Section 6: VolumeCalculator & PlaneEstimator Tool

COGNEX

Objective

VolumeCalculator Tool

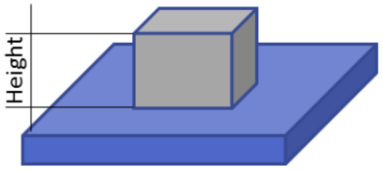
- Explore the VolumeCalculator Tool
- Learn how to get deeper into the tools and share results among them
- Understand how to deal with spikes in the image

❖ Lab: Create a VolumeCalculator Tool

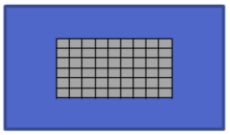
COGNEX

Measuring Volume

- **What is Volume ?**
  - **Sum of all range pixels heights multiplied by size of range pixel**



Base Plane



Top View

- **Result are in mm^3**

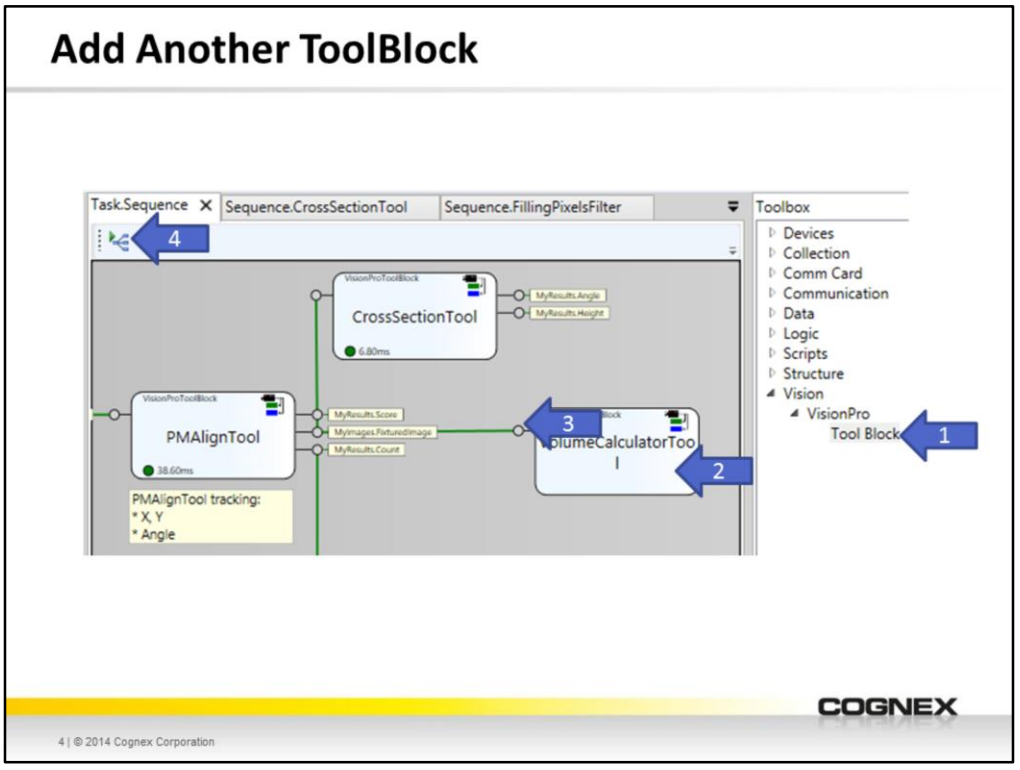
COGNEX

Simply think of volume as the sum of all cubic pixels that are represented by a range pixel. A range pixel's volume is the x-Scale multiplied by the Y-Scale multiplied by the z-Value of the range pixel.

V = Height * X * Y (simplified case with all Pixels same height)

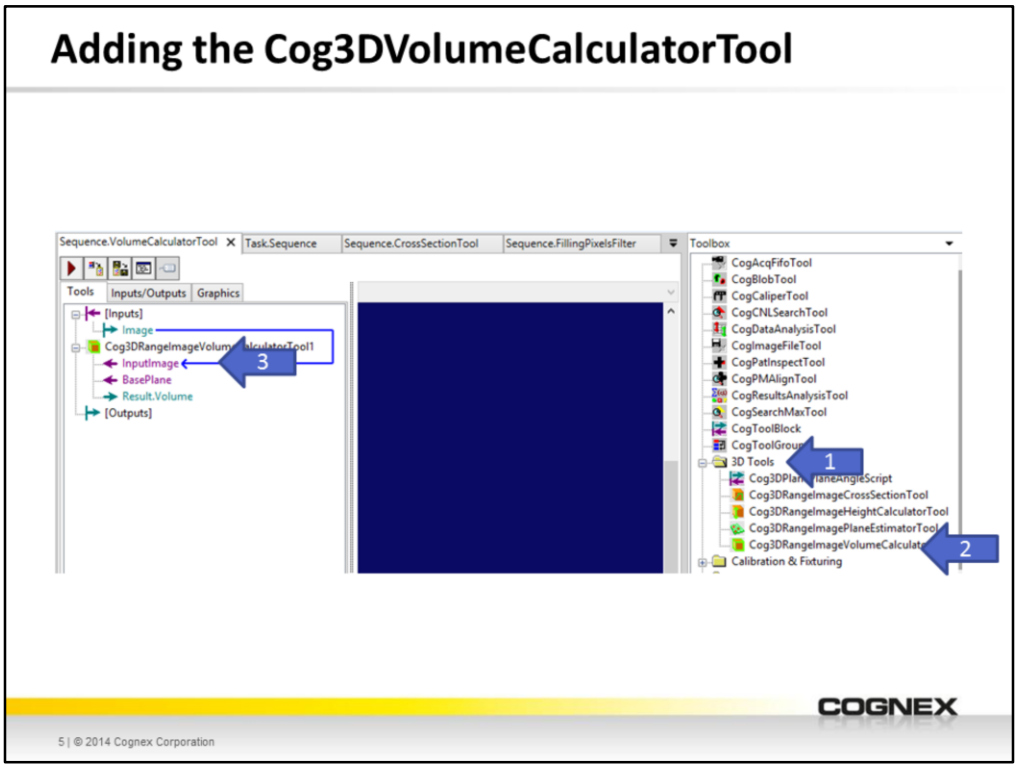
Only pixels that are visible and not masked are used to compute the volume of an object.

- Range pixels are visible, valid , unmasked
- Height in respect to base plane



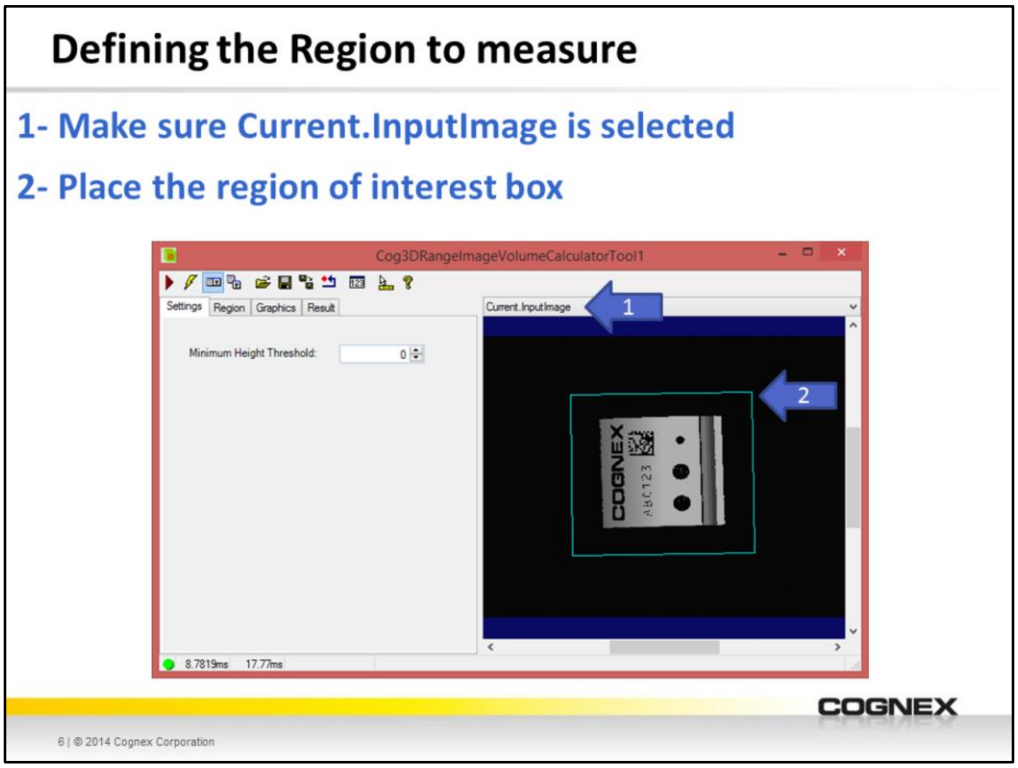
To implement a Cog3DRangeImageVolumeCalculatorTool:

1) Add a new vision tool block to your sequence
2) Rename it “VolumeCalculatorTool”
3) Connect the output image from the PMAlignTool block
4) Run the sequence once



Once our Tool Block is in place and connected to the right image, open it.

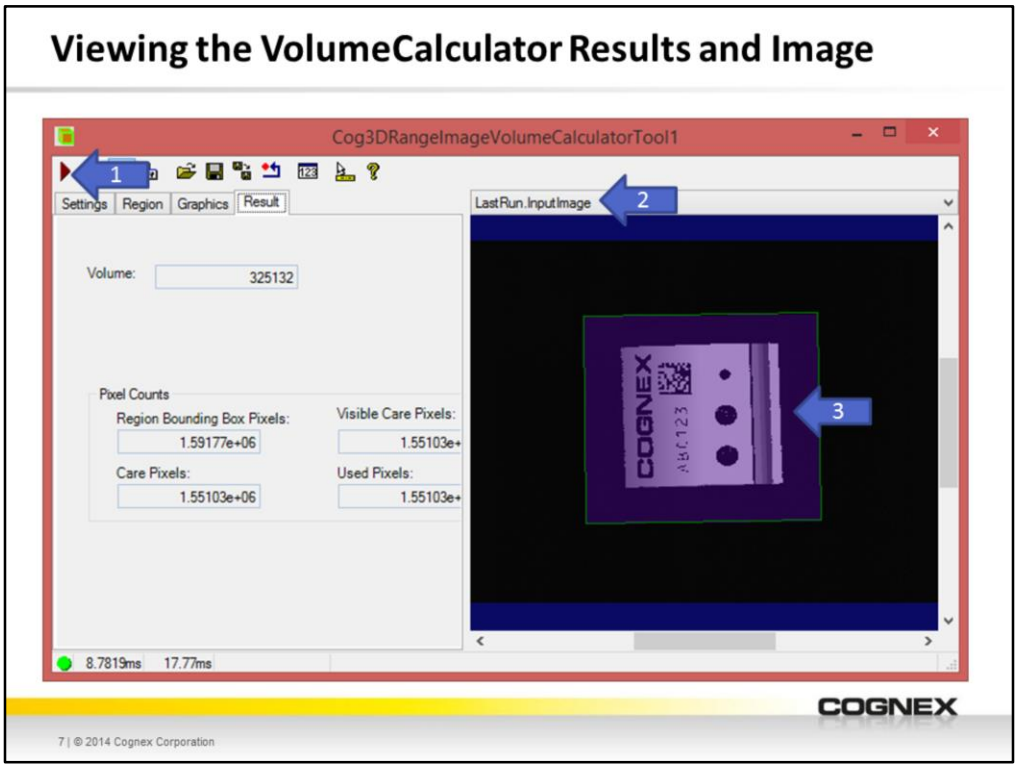
1) Expand the “3D Tools” category
2) Drag a Cog3DRangeImageCrossSectionTool into the tool block listing
3) Drag the Image into the newly added Cog3DRangeImageCrossSectionTool1’s InputImage input terminal



Setting the region allows you to choose what portions of the part you will use to calculate the volume.

For this part and the details we are looking to extract, we recommend the region pictured as the region of interest.

Make sure you are on the Current.InputImage to place the region.



To advance:

1) Run the tool
2) Click the Result tab to display the results of the tool. You can see a result hovering around 325,000 mm cubed. This should be your first indication that this volume measurement isn't quite right.
3) Select the LastRun.InputImage image from the image pull-down menu. Look closely. You can see which portions of the image were used to calculate the volume of the object in purple. This should be your second indication that this volume measurement isn't quite right.

Does it make sense that we are reporting out a value of 325,000 mm cubed as the volume of this object?
Does it make sense to be using portions of the tabletop to calculate the volume of the object?

PlaneEstimator Tool

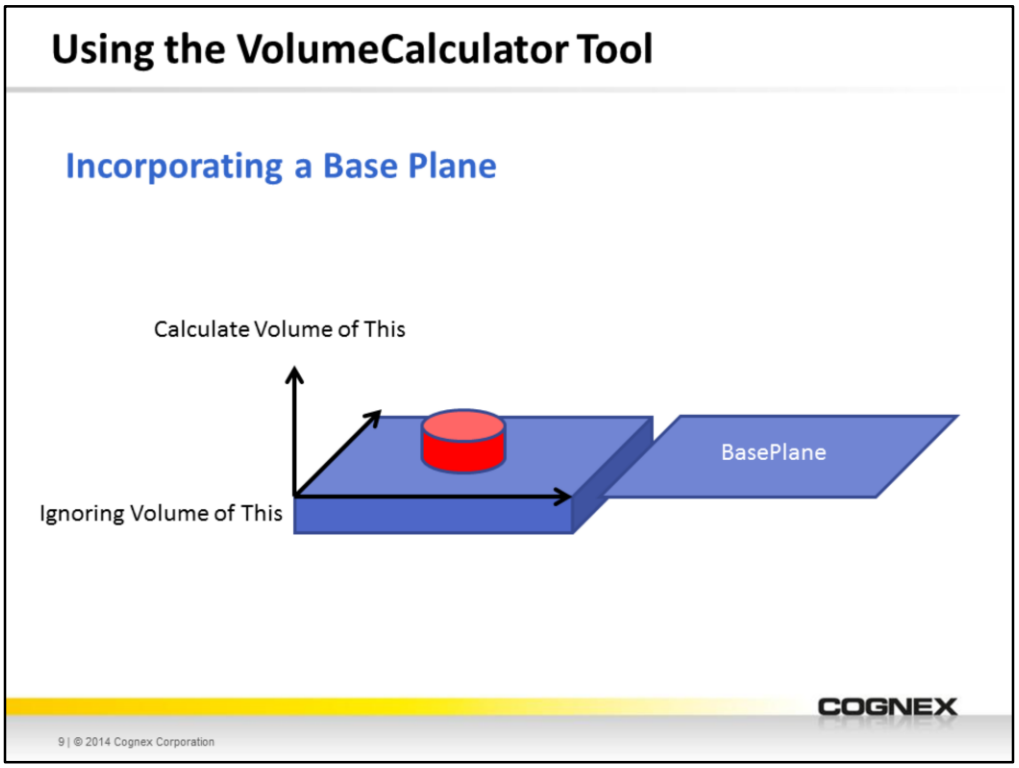
COGNEX

The PlaneEstimator tool allows you to use points or a region to approximate a plane from features in your field of view.

You can then use this plane for calculating measurements and / or to establish a new surface from where your measurements should be based.

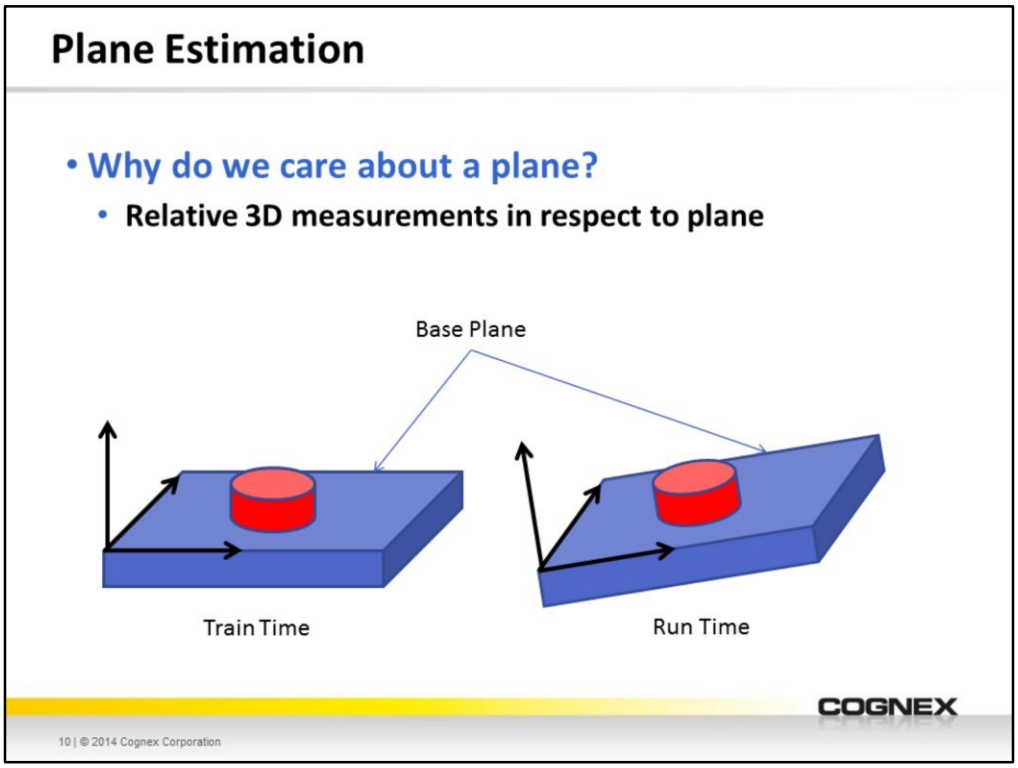
You can use a PlaneEstimator tool in conjunction with a VolumeCalculator tool to limit the volume calculation so that it doesn't factor any portion of the surface on which the part is presented.

The idea is to make the most accurate volume calculations possible on just the features of your part and not any part of the conveyor or other means of part presentation.

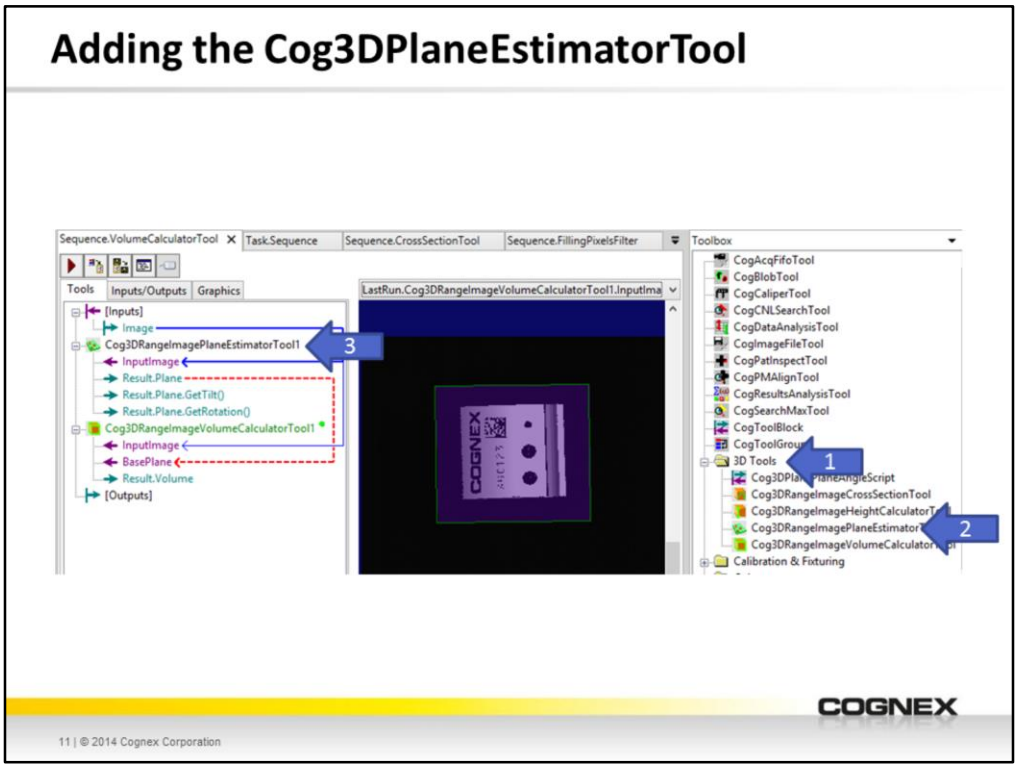


If you want to calculate the volume of this object, you must exclude any portion of the surface on which it rests.

Wouldn't it be nice if there was a tool that let you calculate a base plane that helped you exclude portion that should not be used to calculate the volume.



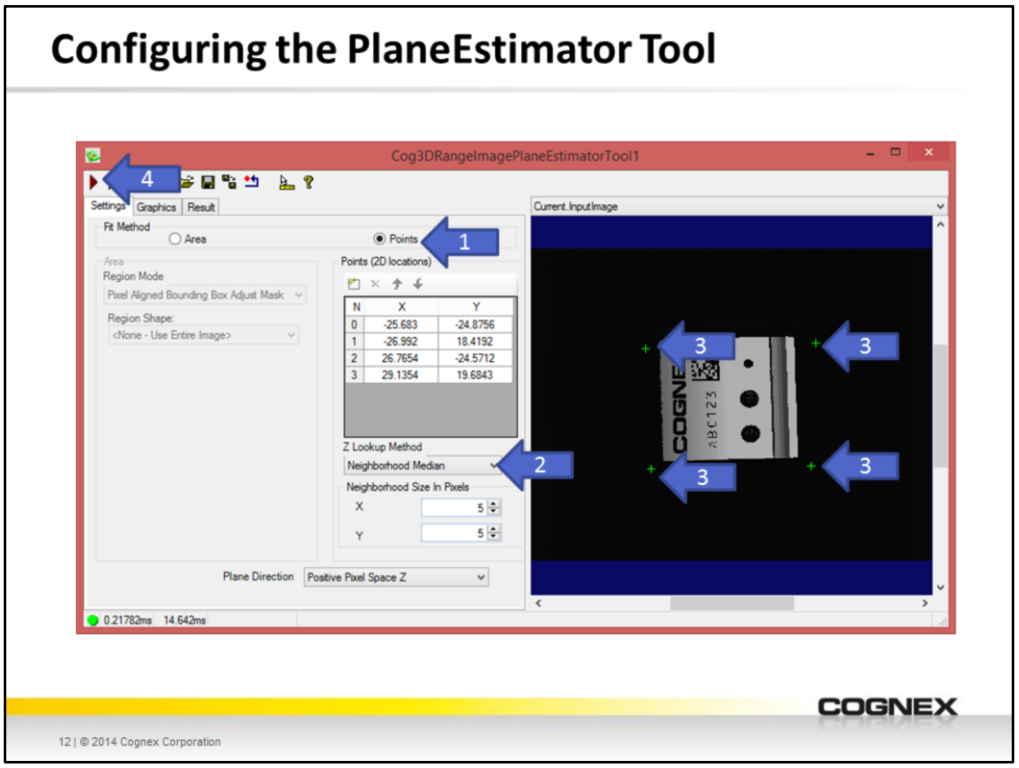
In our know 2D world, we use PatMax to fixture on translation, rotation and scale. In a 3D world we need to add a reference plane from which we do measurements.



To add a PlaneEstimator tool:

1) Expand the “3D Tools” category
2) Drag a Cog3DRangeImagePlaneEstimatorTool into the tool block listing ABOVE the Cog3DRangeImageVolumetCalculator1 tool
3) Drag the Image into the newly added Cog3DRangeImageVolumeCalculatorTool1’s InputImage input terminal
4) Drag the Cog3DRangeImagePlaneEstimatorTool1’s ResultPlane into the Cog3DRangeImageVolumeCalculatorTool1’s BasePLane input terminal
5) Run the tool block once to get all data flowing through

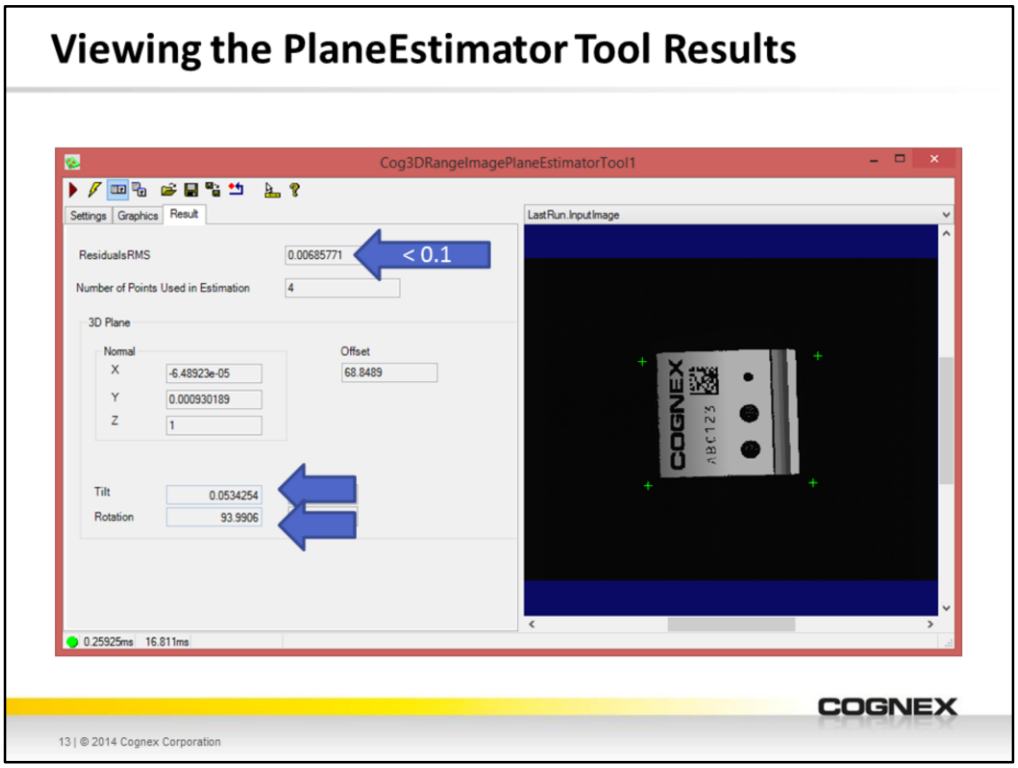
The Result.Plane and BasePlace connection may appear with red dashes initially because



You can use an area or a set of points to estimate a plane.

For best results for this application:

1) Set the Fit Method to Points.
2) Set the Z Lookup Method to Neighborhood Median.
3) Set the default four points around the object. They should fall on the parts of the image the represent the table top. Avoid any area that was once considered missing pixels.
4) Run the tool.



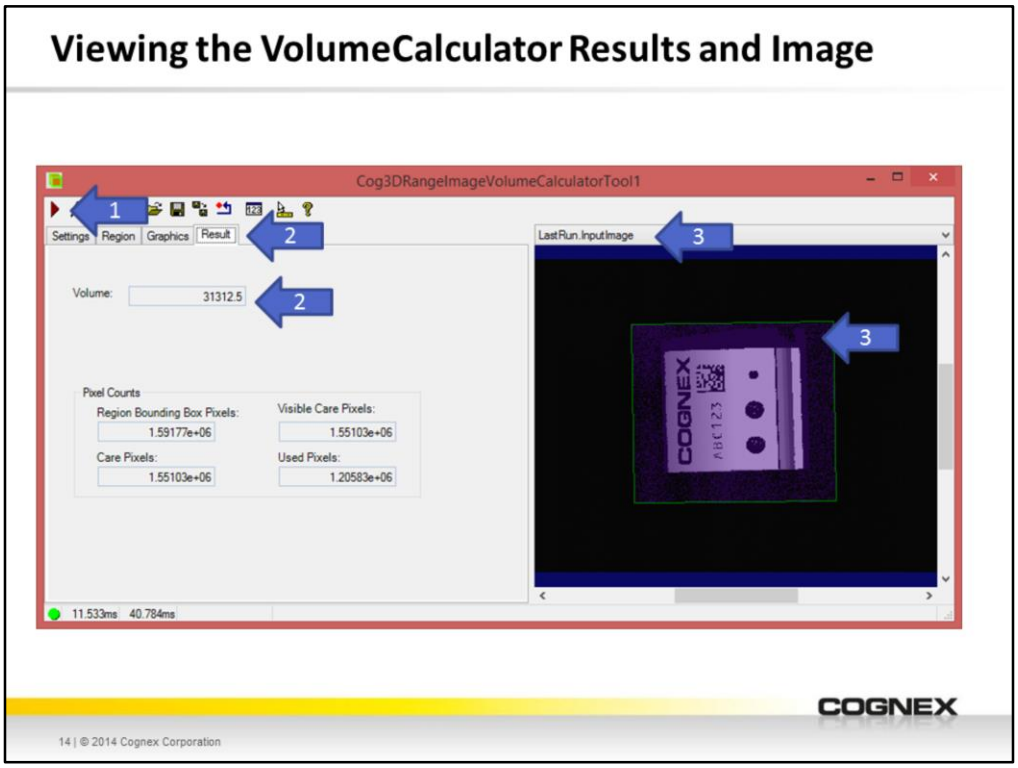
Check the Result ta to confirm a good plane has been estimated.

If ResidualsRMS < 0.01, you can safely assume you have a flat base plane.

The lower this value is, the flatter and more ideal the base plane is for your calculations.

Keep in mind that if the surface you are analyzing is not flat, then you should consider this when making a judgment on this result.

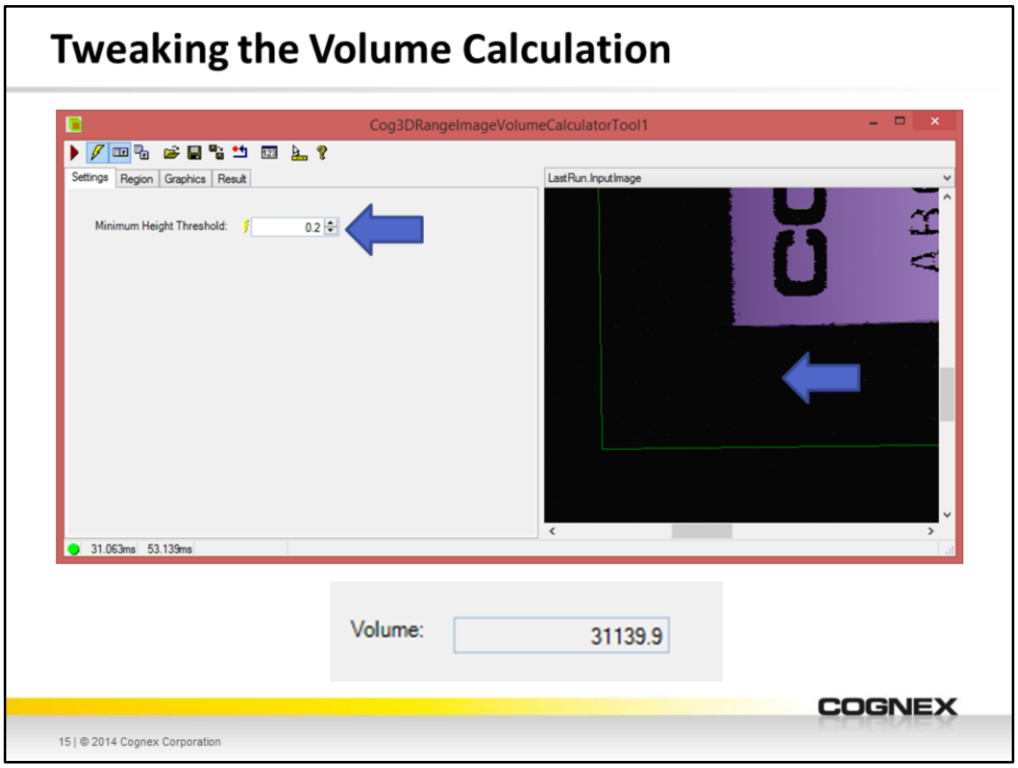
More results:
The tilt of the plane is defined as the angle between the plane Normal and the Z-axis
The rotation of the plane is defined as the angle between the perpendicular projection of the plane Normal on the XY-plane and the X-axis.



To check if this PlaneEstimator tool has helped:
From within the VolumeCalculator tool

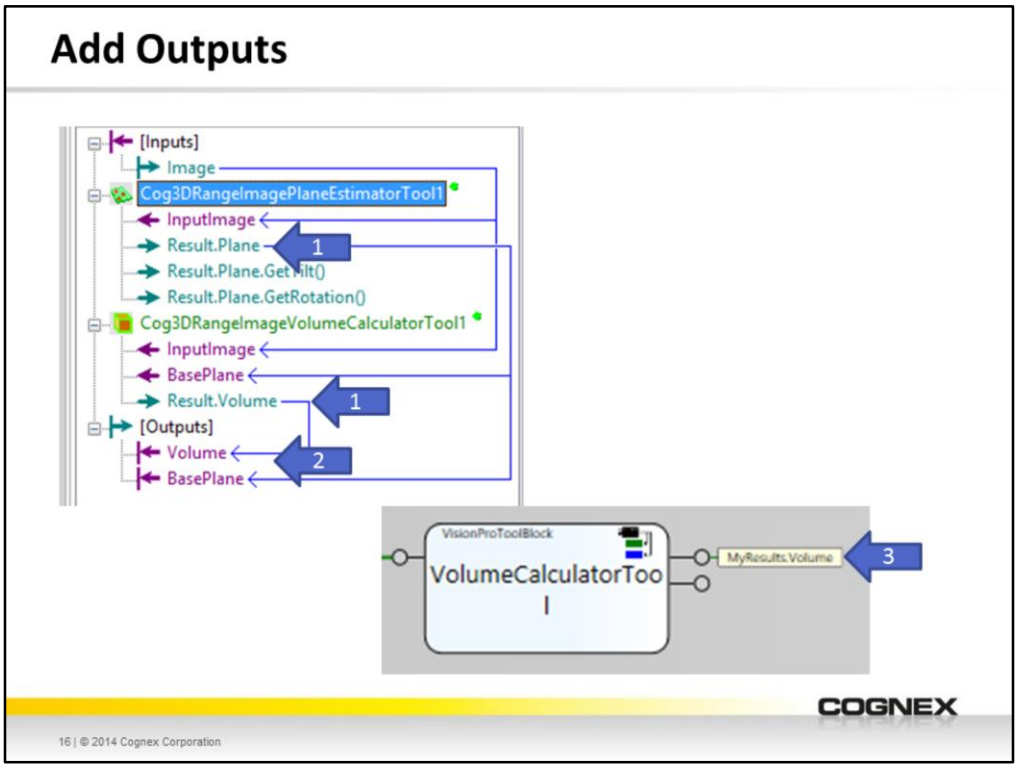
1) Click “Run” icon once to process an image through the tool.
2) Click the Result on the result tab.
   You can see a result hovering around 31,312.5mm cubed.
   This should be your first indication that this volume measurement is closer to the mark.
3) Select the LastRun.InputImage from the image pull-down menu.
   You can see which portions of the image were used to calculate the volume of the object in purple.
   Because of your recent changes, Less of the table surface is being used.
   This should be your second indication that this volume measurement is closer to the mark.

Does it make sense that we are reporting out a value of 31,000 mm cubed as the volume of this object?
Does it make sense to be using small portions of the tabletop to calculate the volume of the object?



To exclude the tabletop from affecting the volume calculation:
On the SETTINGS tab:
Set the Minimum Height Threshold to 0.2
The height threshold is measured in mm
Making this change will raise the BasePlane by the Minimum Height Threshold
In the Result tab, the final volume measurement for a good part should be right around 31,139.9 mm cubed.

This feature is used to remove possible debris or surface imperfections of the table/conveyor belt.



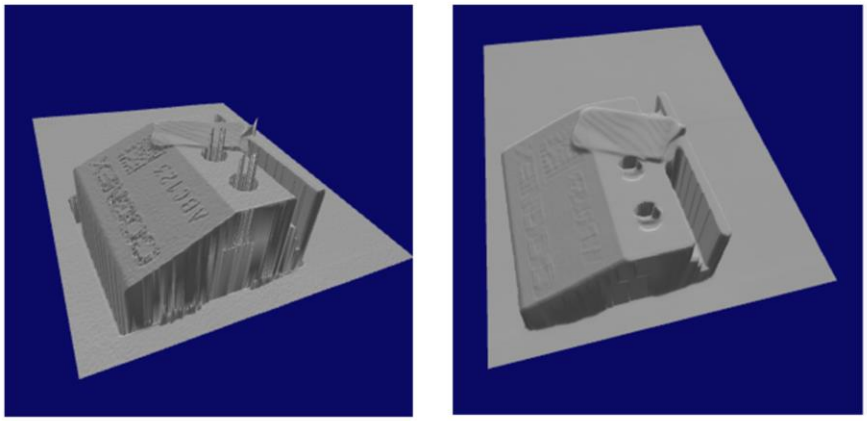
When adding the Result.Volume and Result.Plane as output terminals,
It is best to rename the terminals as opposed to leaving the very long names the tool uses by default.

1) Drag output terminals Result.Plane and Result.Volume to the [Outputs] collection
2) Right-click and rename the outputs to Volume and BasePlane respectively
3) Verify you now have additional outputs visible at the sequence level
    a) Assign only the Volume to a new tag called “MyResults.Volume”

We need the BasePlane exposed, but not as a new tag.

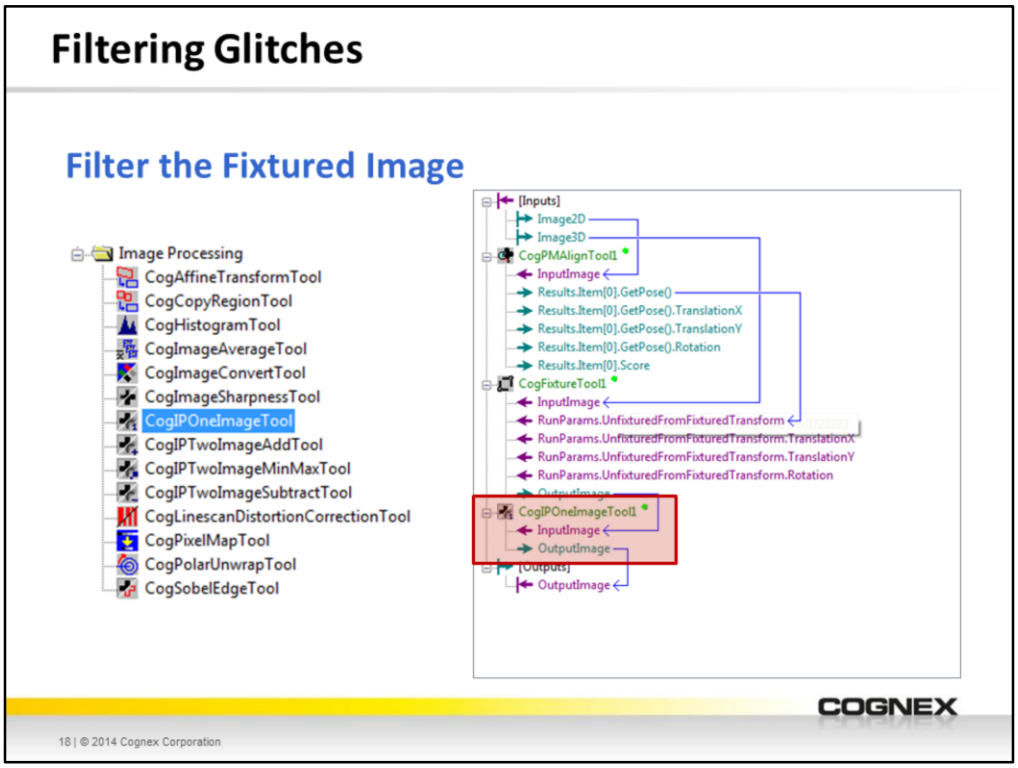
FAQs

Q: What about the peaks on a part?

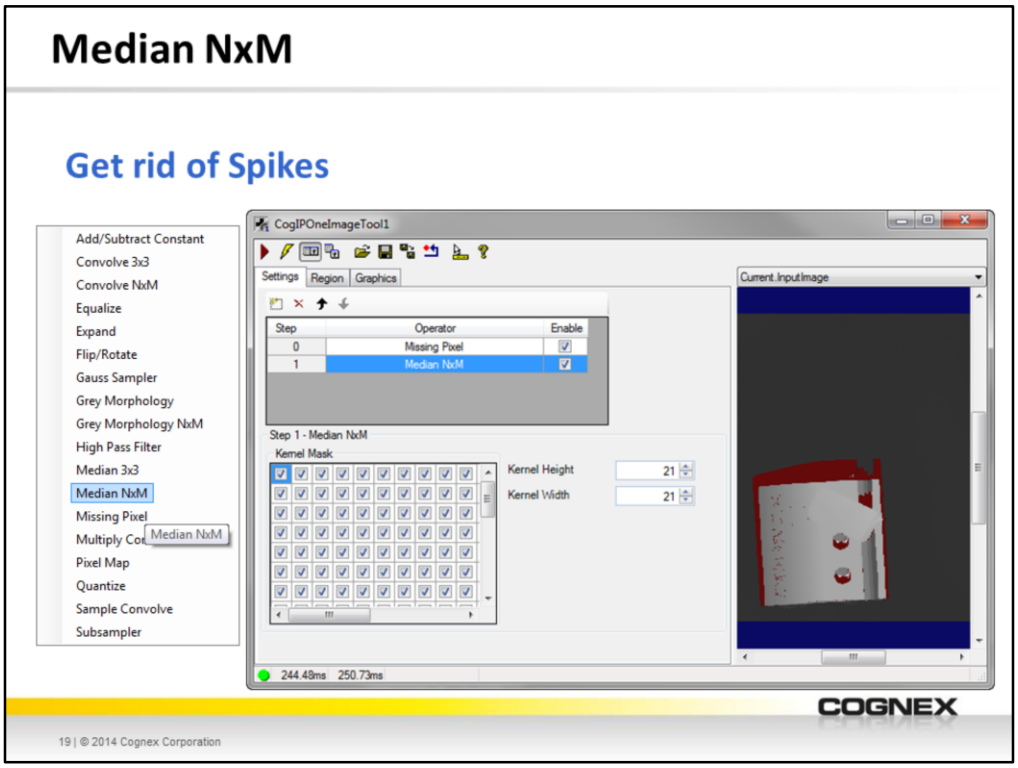


COGNEX

Unlike in a 2D image, all values are “ground truth” measurements.
The glitches show incorrect data, but these matter little and are easily ‘cleaned up’.



The CogIPOneImageTool is a Swiss army knife of image processing tools.
This tool, by itself, deserves its own class.
We are going to take a cursory look at CogIPOneImageTool to see how to manage some of the spikes that we are seeing.

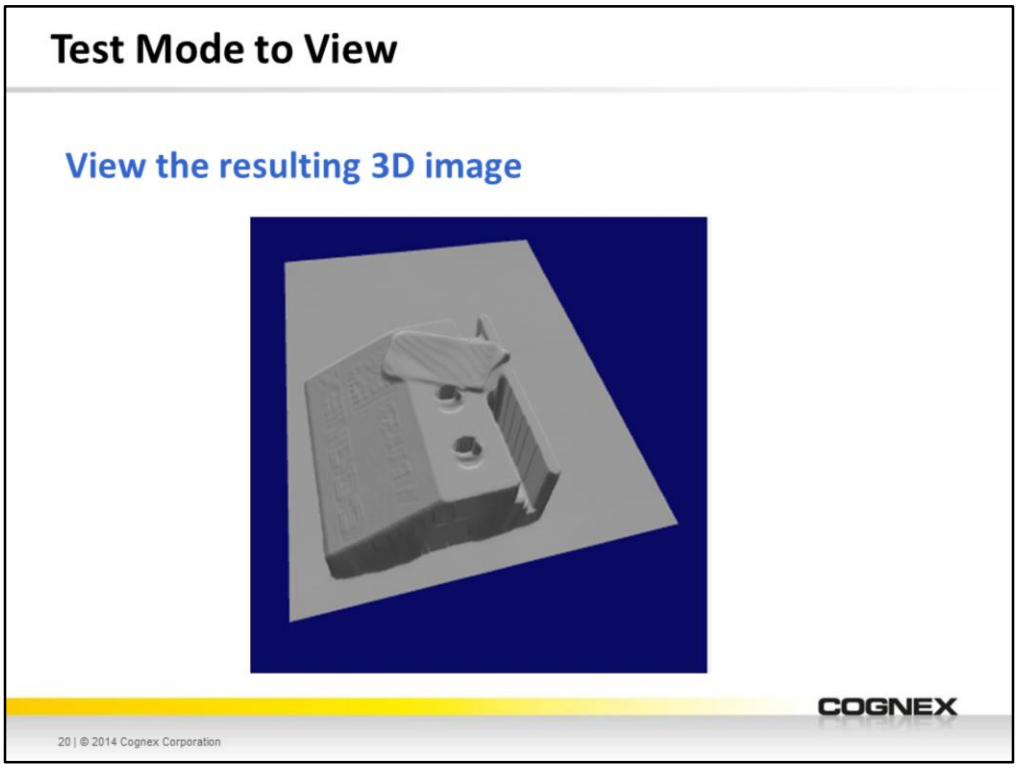


From the HelpFile:

> Reduce the effect of image noise in the input image by examining the matrix of pixels around each original pixel using a kernel of custom size. Larger kernels have a greater effect at reducing image noise but can reduce the quality of fine features in the image.

The Kernel Height / Width must be set to higher values to normalize larger spikes.

Spikes and aberrations can be minimized through better lighting / environment control.



Note the spikes are gone.
The Missing Pixel tool combined with the Median tool has made the holes look much different.

Metallic or very reflective parts are more likely to cause larger spikes.
All 3D laser based imaging systems are susceptible to these spikes.
Some systems claim they do not experience these spikes
but the truth is that those systems pre-filter the image before displaying a more normalized part to the user.

Summary

VolumeCalculator and PlaneEstimator Tool

- Implemented a VolumeCalculator and PlaneEstimator tool
- Passed output results from one tool block to another
- Minimized image spikes

COGNEX