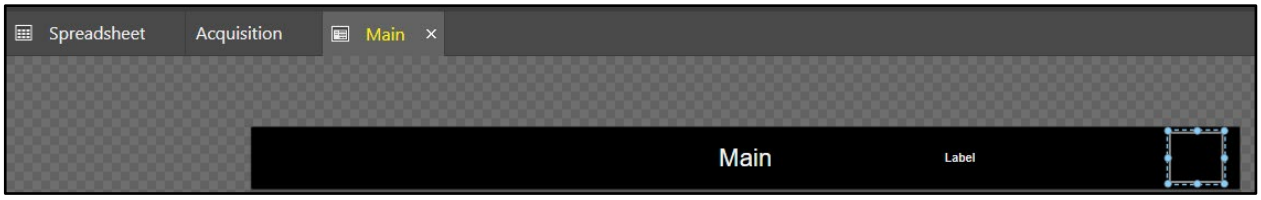


The **Main** Web Page opens in a new tab.

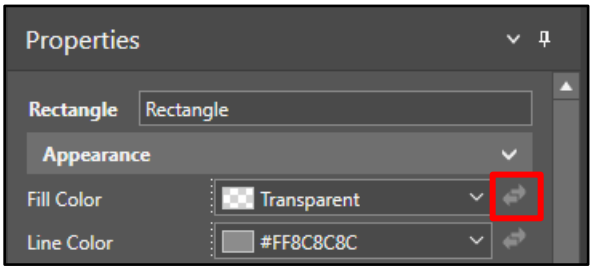


6. Add a **Rectangle** to the top right corner of the Main page.

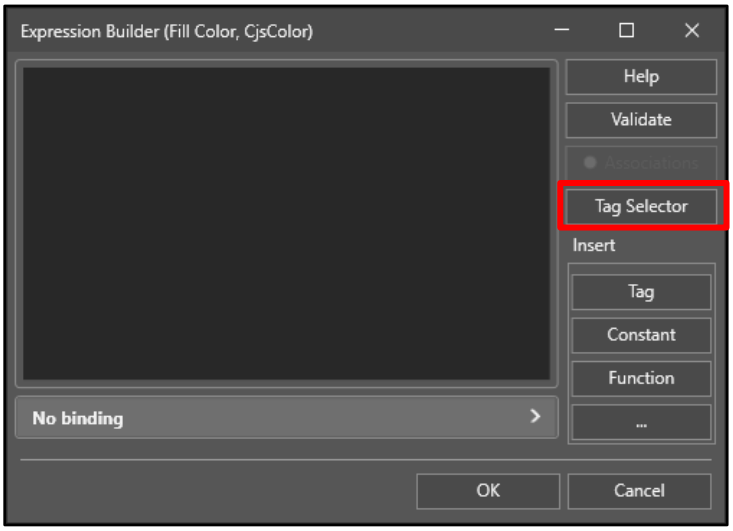
NOTE: *The Rectangle is found in the Web Pages Toolbox → Graphics → Rectangle.*



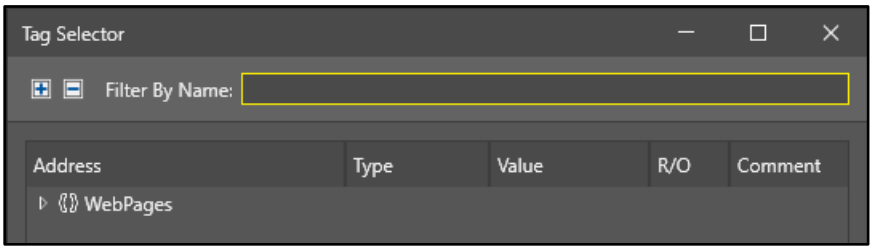
7. Click the **Source** arrows on the **Fill Color** property.



The **Expression Builder** displays.

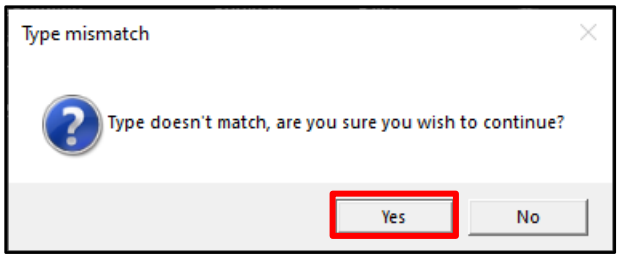


8. Click the **Tag Selector** button.
   The **Tag Selector** dialog displays. Only *WebPages* displays.

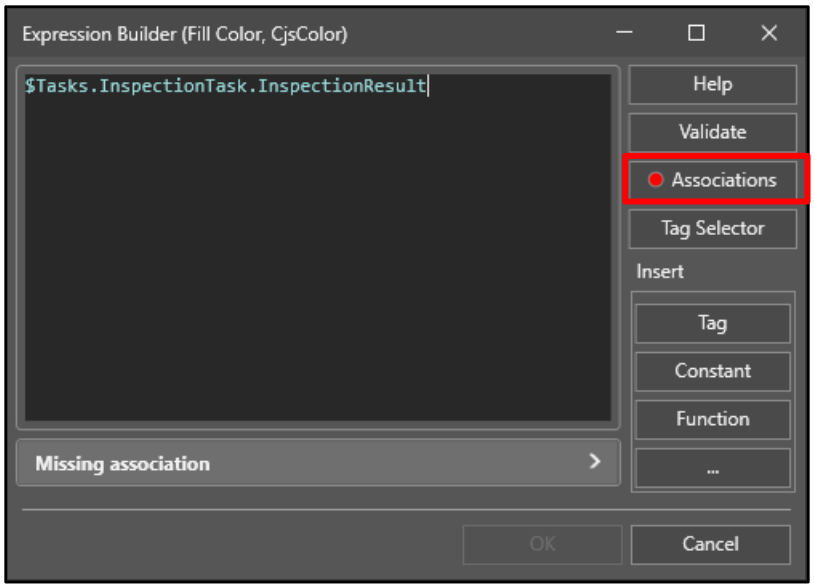


9. Check the **Show All Types** checkbox at the bottom of the dialog.

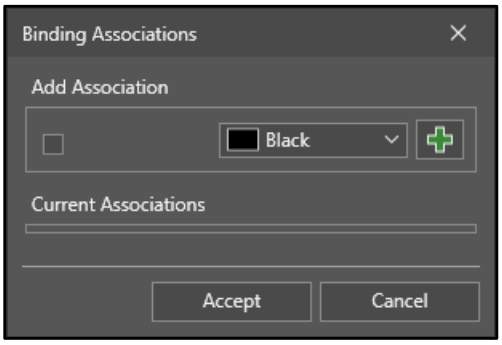
10. Navigate to **Tasks → InspectionTask → InspectionResult** and click the **Accept** button.
    Note: *You can also type $Tasks.InspectionTask.InspectionResult directly in the Expression Builder to build the expression.*
11. The **Type mismatch** dialog displays. Click the **Yes** button to continue.



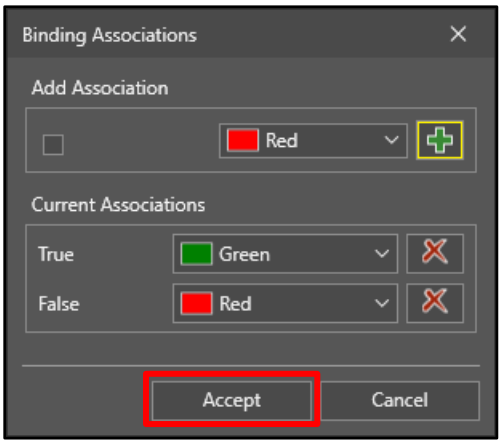
The **Expression** is built.



12. Click the **Associations** button.
    The **Binding Associations** dialog displays.

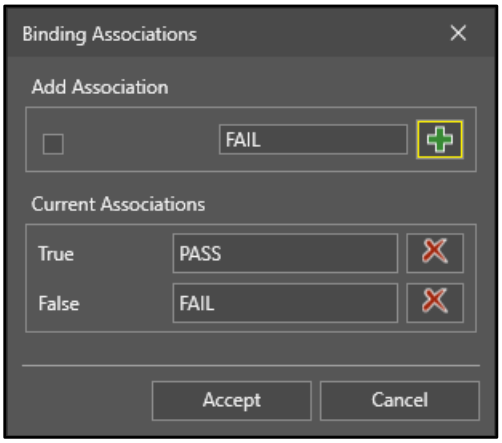


13. Build your Association and click the **Accept** button.

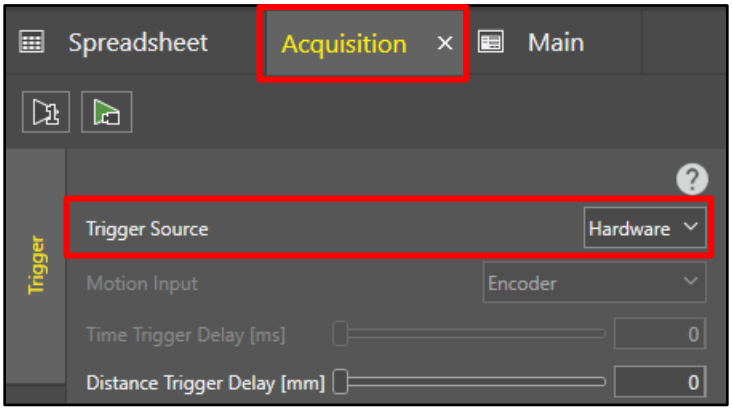


14. The Association is built, click the **OK** button to close the Expression Builder.

15. Add a **Label** next to the Rectangle in the top right corner of the Main page.
    NOTE: *The Label is found in the Web Pages Toolbox → Data Display → Label*
16. Repeat steps 7 – 14 to add **PASS** or **FAIL** for the **Text** field association.

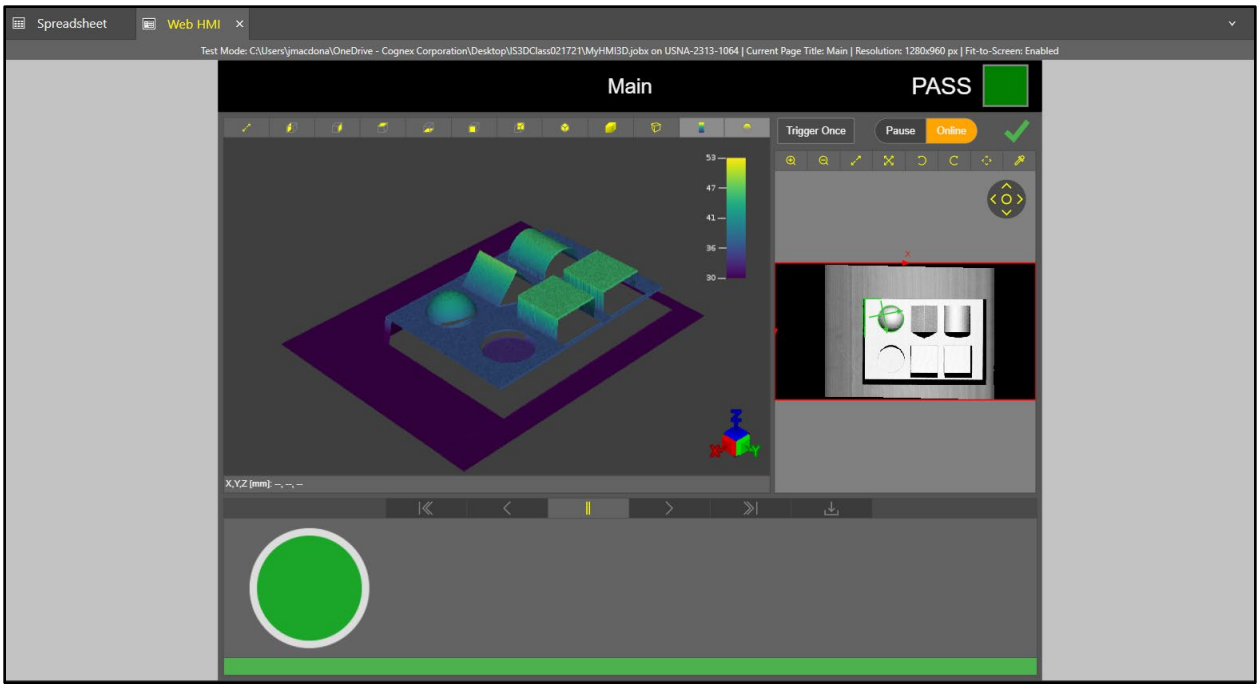


17. Move to the **Acquisition** tab and change the **Trigger Source** to *Hardware*.

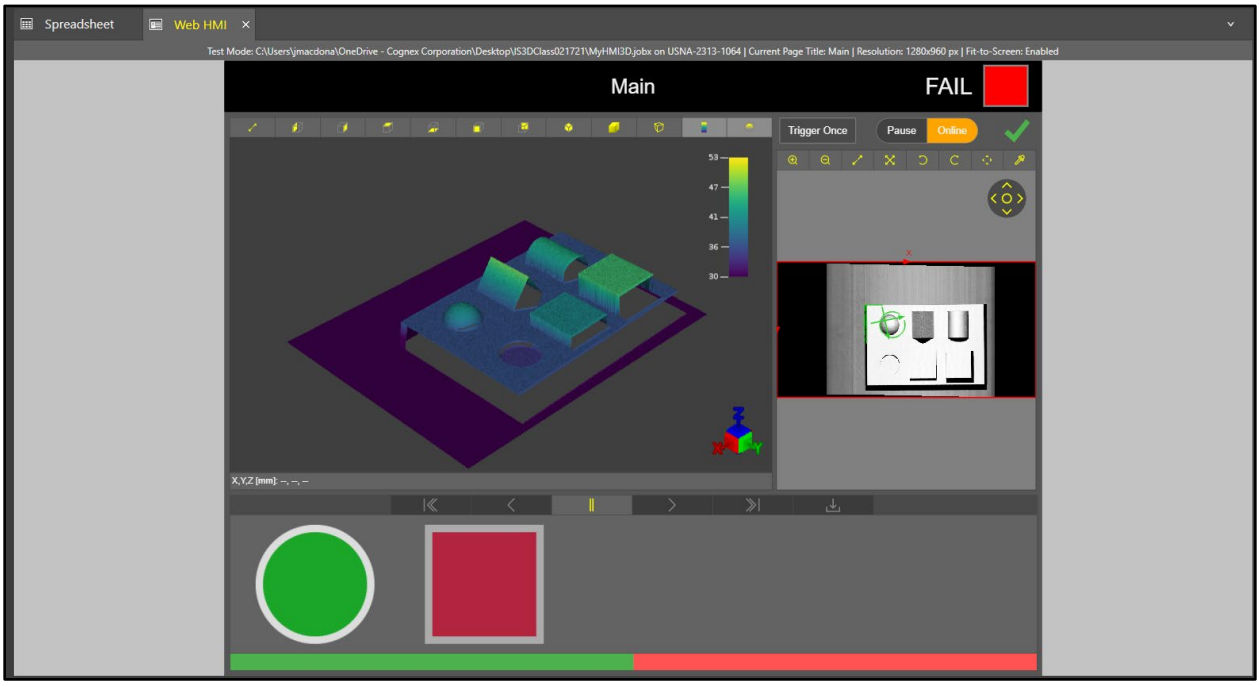


18. Return to the **Main** tab and click the **Online** button to go Online.
19. Click the silver **Trigger** button on the backside of the demo station to acquire an image.
    NOTE: *Make sure to scan the part slowly – it the part is scanned too quickly it will return an error message.*

Good Part:



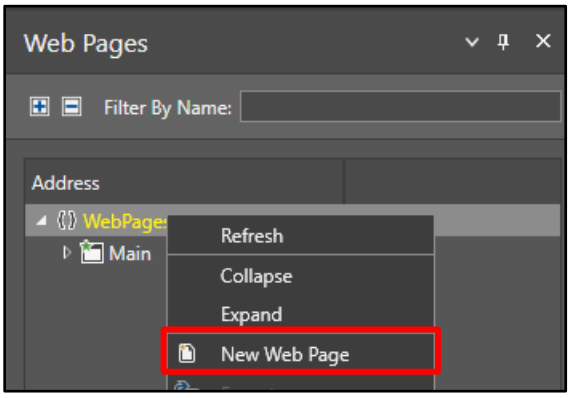
Bad Part:



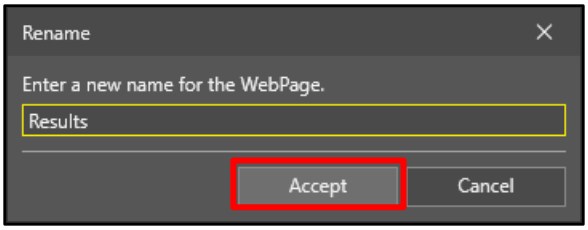
20. Click the **Offline** button to go Offline.
21. Save your job.

Add a New Web Page to Display Data from the Spreadsheet

1. Continue with the current project.
2. Right click on **WebPages** in the Project Explorer and select **New Web Page**.

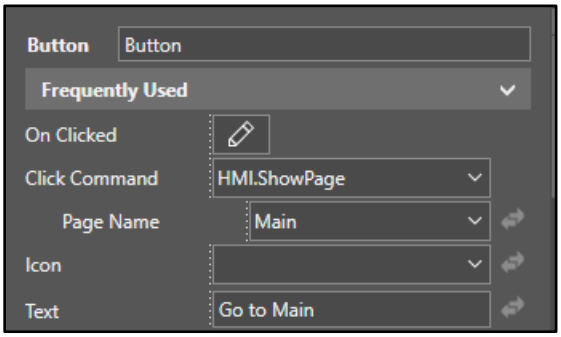


3. Right click on WebPage and select **Rename**.
4. Rename the WebPage *Results* and press the **Accept** button.



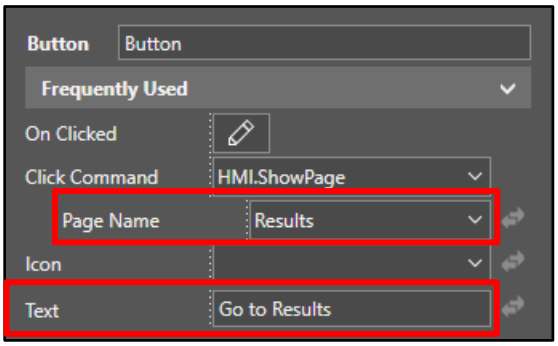
5. Add a **button** to the *Results* WebPage.

   NOTE: *The button is found in the Toolbox under User Inputs.*
6. Set the button properties as follows:
   - Click Command = *HMI.ShowPage*
   - Page Name = *Main*
   - Text = *Go to Main*

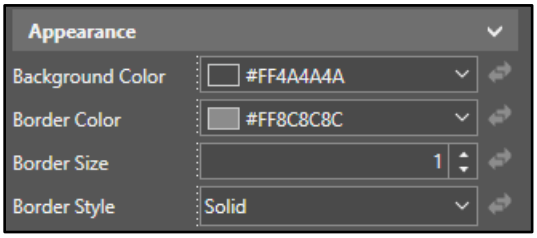


7. Add a **button** to the *Main* WebPage.
8. Set the button properties as follows:
   - Click Command = *HMI.ShowPage*
   - Page Name = *Results*
   - Text = *Go to Results*

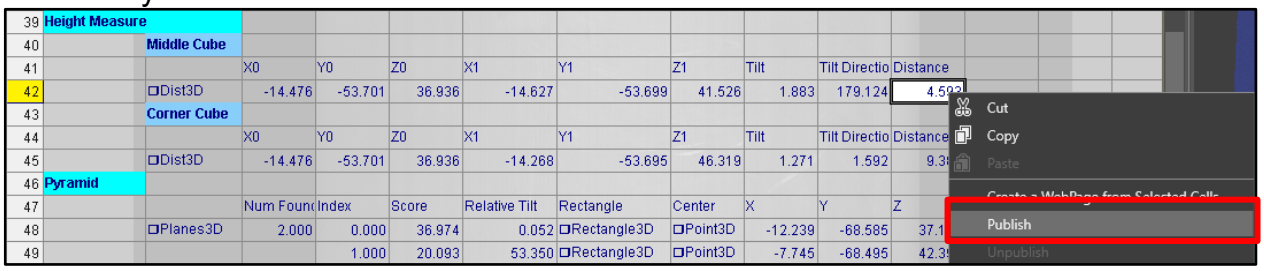
NOTE: *The button can also be copied from the Results page and pasted to the Main page – simply change the information in the button properties to the Results page.*



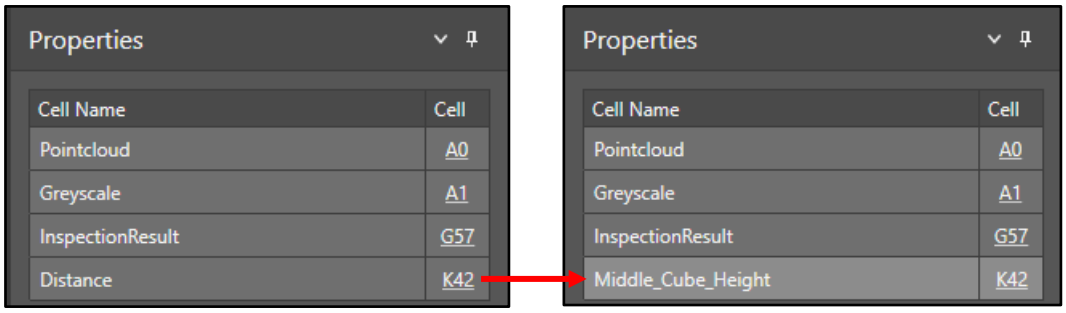
NOTE: *The button can be customized by changing the settings in the Appearance section of the Toolbox.*



9. Go **Online** and confirm that clicking the button changes the HMI page.
10. Go Offline.
11. Return to the Spreadsheet.
12. Right click on cell **K42** (Middle Cube Height Measurement) and select **Publish** from the fly-out menu.



13. A new output named Distance is added to the Web Pages properties list. Double-click to rename the output to **Middle_Cube_Height**.

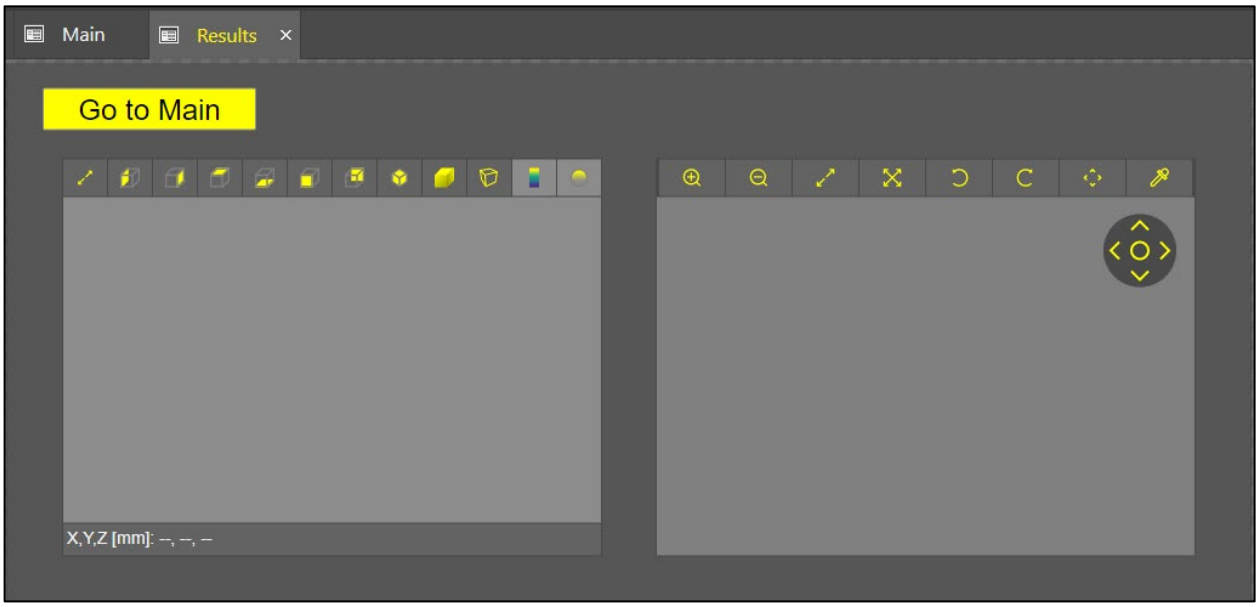


14. Right click on cell **K45** (Corner Cube Height Measurement) and select **Publish** from the fly-out menu.

15. Change the name of the output to **Corner_Cube_Height**.
16. Repeat steps 13 and 14 for the following:
    - Cell **C22** – rename to **Number_of_Blobs**
    - Cell **B51** – rename to **Pyramid_Angle**

    Publish any other results that you would like to display in your HMI.
17. Return to the Results page.
18. Add a **Display3D** control to the page, resize to fit in the top left corner.

    NOTE: *The Display3D is found in the Toolbox → Vision Controls and Displays → Display 3D.*
19. Add a **Display** control to the page, resize to fit next to the Display 3D control.



NOTE: *The locations are suggestions, arrange the HMI page as you would like.*

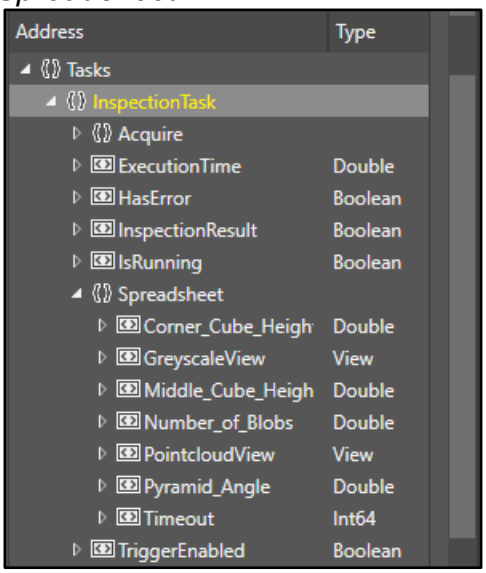
20. Add a **Button** and set the parameters as follows:
    - Click Command = *Tasks.InspectionTask.TaskRun*
    - Text = *Trigger Once*

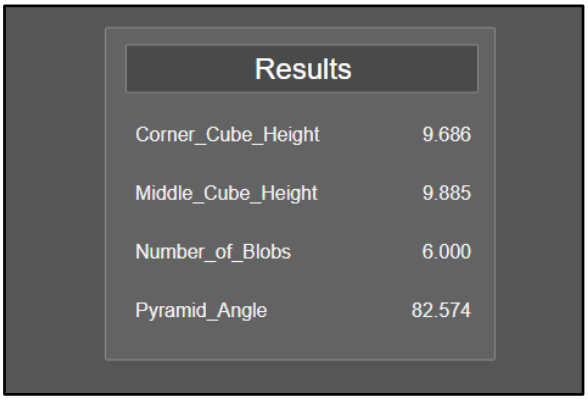
    Customize the look of the button using the *Appearance* parameters.

21. Add a **Panel** and a **TextBox** to the page – place the TextBox on the top center of the Panel and change the Text to *Results*.

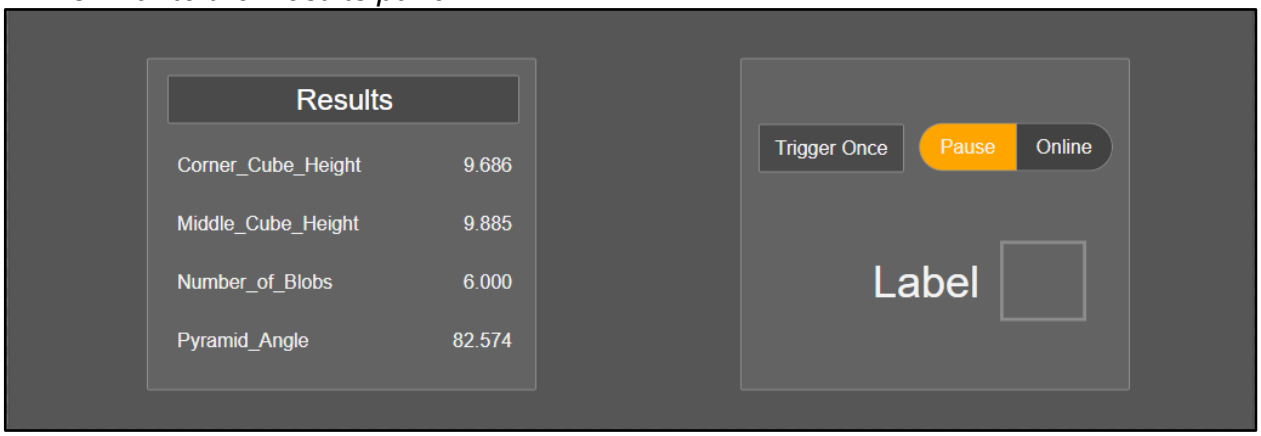
NOTE: *The Panel and TextBox are found in the Toolbox → User Inputs.*

22. Drag the Tags that you published in the spreadsheet onto the Panel – adjust the text boxes to see the full information.
NOTE: *Tags are found on the Tags tab under Tasks → InspectionTask → Spreadsheet.*



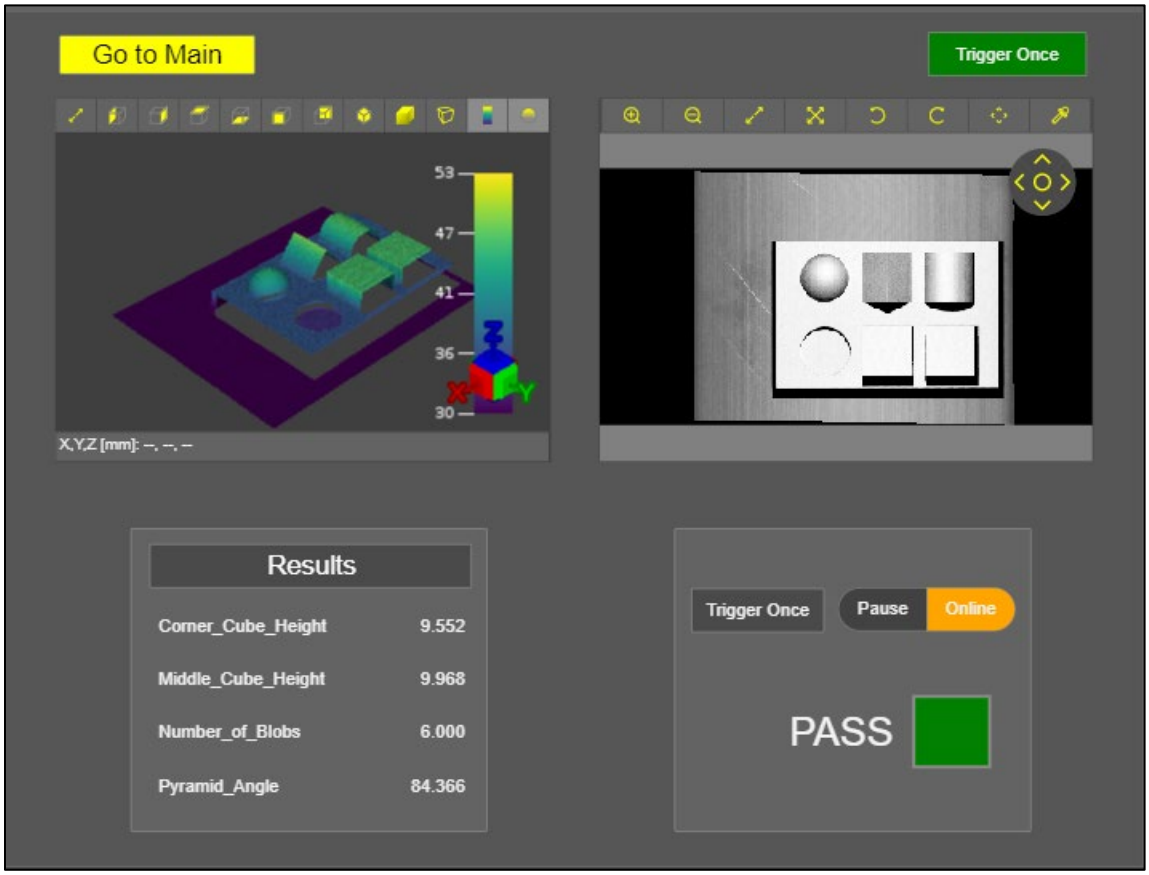


23. Copy the Controls from the Main page and paste on this page.
Note: *To make the page more balanced the copied controls can be placed in a Panel similar to the Results panel.*



24. Go **Online**. Trigger your device and review the results.
    NOTE: *To use the Trigger Once button the Trigger Source should be set to Software, if using the button on the demo station the Trigger Source should be set to Hardware.*

Results Web Page:



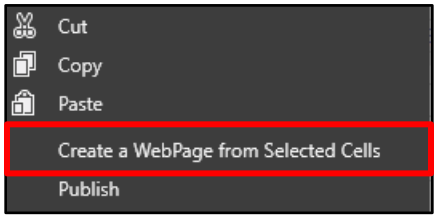
25. Go Offline.
26. Save your job.

Add a New Web Page from Spreadsheet Cells

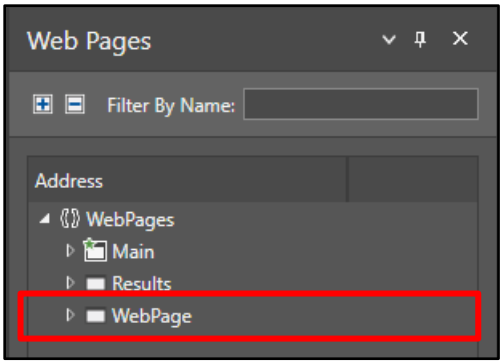
1. Continue with the current project.
2. Return to the spreadsheet.
3. Highlight cells **A53 through G58**.

53	TCP/IP Inspection Output					
54	Label	Value	Delimiter		Height Check (Pass/Fail)	Global Pass/Fail
55	Inspection:	Pass	,			
56	# of 3D Blobs:	6.000	,			
57	Middle Cube:	9.876	mm,		1.000	1.000
58	Corner Cube:	9.631	mm		1.000	

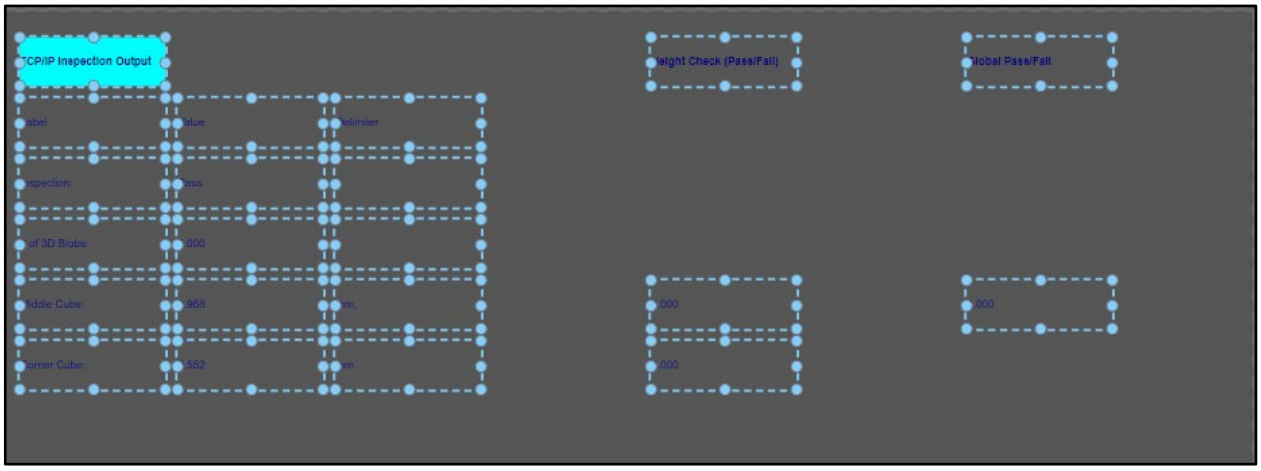
4. Right-click and select **Create a WebPage from Selected Cells** from the fly-out menu.



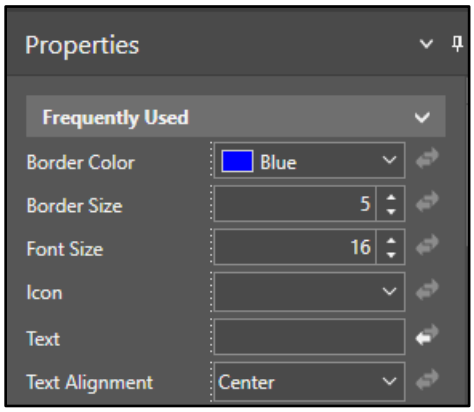
A new WebPage is created.



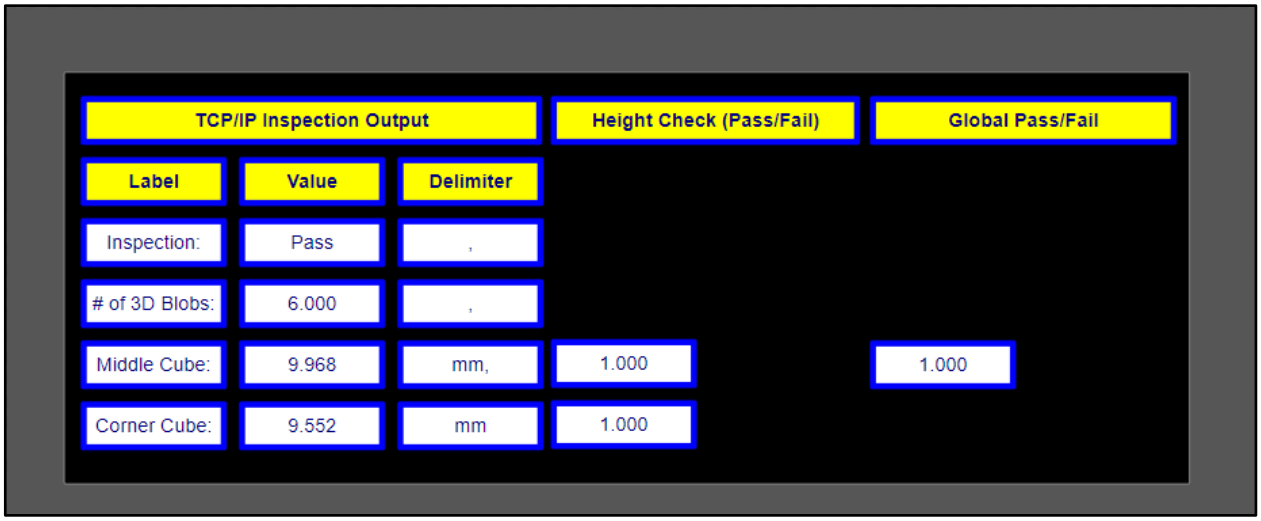
5. Right-click and rename the page *Table*.
6. Highlight all items on the new WebPage.



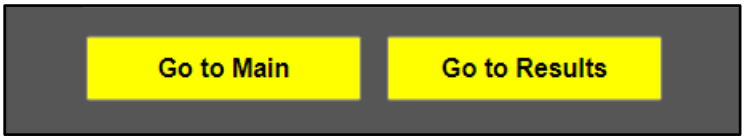
7. Change the **Border Color** to *Blue*, **Border Size** to *5*, **Font Size** to *16* and **Text Alignment** to *Center*.



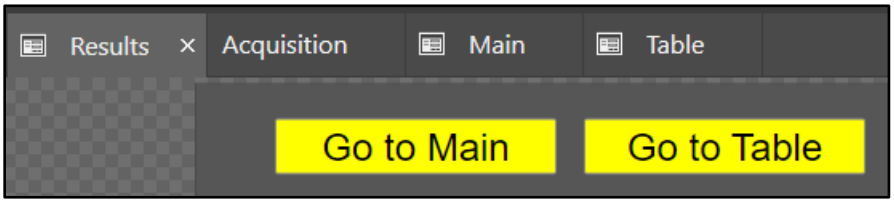
8. Change the **Background Color** to *White*.
9. Customize the Appearance of the table – there is a Panel with a Black background added behind the Table in this example.



10. Add 2 buttons that when clicked bring the user to the other WebPages. Format the text color and background color as you choose.
    1. Click Command = *HMI.ShowPage*
       Page Name = *Main*
       Text = *Go to Main*
    2. Click Command = *HMI.ShowPage*
       Page Name = *Results*
       Text = *Go to Results*

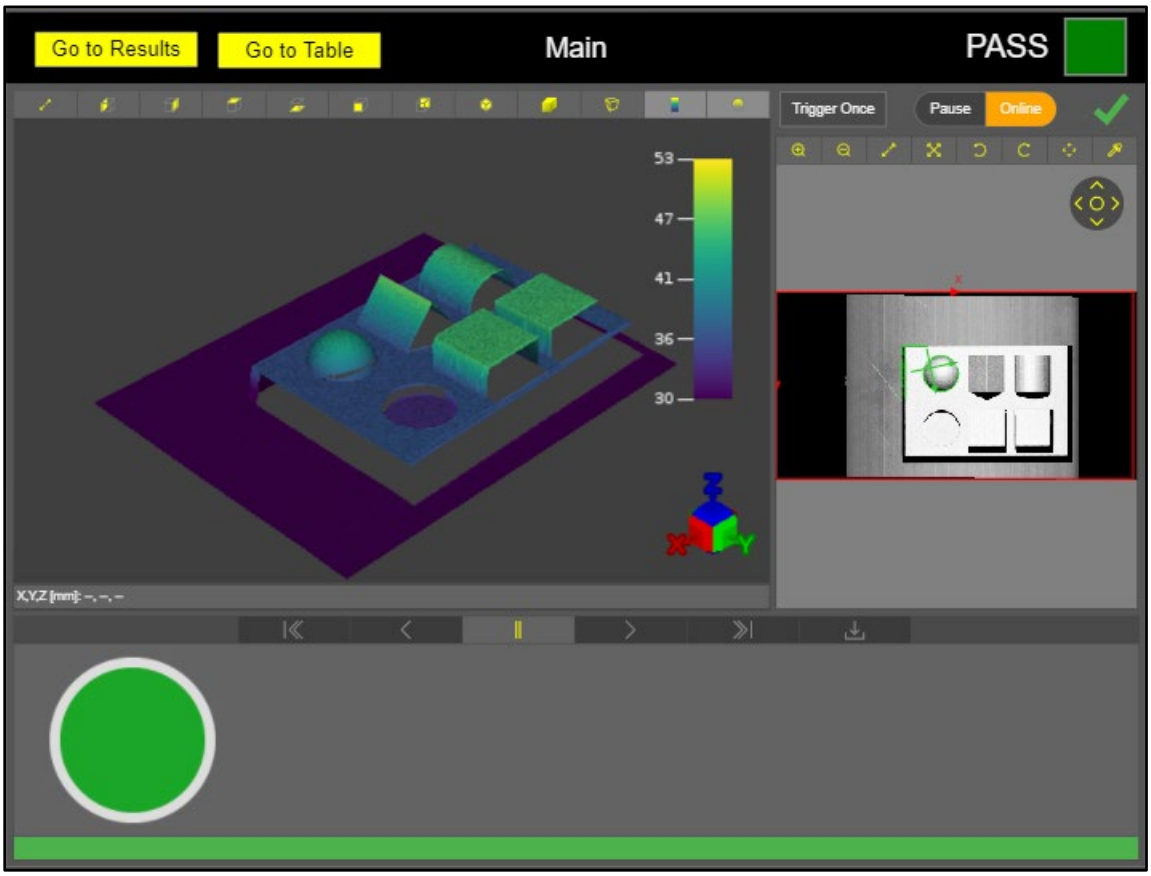


11. Add a button to the Main page and Results page to go to the Table page.
    - Click Command = *HMI.ShowPage*
    - Page Name = *Table*
    - Text = *Go to Table*



12. Go **Online**. Trigger your device and review the results.

Main Page:



Results Page:

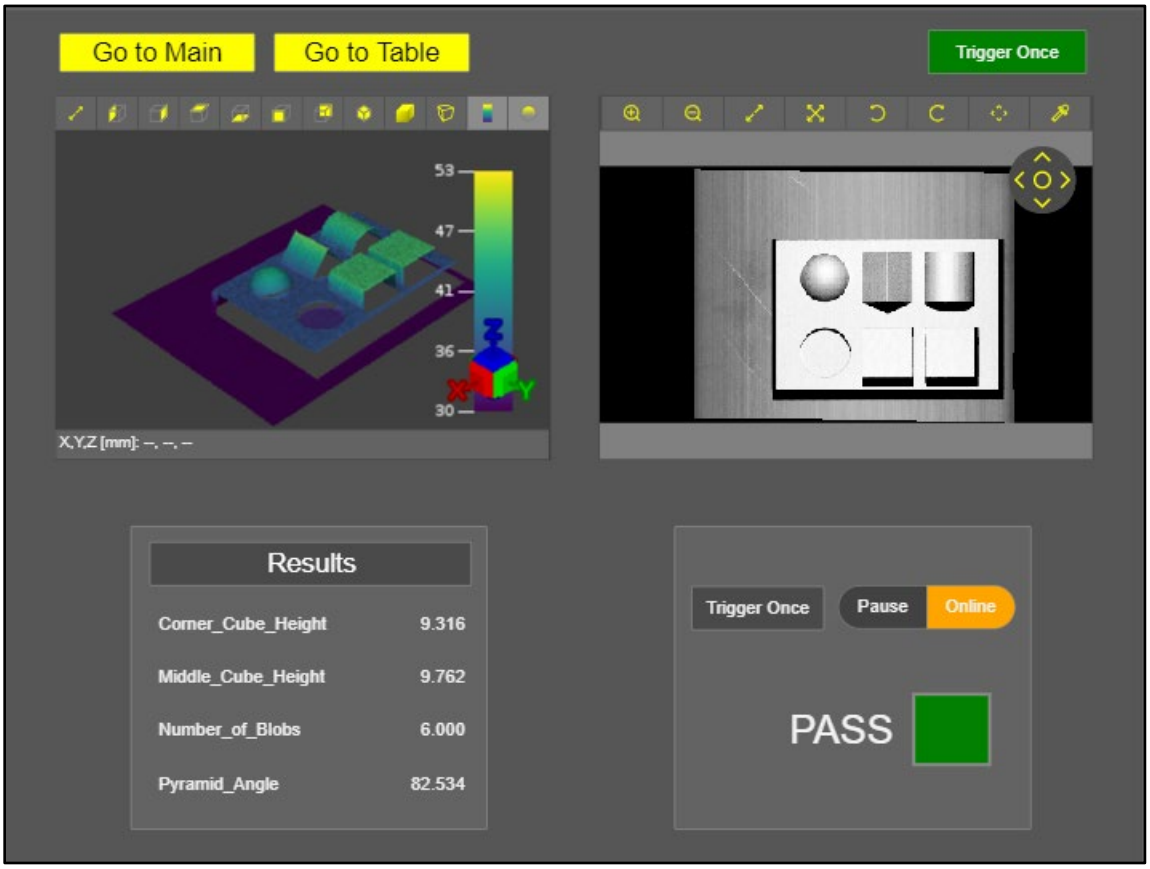
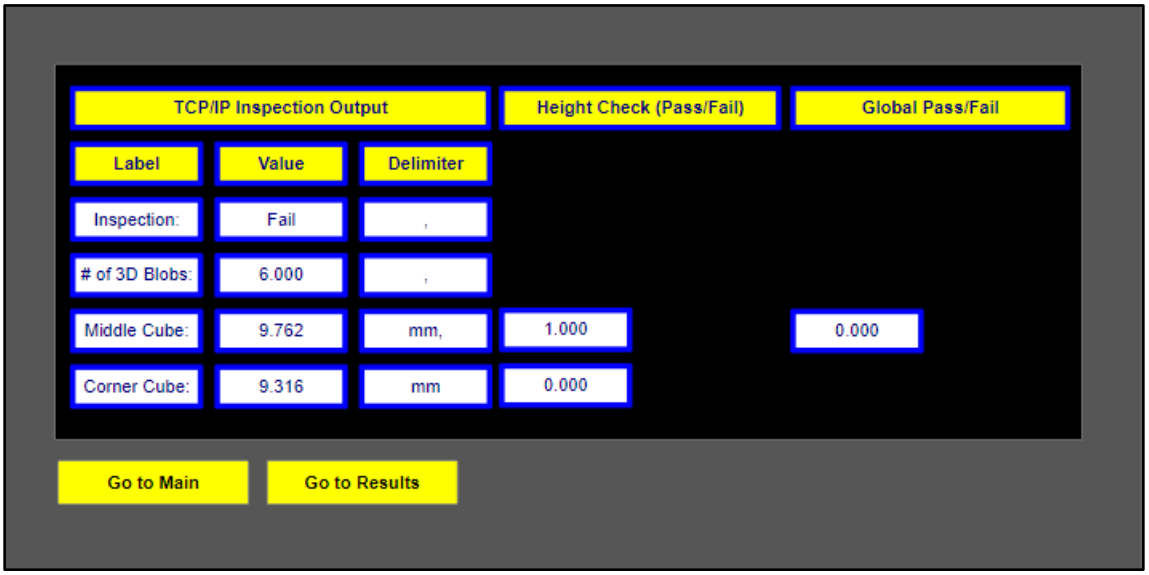


Table Page:



13. Go Offline.
14. Save your job.

Lab Exercise 8.1 – Deployment

At the end of this lab exercise, Participants will be able to:

- Utilize the utilities available in In-Sight Vision Suite to finish deploying the application

The Participant will utilize the following In-Sight Vision Suite Functions to successfully complete this exercise:

- User Settings
- Update Firmware
- Network Settings
- Backup
- Restore

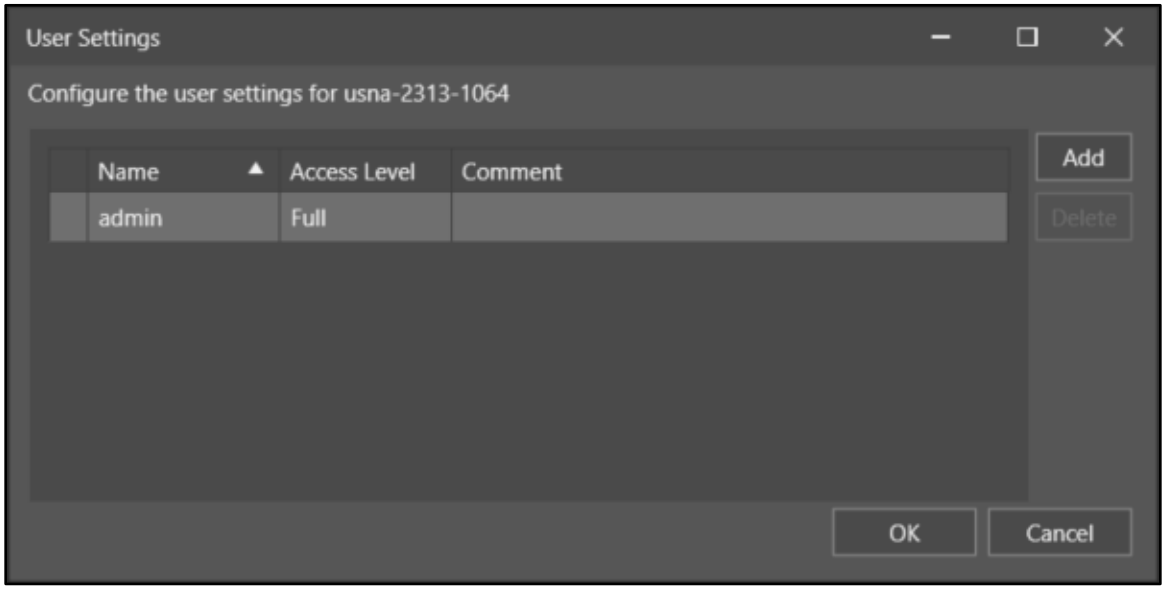
NOTE: *In order to complete this lab exercise, you should not be connected to your camera or emulator. This will allow you to access the Utilities.*

User Settings

Follow the steps below to complete the lab exercise:

1. Click on the **User Settings** link – this is found in the **Utilities** menu.

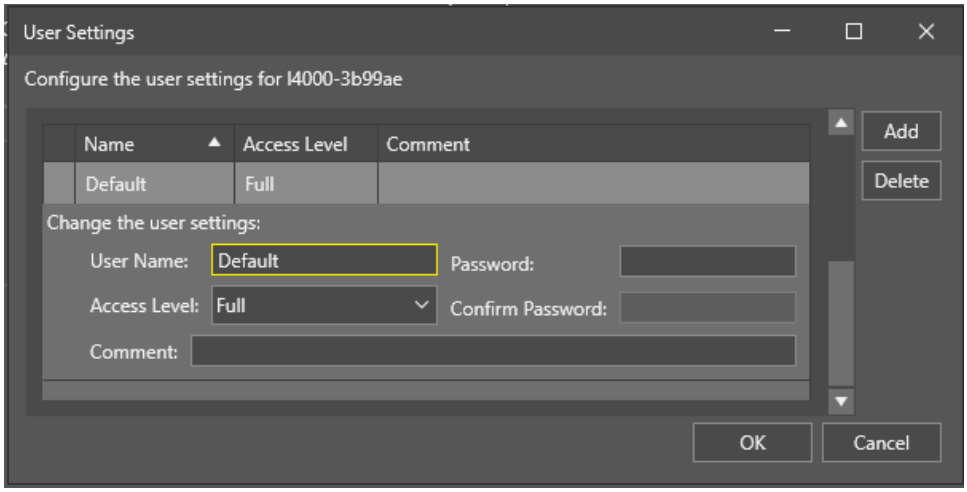
The **User Settings** dialog displays.



2. A user with the Name **admin** should already be there, with Full access. Click the **Add** 

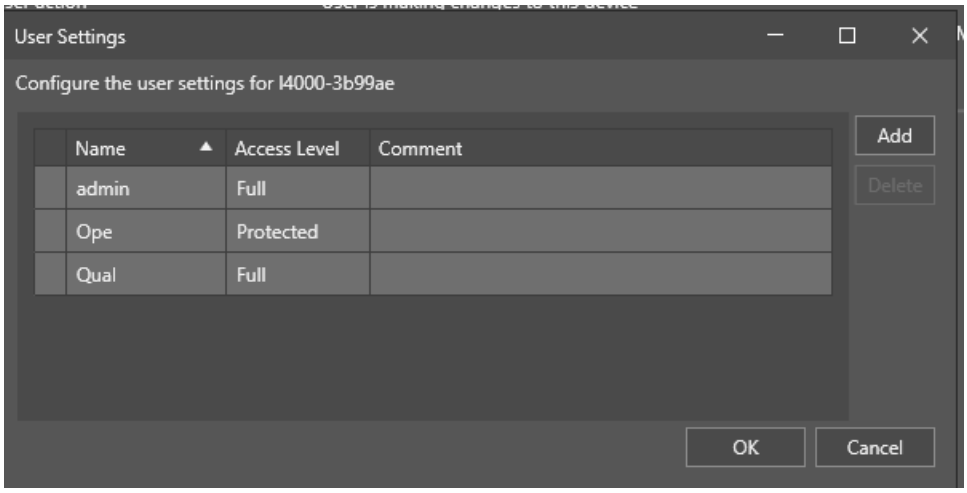
button to create a new user.

A new line displays.

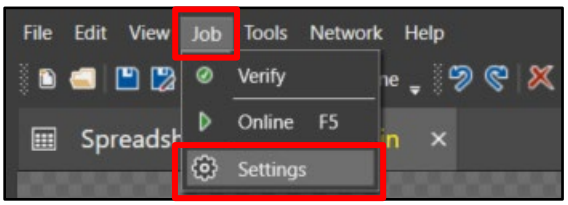


3. Enter the new user's information in the appropriate fields and click the **OK**  button.

NOTE: *Create two new users, one with Protected access and one with Locked access. Choose the names you would like, use the password Cognex for both.*

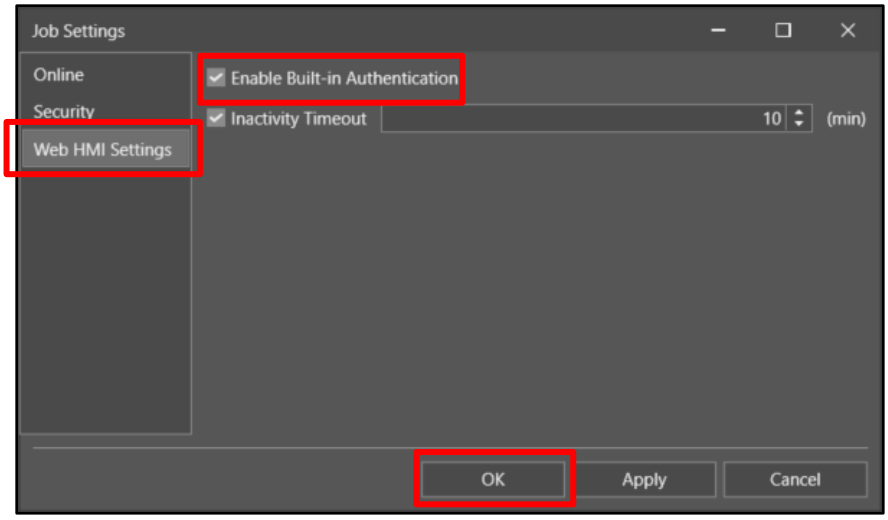


4. Connect to your camera. (If there is a job open on your camera, close it and open a new job).
5. Click the **Main** WebPage tab.
6. From the **Job** menu, select **Settings** from the drop-down list.

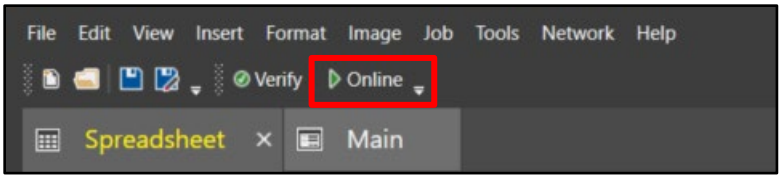


The **Job Settings** dialog displays.

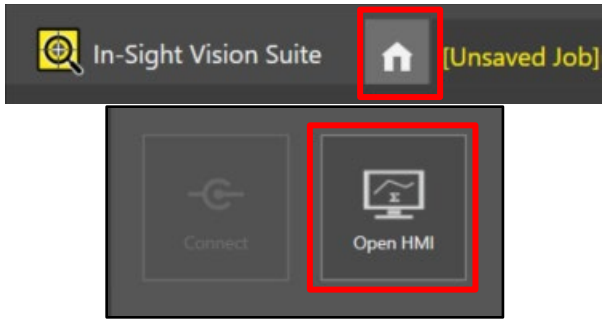
7. Click **Web HMI Settings** and check the **Enable Built-in Authentication** checkbox.



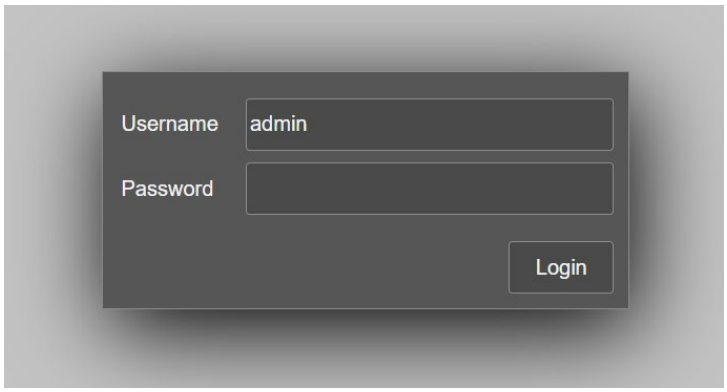
8. Click the **OK** button.
9. Click the **Online** button to go Online.



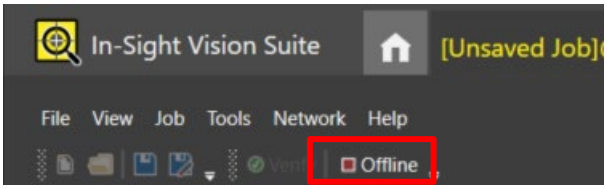
10. Click the **Home** tab and click the **Open HMI** button.



11. A new web browser opens – login as admin (with no password)



12. Log into the HMI with the other users that you created.
    Notice the difference in the access that the different users have based on their access levels.
13. Return to your camera and click the **Offline** button to go offline. Do not save the job.



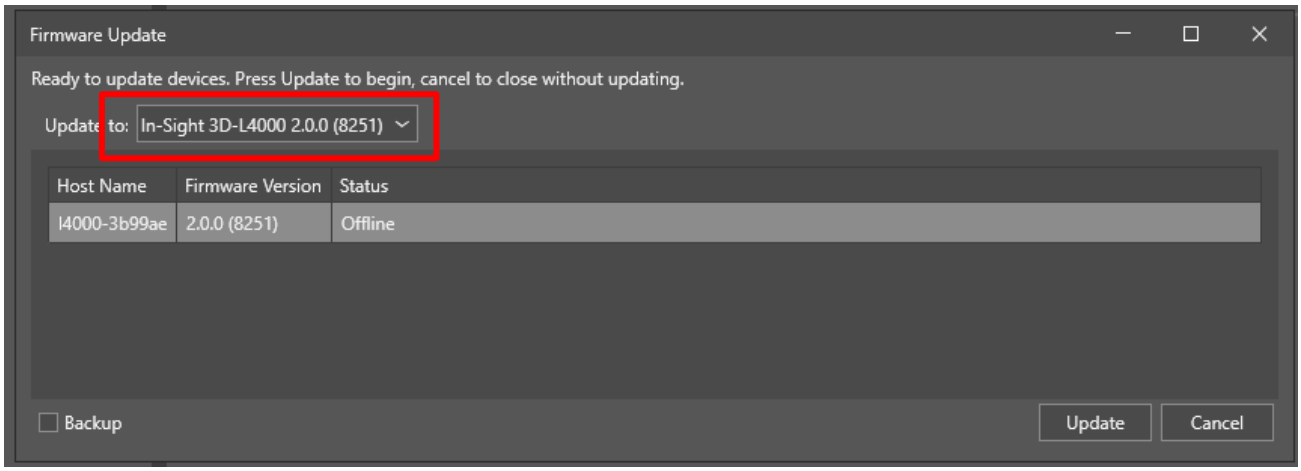
Firmware Update

NOTE: *In this lab, you will look at the steps needed for a firmware update to the firmware and cameras, but you will **not** actually do an update.*

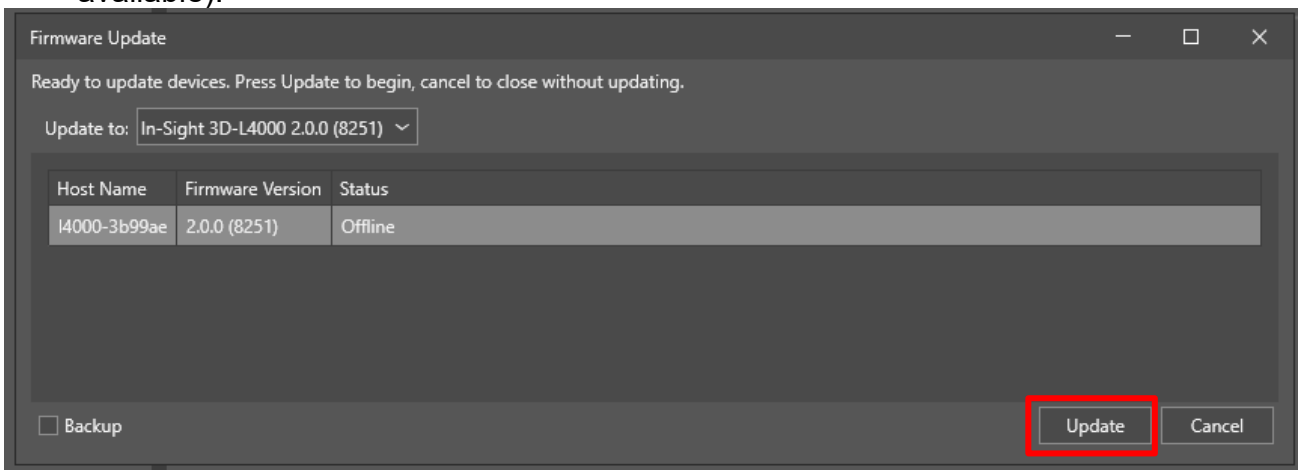
1. From the Utilities tab select **Firmware Update**.

The **Firmware Update** dialog displays.

2. Select the Firmware version from the **Update to:** drop down list.



3. ***Do not actually do an update,*** but if you were, highlight the camera to be updated and click the **Update** Update button. (In this screenshot there is only one camera available).



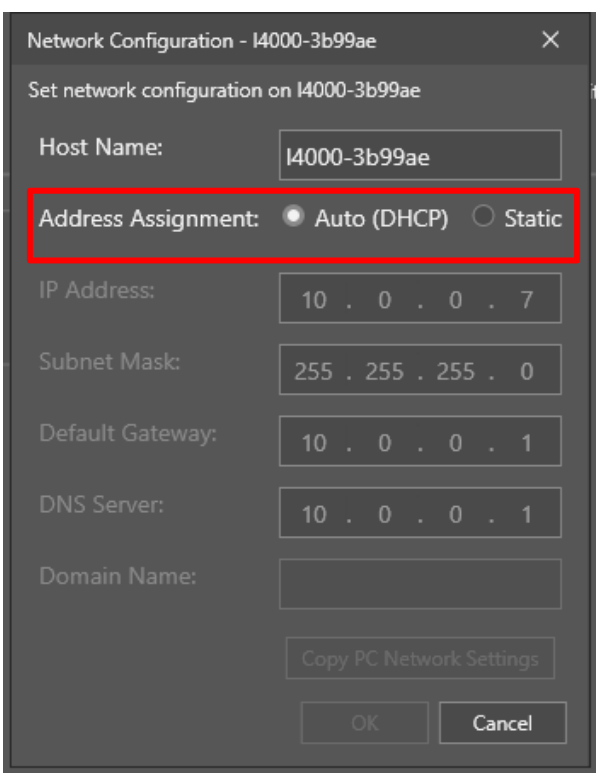
The **Update** will begin.

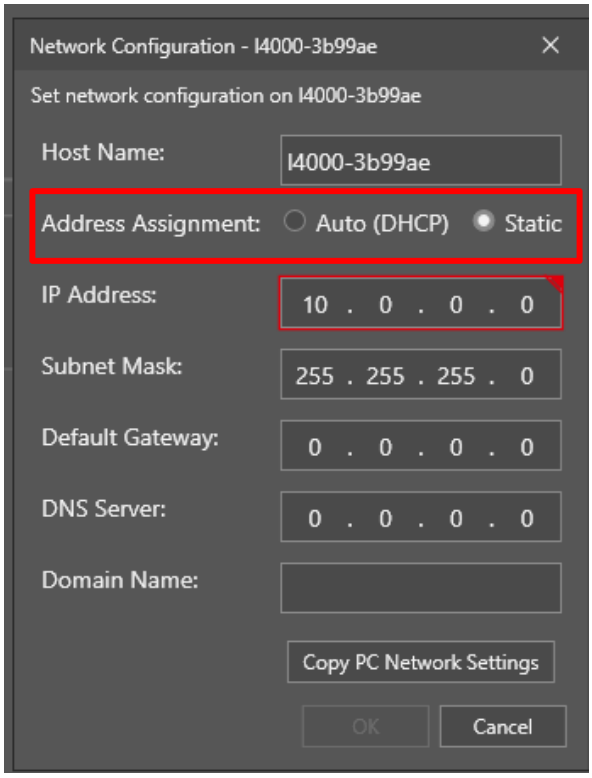
4. Click the **Cancel** Cancel button to exit from this dialog.

Network Settings

1. From the Utilities tab select **Network Settings**.

The **Network Configuration** dialog displays and might look like one of the following:



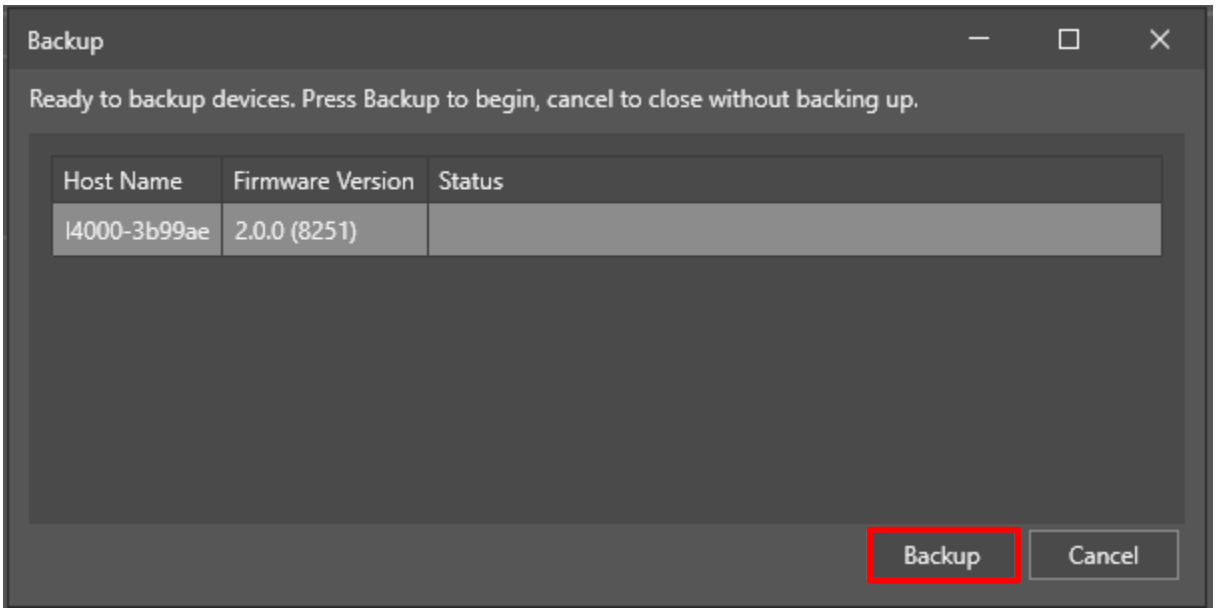


2. Review the settings.

Backup

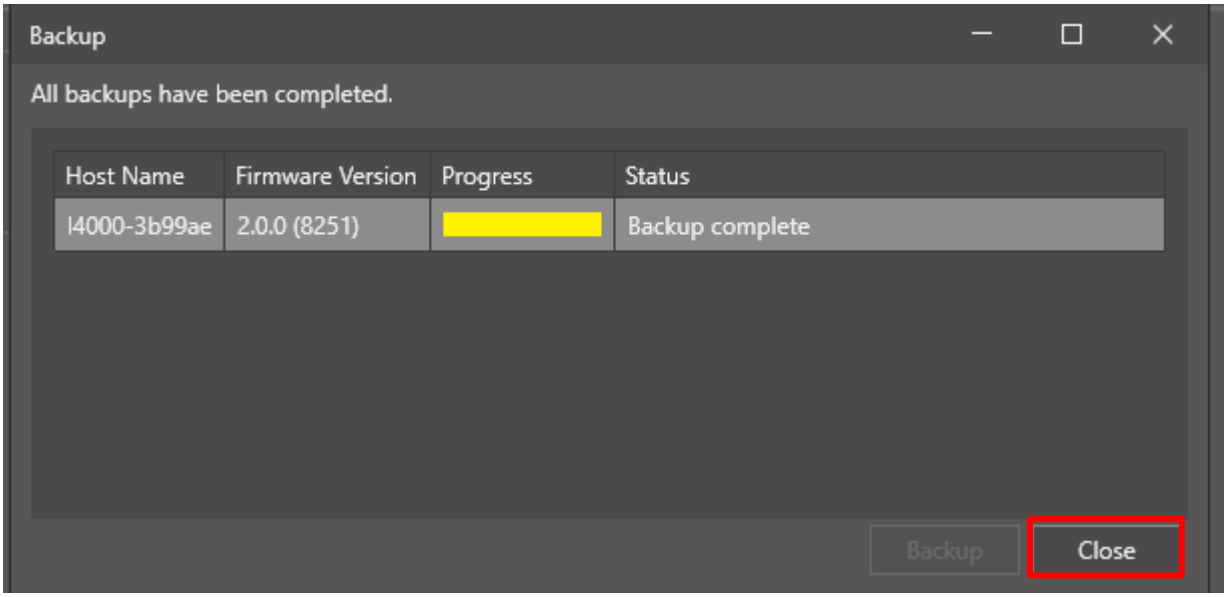
1. From the Utilities tab select **Backup**.

The **Backup** dialog displays.



2. Select the camera to backup and click the **Backup**  button.

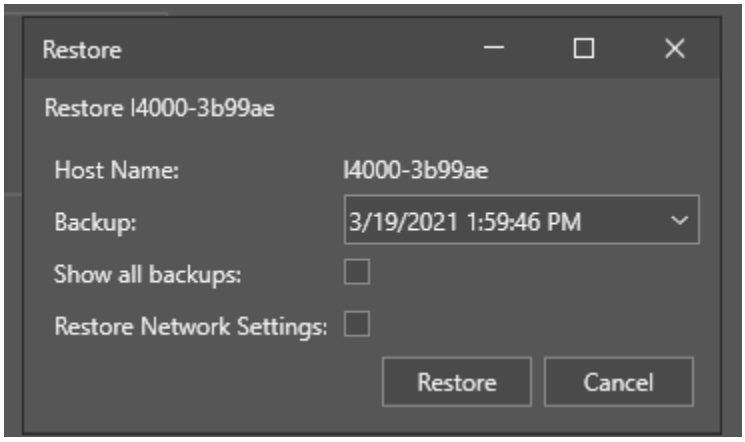
3. Once the Backup is complete click the **Close**  button.



Restore

1. From the Utilities tab select **Restore**.

The **Restore** dialog displays.



NOTE: *If you want to see all the backups available on the network check the Show all backups checkbox.*

2. Select the Backup that you would like to restore the camera from and click the **Restore** Restore button.
3. Once the Restore is complete click the **Close** Close button.