HADI - IBOARDPRO DOCUMENT

VERSION	AUTHOR	DATE
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3D INDUSTRIAL IMAGING

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1 Introduction

1.1 Introduction

HADI - iBoard Pro is a Template-based inspection 11 software.

User can deploy HADI - Inspection Pro as an Inline PCB Inspection 115 and Inline Void Inspection 115 software.

It supports following inspection features:

	Inspection Functions	Support
1	Template Management	YES
2	Automated BGA Detection	YES
3	Automated Void Inspection	YES
4	Inline Void Inspection	YES
5	Inline PCB Inspection	YES
6	Batch Processing Simulation	YES

Check more detail products comparison 6.

1.2 Baisic Features

- Support various image formats loading and saving.(gif, bmp, jpg, tif, tiff, png, etc.)
- Support image/scene 50 loading and saving.
- Support 16bit image I/O and Window/Level adjust 23.
- Support image calibration.
- Support image histogram and profile.
- Support multiple languages. (English, Korean, Japanese, Chinese)
- Support up to 21 measurement tools.
- Support up to 14 images filters 24.
- Support command line invoke with various parameters.
- Advanced template management. 76
- Full featured reporting and printing functions.
- Support windows explorer integration.

1.3 HADI Products Comparison

Functions	HADI - Inspection	HADI - BGA	HADI - Inspection Pro	HADI - iBoard	HADI - iBoard Pro
Image Import / Export	√	√	√	√	√
Scene Import / Export	√	√	√	√	√
Print Images	√	√	√	√	√
Image / Screen Capture	√	√	√	√	√
Multiple Language Support	√	√	√	√	√
Measurement Tools (21)	√	√	√	√	√
Image Filters (14)	√	√	√	√	√
Image Calibration	√	√	√	√	√
Histogram and Profile	√	√	√	√	√
Multiple Image Display	√	√	√	√	√
16 bit image support	√	√	√	√	√
Image Conversion	√	√	√	√	√
Image Alignment	√	√	√	√	√
Command Line Support	√	√	√	√	√
Void Inspection	√	√	√		√
BGA Detection		√	√	√	√
Batch Processing Simulation			√	√	√
UDP Communication Support			√	√	√
PCB Inspection				√	√

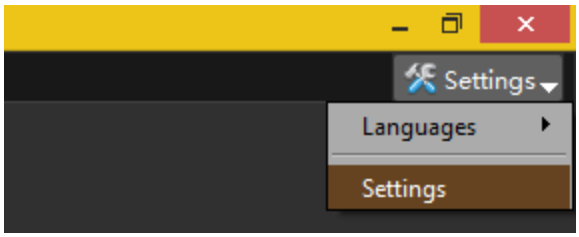
1.4 System Requirements

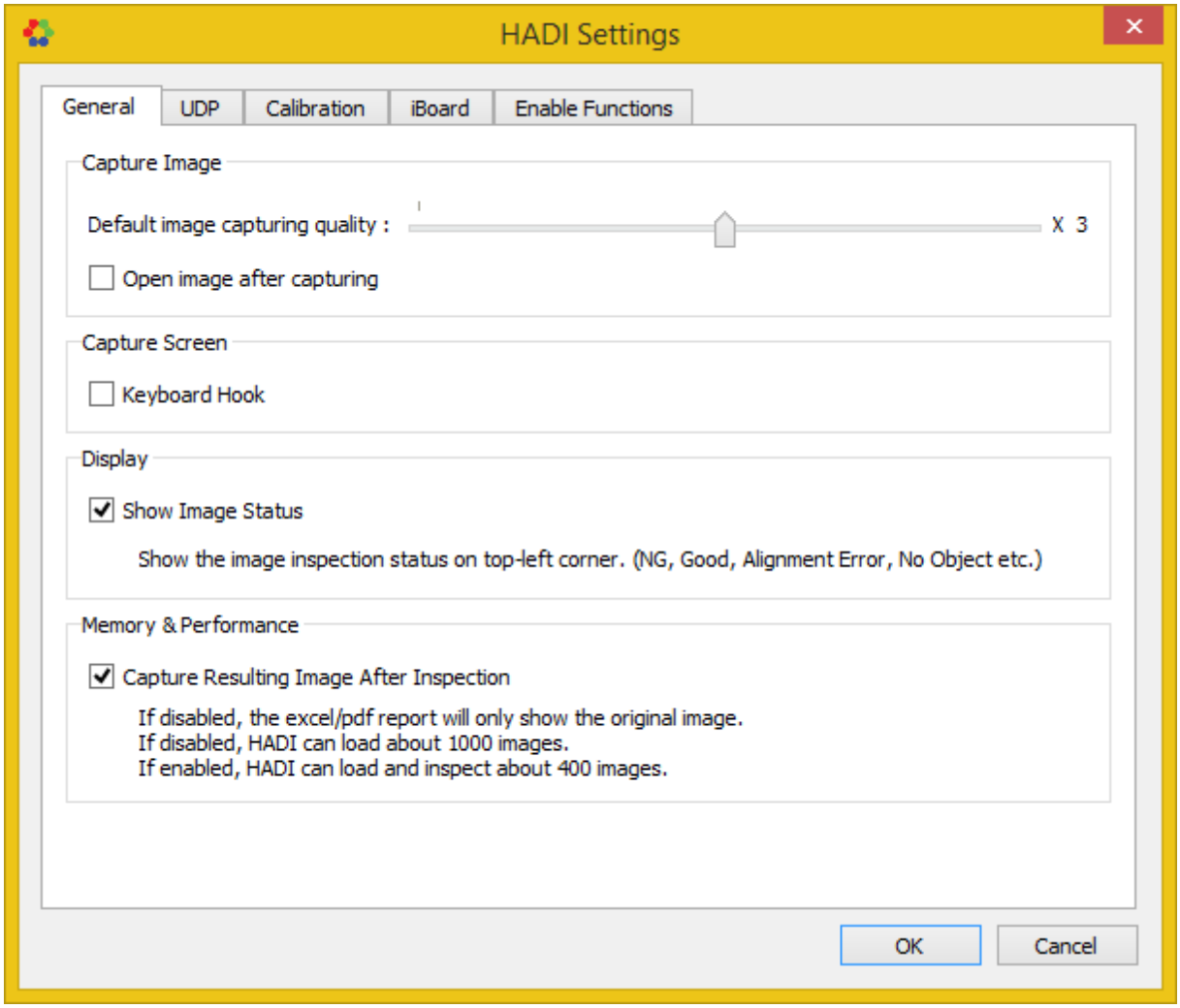
	Minimum	Recommended	Inline Inspection
OS	Windows 7	Windows 7	Windows 7 64bit
HDD	20GB	200GB	500GB or Higher
SSD	None	128G	128GB or Higher
CPU	Intel i5	Intel i7	Intel i7 3.40 GHz or Higher
RAM	2G	4G	8G
GPU	None	Individual Graphic Cards	Individual Graphic Cards
Display Resolution	1920 x 1080	1920 x 1080	1920 x 1080
Additional Apps	None	Microsoft Office PDF Reader	Microsoft Office PDF Reader
Network	Required	Required	Required

2 HADI Settings

2.1 Global Settings - General

Click on top right menu "Settings" -> "Settings" -> "General".





Capture Image

Default image capturing quality

Set the image capturing quality. "X3" means the captured image resolution is 3 x 3 = 9 times of original resolution.

Higher quality image capturing takes more time.

Open Image After Capturing

Open the image after capturing.

Show Image Status

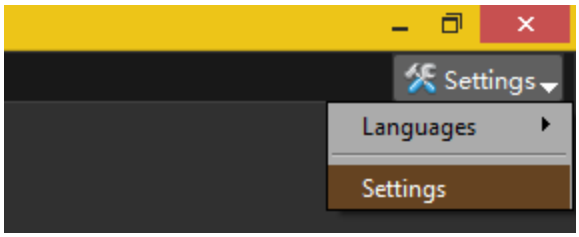
Show/Hide the Image status appeared in Top Left corner of main view.

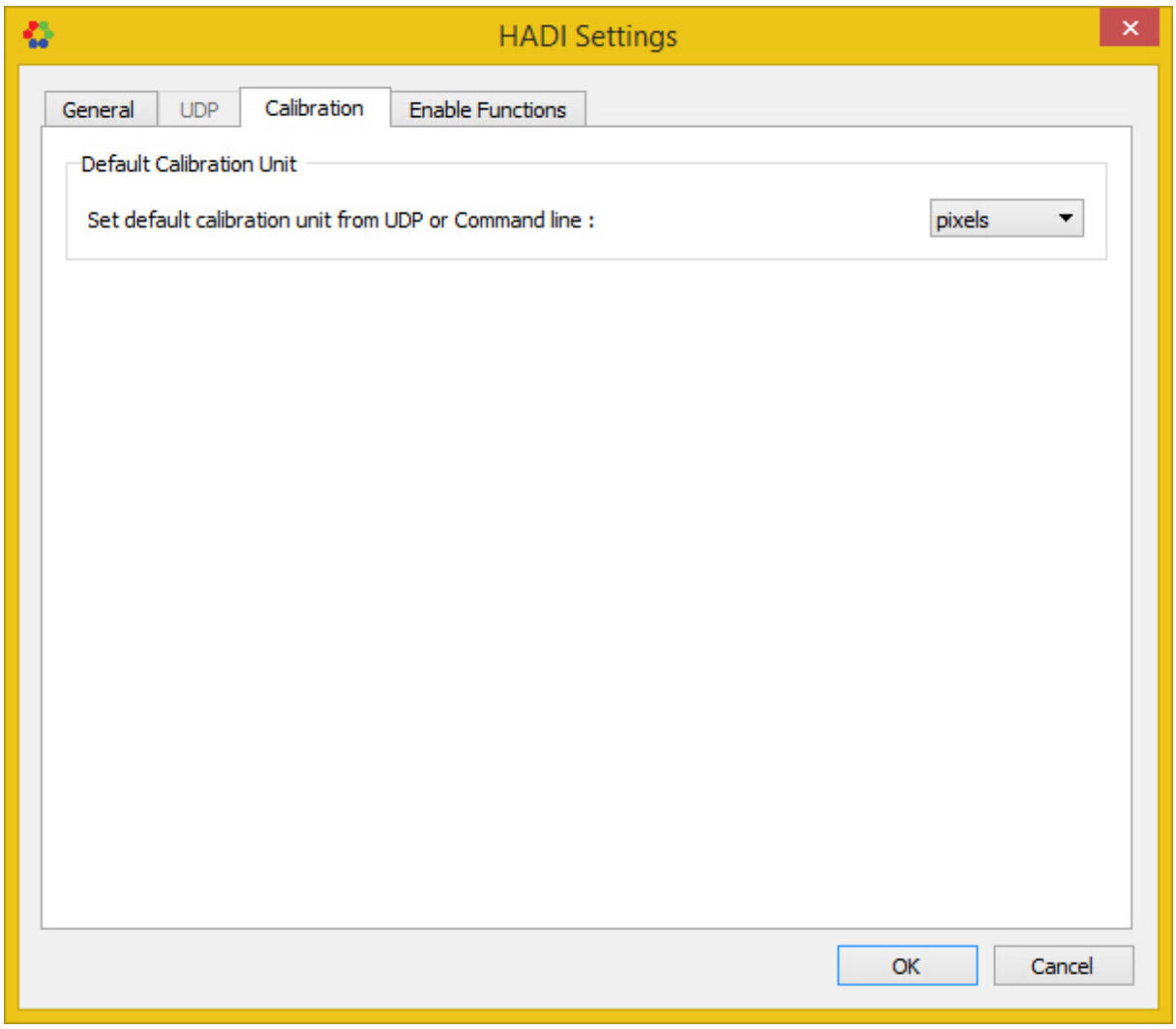
Capture Resulting Image After Inspection

Set that whether to capture the resulting image or not.
See the discussion in "Improve Performance 56".

2.2 Global Settings - Calibration

Click on top right menu "Settings" -> "Settings" -> "Calibration".





Default Calibration Unit

In UDP mode, if user sends the calibration command, the default unit is millimeter. This option will convert the displaying calibration info to target unit.

For example

User send "image_name; 1.5" to HADI by calibration command.

1.5 means: 1 pixel = 1.5 millimeter.

When the default calibration unit set to centimeter, the displaying calibration info will be set to 1 pixel = 0.15 centimeter.

2.3 Template-based Inspection

All HADI products support Template-based inspection.

Template Saves

The purpose that using Template is to

- Save all parameters in Image or in Measurement Tools.
- Save the image alignment information.
- Apply all saved parameters and Measurement Tools to a new image (to do inspection).

Template Auto Saving

In a Template, every editing will be automatically saved, including,

- Measurement Tool moves, changes.
- Window/Level changes for 16bit image.
- Void Inspection parameter changes.
- BGA Detection parameter changes.
- PCB Inspection parameter changes.

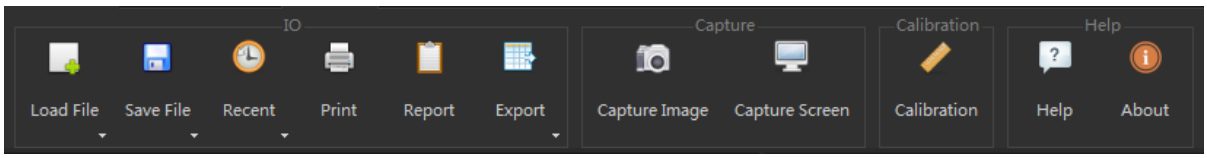
See also:

- How to create a Template? 57
- Teach a Template 58

3 Toolbars

3.1 Toolbar - FILE

Click on Toolbar "FILE", the following toolbar will be shown



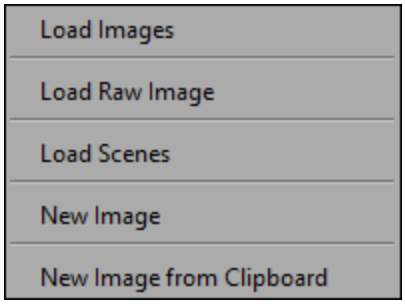
IO

Load File

Users can load image files into HADI using various approaches.

HADI can remember last used directory, and the last used directory for Images and Scenes are memorized separately.

See "How to load image into HADI".



- **Load Images**

  load general images from disk.

- **Load Raw Image:**

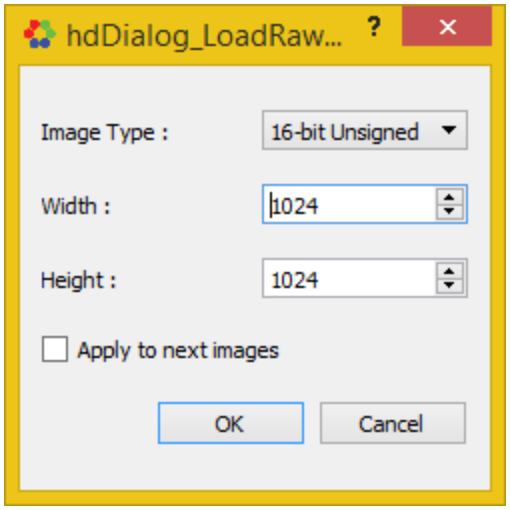
  HADI supports RAW Images.

  Image Type: specify image types.

Width: specify image width.

Height: specify image height.

Apply to next images: all above parameters will be applied to next images when loading multiple raw images.

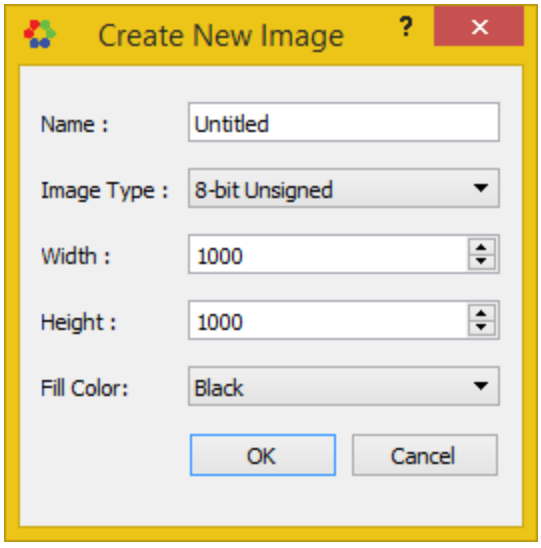


- **Load Scenes:**

  All the working scene 50 can be saved as XML file, and user can load multiple scenes into HADI.

- **New Image**

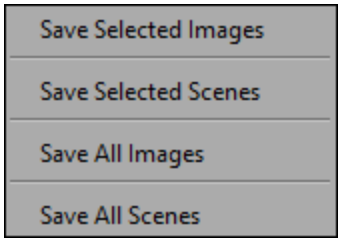
  Create a new image by specified parameters.



- **New Image from Clipboard**
  Create a new image from Clipboard.

Save File

User can save images and scenes to disk.



- **Save Selected Images**
  Save selected images in dock panel "Images 79" as images to disk.

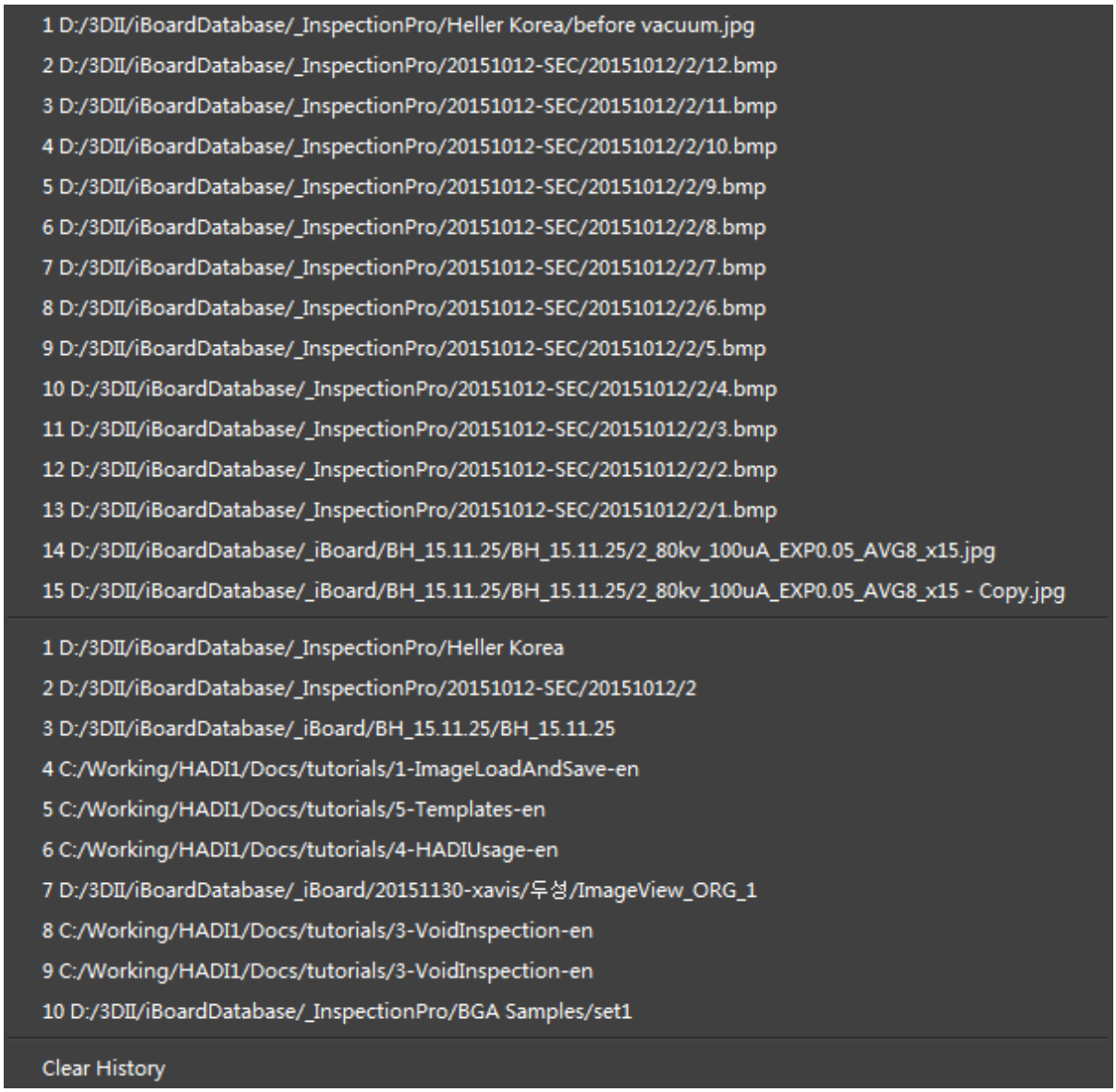
- **Save Selected Scenes**
  Save selected images in dock panel "Images 79" as working scenes 50 to disk.

- **Save All Images**
  Save all images in dock panel "Images 79" as images to disk.

- **Save All Scenes**
  Save selected images in dock panel "Images 79" as working scenes 50 to disk.

Recent

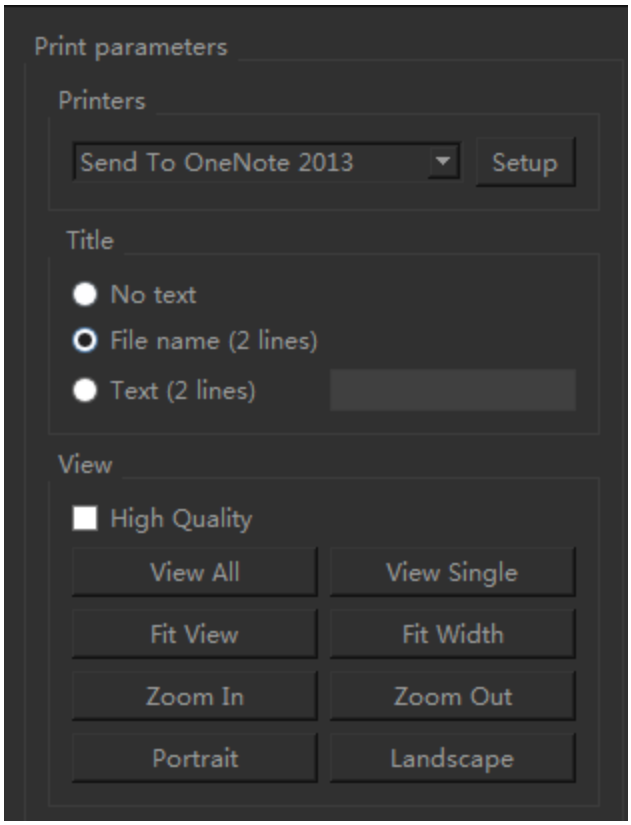
Shows the recently used images and directories.



Print

Print selected images.

User can set title for each image, or print with high quality.



Report

Generate general report for selected images.

Now, most modules have their specific file format, please find out the related Toolbar to get more information.

If user needs customized report format, please contact with 3DII (xin.chen@3dii.kr)

Capture

Capture Image

User can capture the current displaying image by

- Clicking "Capture Image" in Capture panel,
- Clicking the camera icon on the top left corner of any view 51.

User can also capture high quality images.
Go to “Settings” -> "General" -> “Capture Image” 8, to adjust default image quality.

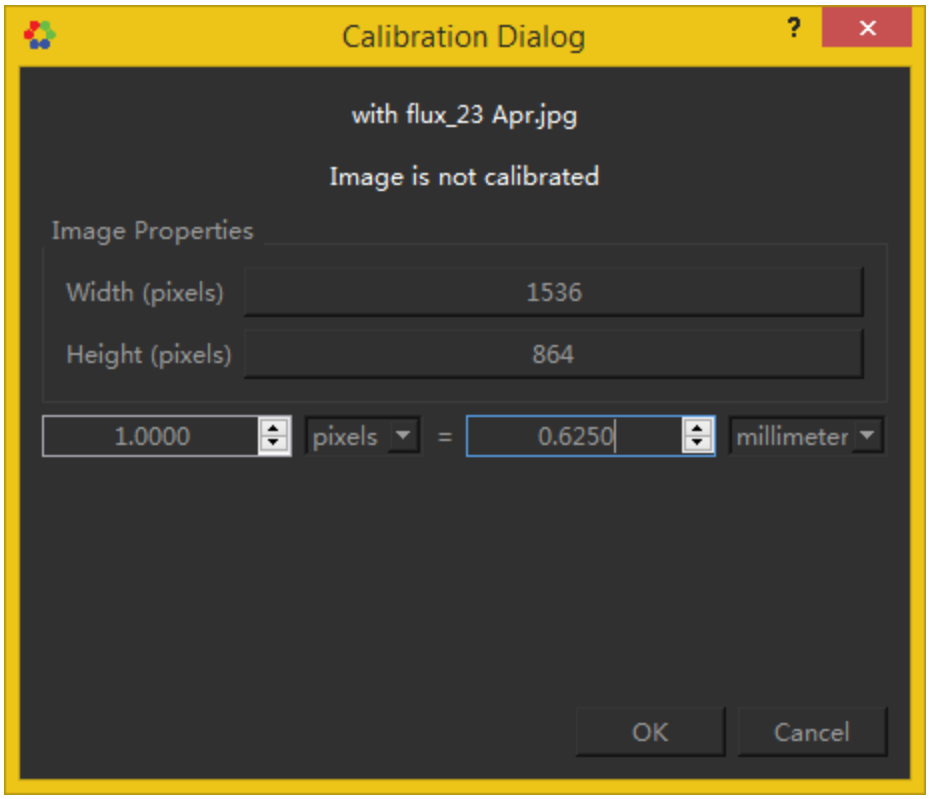
Capture Screen

User can capture the whole desktop by clicking "Capture Screen" or using "Ctrl + 1".

Go to "Settings" -> "General" -> "Capture Screen" 8 to see more options.

Calibration

For current displaying image, make a connection between Pixel Size and Real World Size.
See "Image Calibration 64".



Help

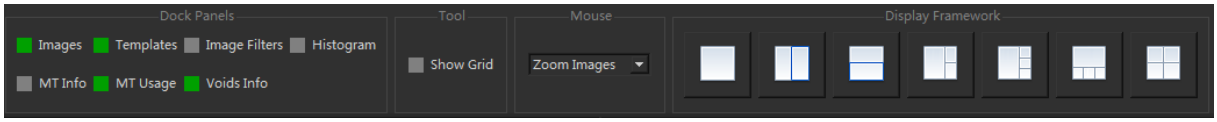
Show this document.

About

Show about information.

3.2 Toolbar - VIEW

Click on Toolbar "VIEW", the following toolbar will be shown



Dock Panels

Images

Show/hide Images dock panel 79.

Templates

Show/hide Templates dock panel 76.

Image Filters

Show/hide Image Filters dock panel.

Histogram

Show/hide Histogram dock panel 87.

MT Info

Show/hide MT Info dock panel 82.

MT Usage

Show/hide MT Usage dock panel 85.

Voids Info

Show/hide Void Info dock panel 89.

Tool

Show Grid

Show guiding grid in image.

Mouse

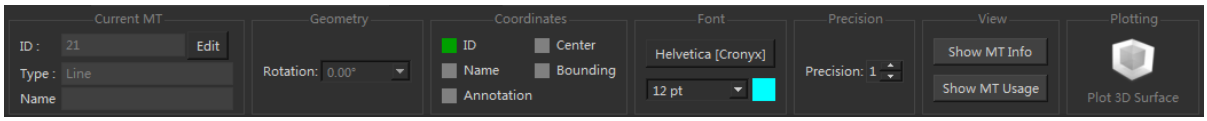
Choose left mouse behavior to "Zoom Images" or "Switch Images".

Display Framework

Set the display framework of main workspace.

3.3 Toolbar - MEASURE

Click on Toolbar "MEASURE", the following toolbar will be shown



Note: All the parameters are acting on selected Measurement Tools

Current MT

ID

Shows the ID of the selected Measurement Tool.

Edit

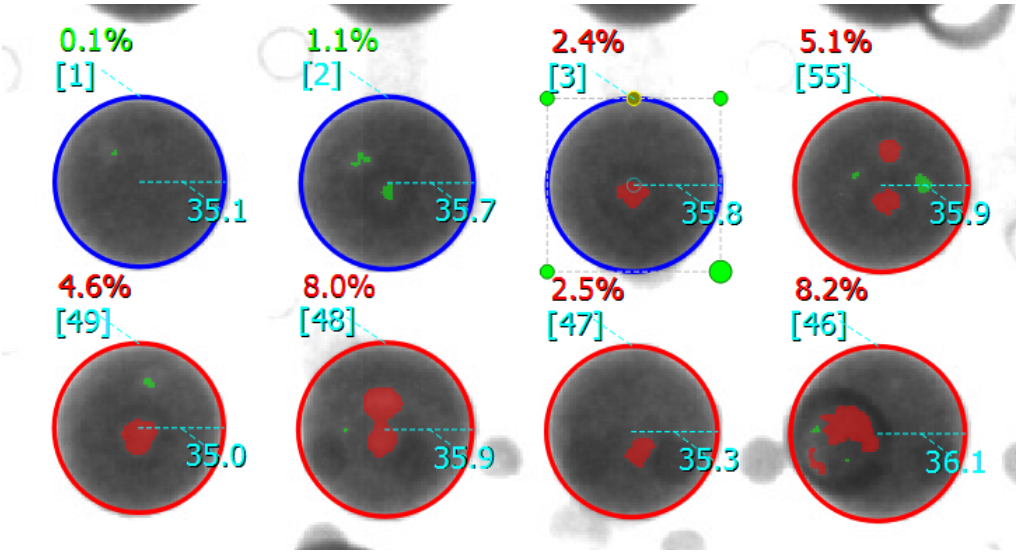
User can change the ID of Measurement Tools.

1. Select Measurement Tools in active view 51.

2. Click "Edit", the MT color will change to red color.

3. Click each MT in order, the ID will be reassign from 1, new ID assigned MT will become blue color as shown in following pictures.

4. If all MTs have been clicked, the editing will be finished automatically. Or user can click "Edit" again to finish editing.



Type

Shows the Type of the selected Measurement Tool, such as Line, Rectangle, Circle, Polygon and so on.

Name

Shows the Name of the selected Measurement Tool(s).

There's no Name by default, user can input name and press "Enter" to let MT remember it.

Geometry

Rotation

Set the rotation angle of the selected Measurement Tool(s).

User can operate multiple Measurement Tools at a time.

Rotation angle starts from -180°(Counterclockwise Rotation) to 180°(Clockwise Rotation).

Coordinates

Shows the coordinate information and label information of the selected Measurement Tool(s).

ID

Shows the ID of the selected Measurement Tool.

Name

Shows the Name that edited by user in Current MT of the selected Measurement Tool.

Annotation

Shows default annotation of the selected Measurement Tool.

Center

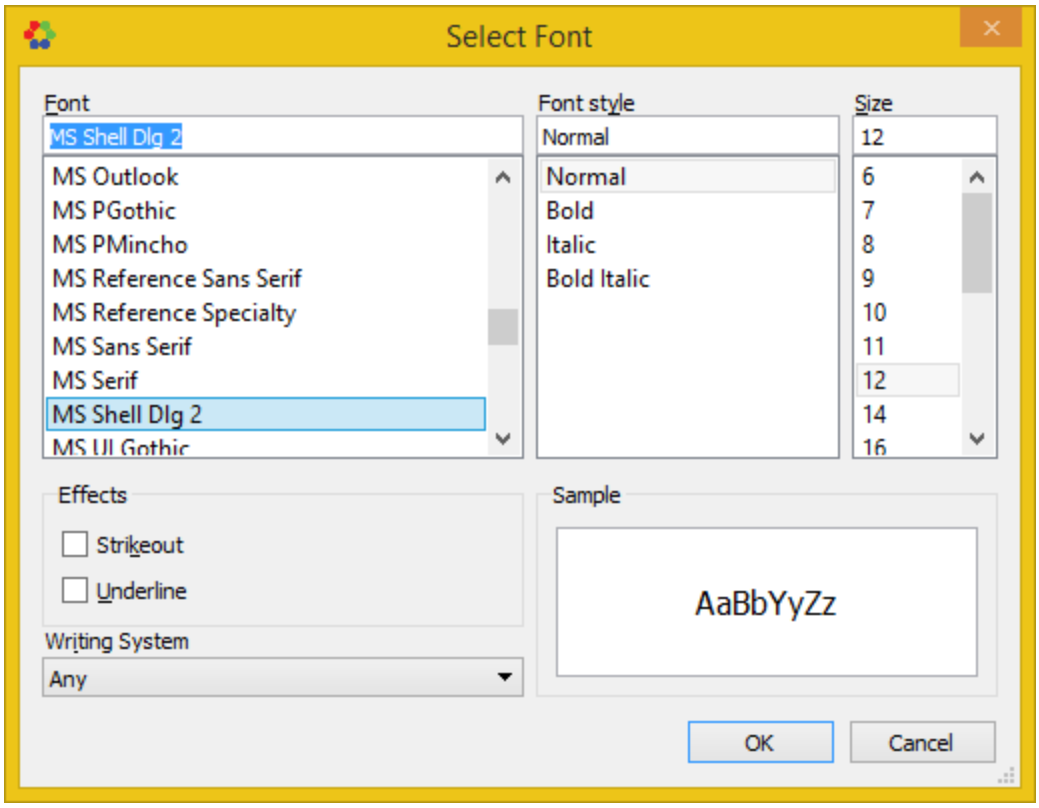
Shows the center coordinates of the selected Measurement Tool.

Bounding

Shows the vertex coordinates of the selected Measurement Tool.

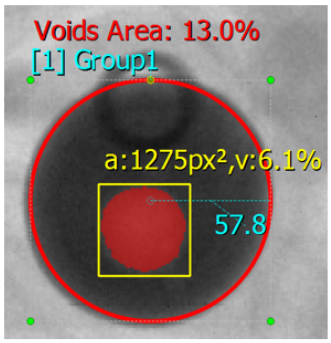
Font

User can change the font and font size of the selected MTs.

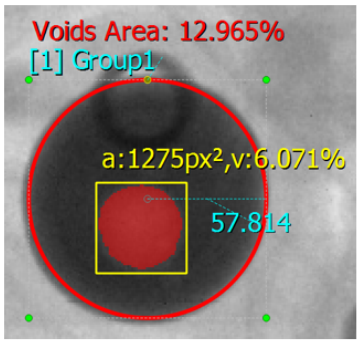


Precision

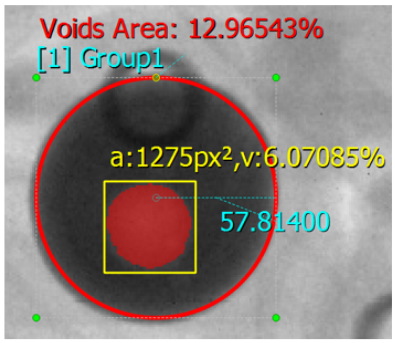
User can change the precision of the selected MTs.



Precision = 1



Precision = 3



Precision = 5

View

Show MT Info

Show Measurement Tool Info dock panel 82.

Show MT Usage

Show Measurement Tool Usage dock panel 85.

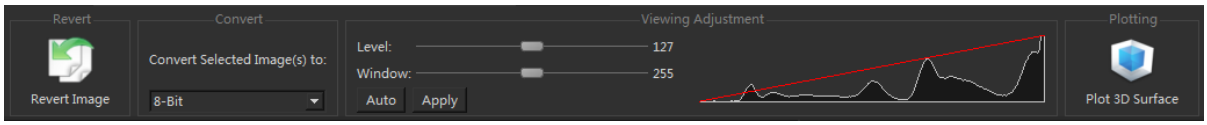
Plotting

Plot 3D Surface

Plot 3D surface of selected closed-shape 95 Measurement Tools 94

3.4 Toolbar - IMAGE

Click on Toolbar "IMAGE", the following toolbar will be shown



Revert

Revert Image

Reload the image from disk again, all changes will be abandoned.

Convert

User can convert the displaying image format among 8-Bit, RGB Color and 16-Bit.

Viewing Adjustment

Level

Adjust the viewing level of current image.

Window

Adjust the viewing window of current image.

Auto

Auto adjust the viewing of current image.

Apply

Apply current viewing effect to current image.

Histogram

Show the histogram of current image.

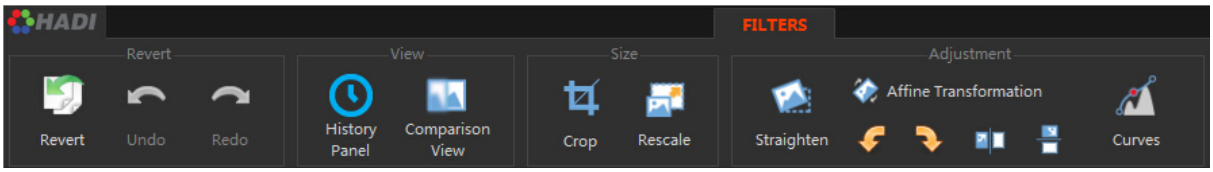
Plotting

Plot 3D Surface

Plot 3D Surface of current image.

3.5 Toolbar - FILTERS

Click on Toolbar "FILTERS", the following toolbar will be shown



Revert

Revert

Restore the current image as original image, and lost all undo/redo history at the same time.

Undo

Reverse the last operation user performed.

Redo

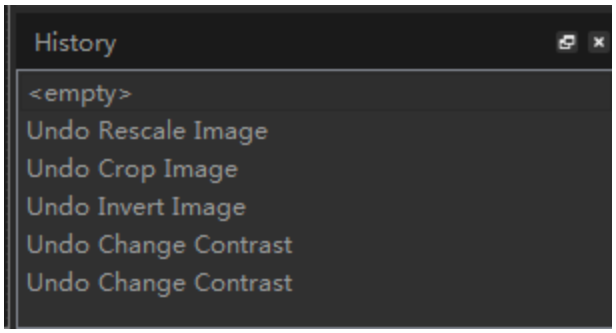
Perform the last undo operation again.

View

History Panel

Display the sequence of HADI states recorded during image filters, and its main purpose is to let user manage and access the history states recorded by HADI.

Click the desired history state to activate a previous state.



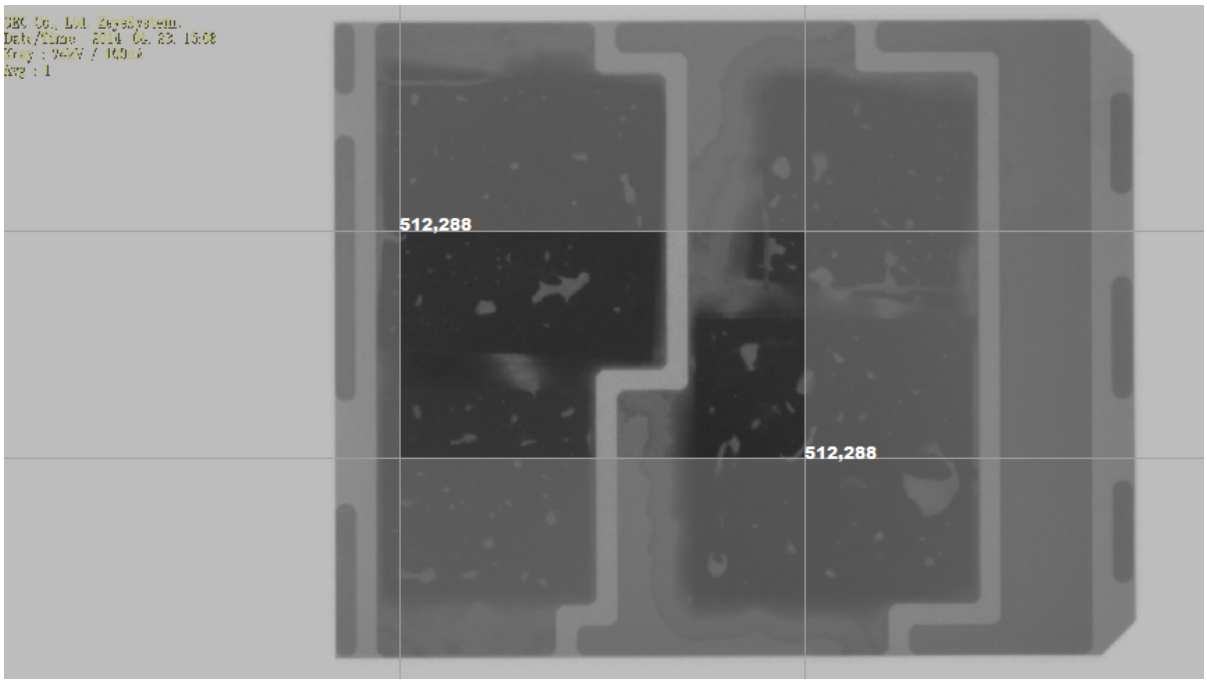
Comparison View

Compare the current image after processing with filters with the original image.

Size

Crop

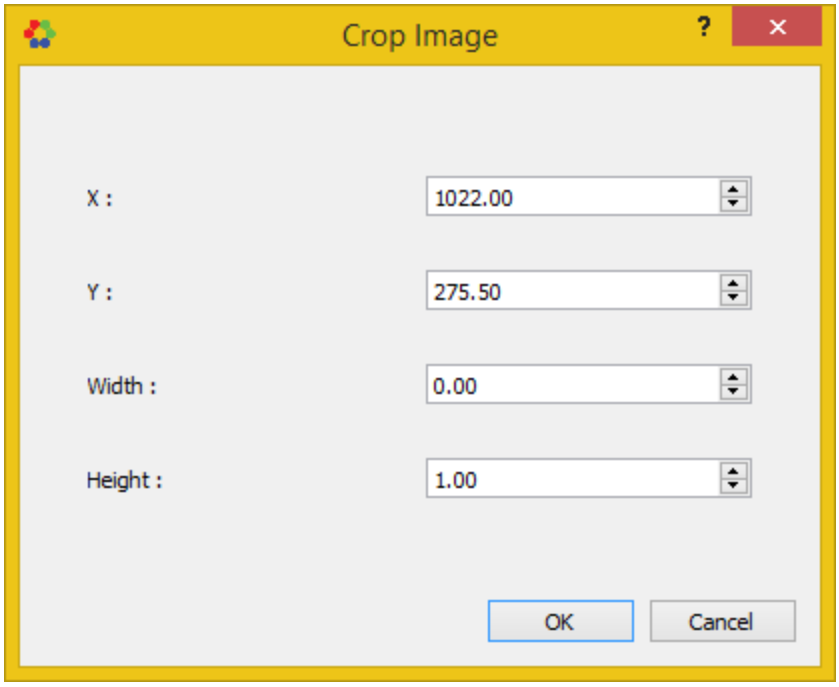
Click on Crop Button. The main view shows



The center area show the preview of cropped image.

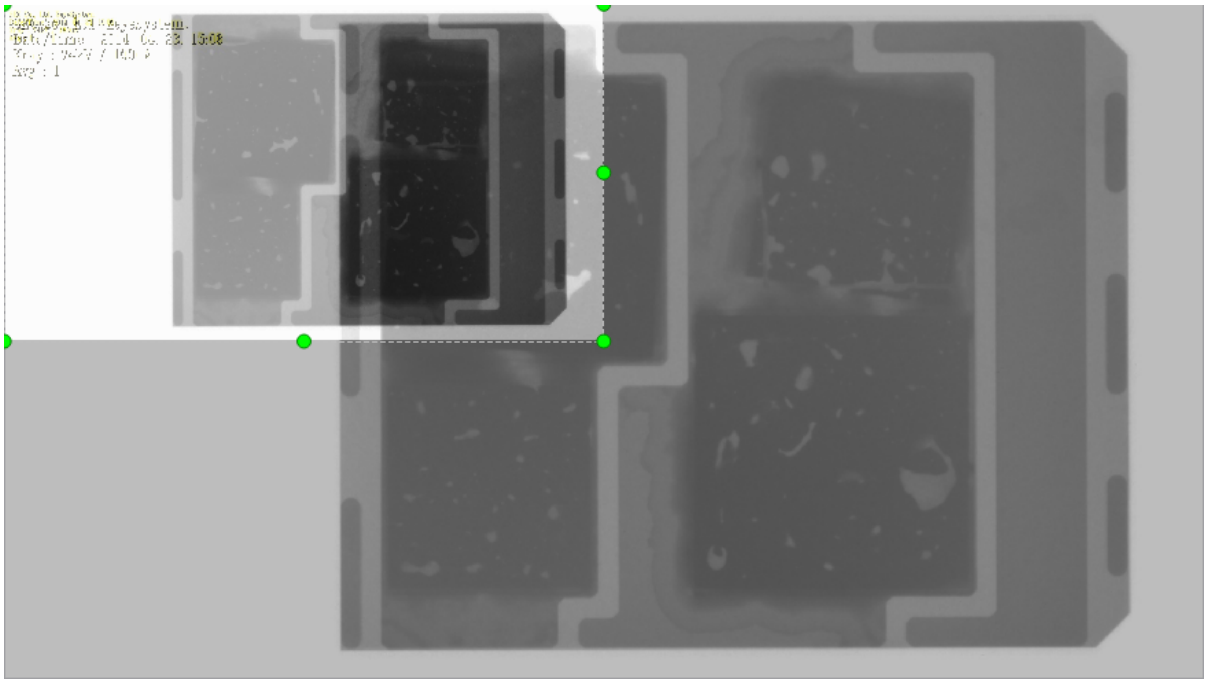
- User can set top-left position by clicking near to current top-left position.
- User can set bottom-right position by clicking near to current bottom-right position.
- User can also set the exact X,Y,Width,Height in the parameter panel as shown in below

figure.



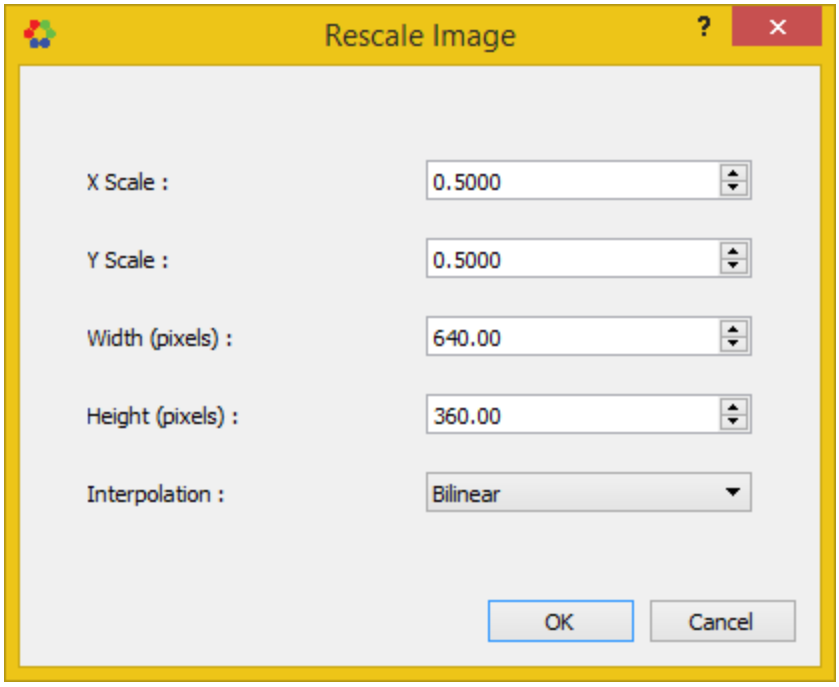
Rescale

Click on Rescale Button. The main view shows



The ROI area shows the preview of rescaled image.

- User can drag the eight hover points to see the result.
- User can set exact X Scale, Y Scale, Width, Height, Interpolation Algorithm in the parameter panel as shown in following picture.

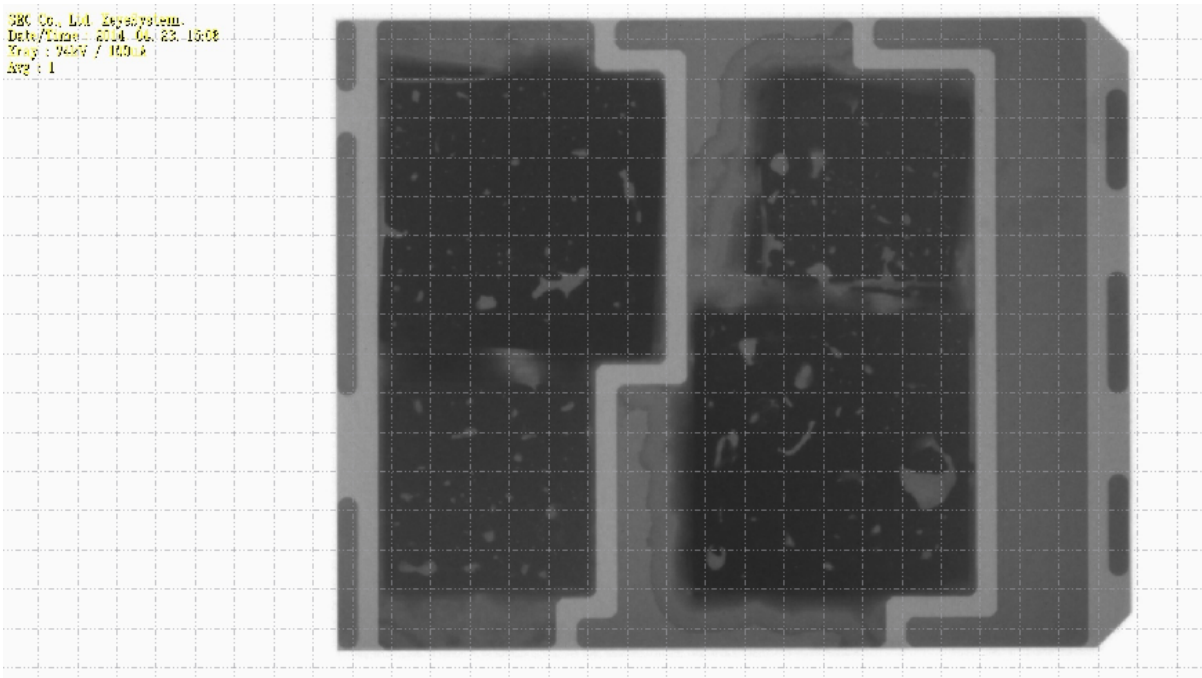


Adjustment

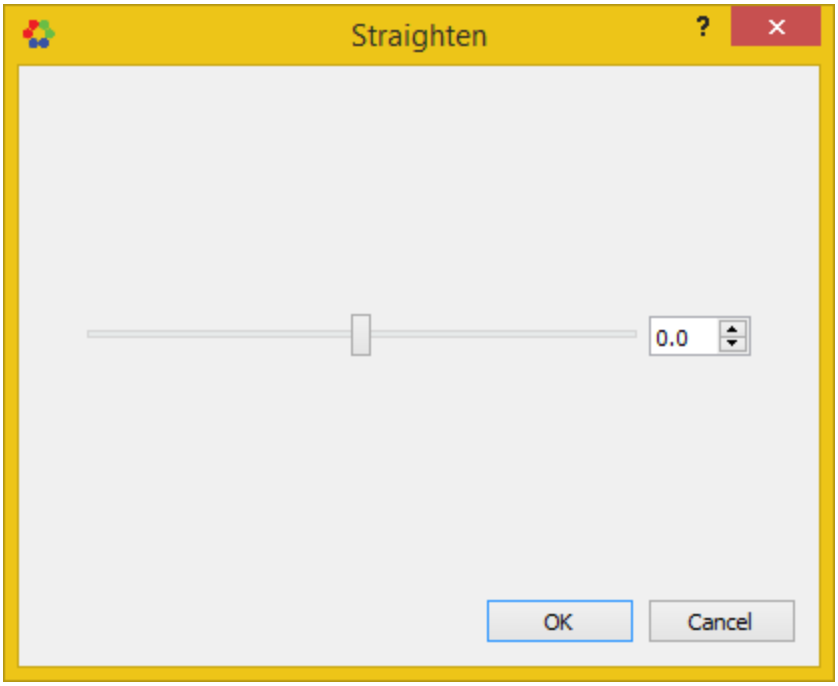
Straighten: slightly change rotation and scale

Click on Straighten Button. The main view show grid line to help straighten,

The difference between Rotation and Straighten is that Straighten will has slightly rescale to avoid black border.



- User can use Straighten parameter panel to tune the straighten weight.

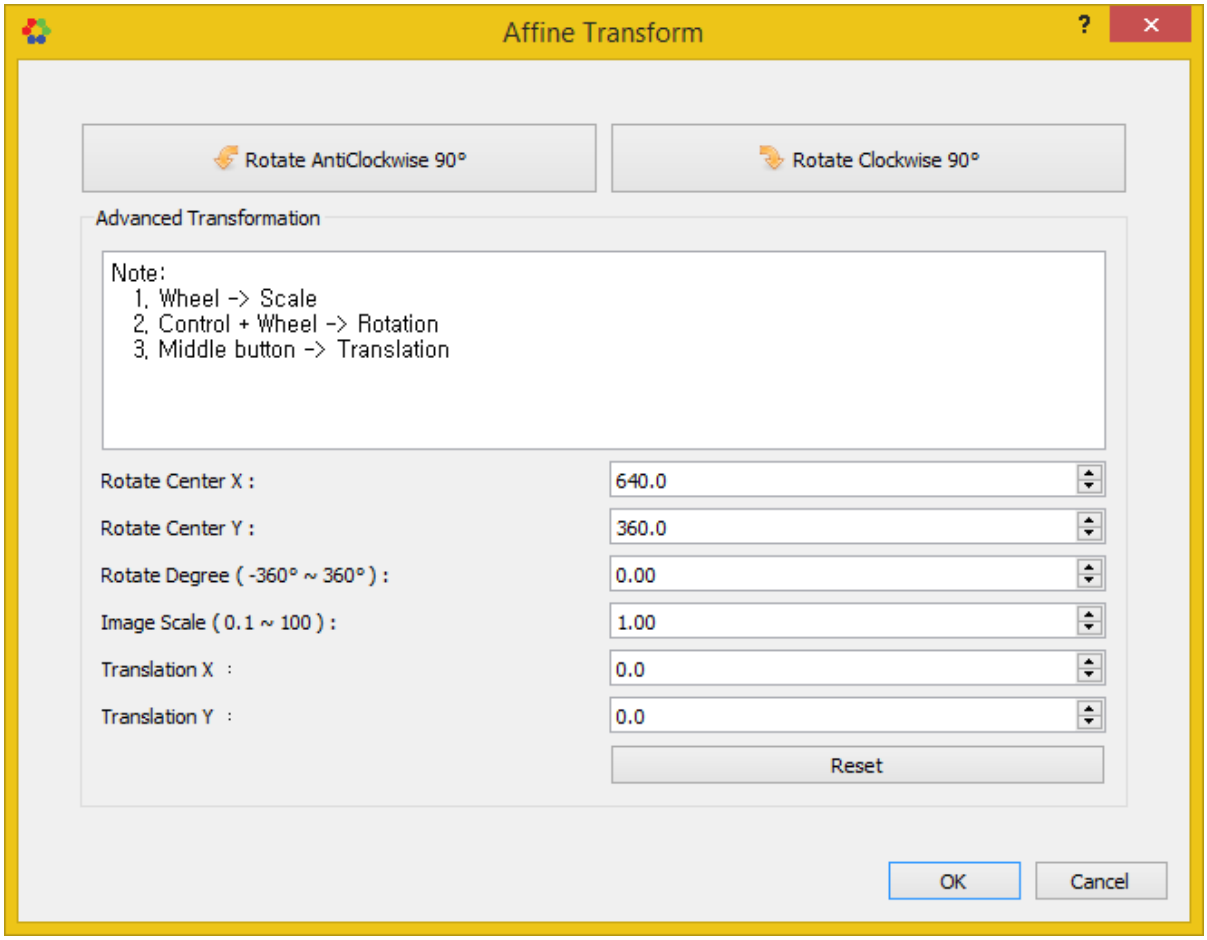


Affine Transformation

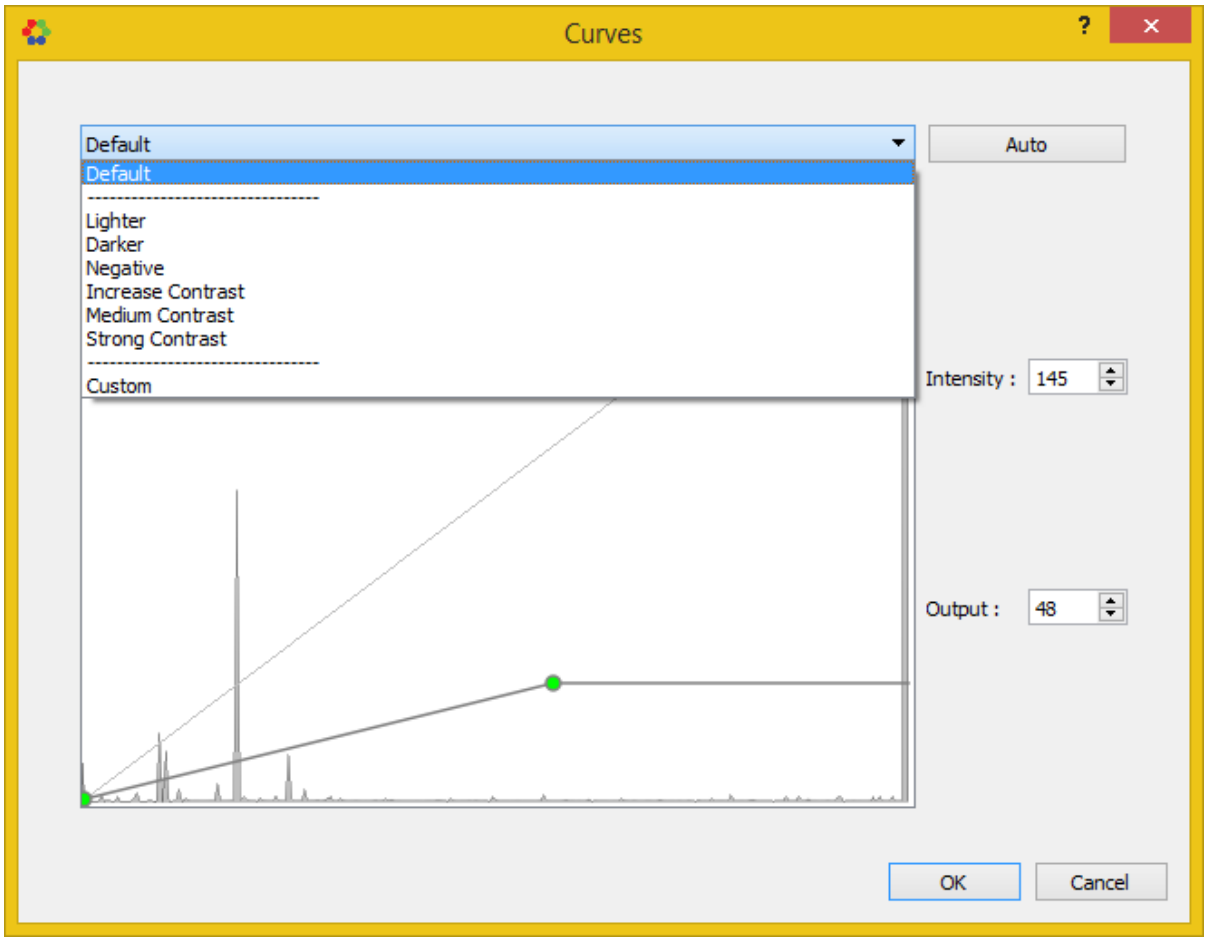
Click on Affine Transformation Button. The parameter panel is shown as following picture.

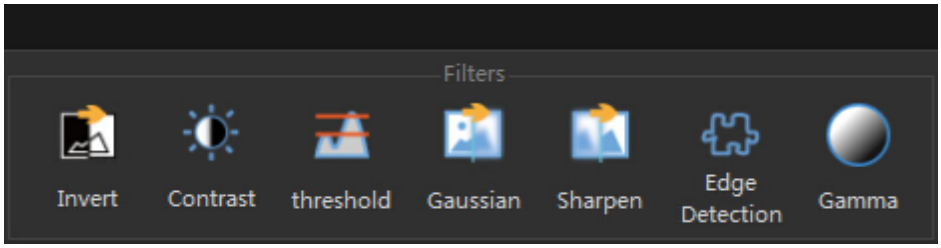
- User can rotate the image clockwise or anticlockwise by 90°.

- User can define the rotate center by adjusting Rotate Center X and Rotate Center Y.
- User can rotate the image for a defined degree by editing Rotate Degree.
- User can zoom in and zoom out the image by adjusting Image Scale.
- User can shift an image by a specified number of pixels in either the *x* or *y* direction, or both by adjusting Translation X and Translation Y.



Curves





Filters

Invert

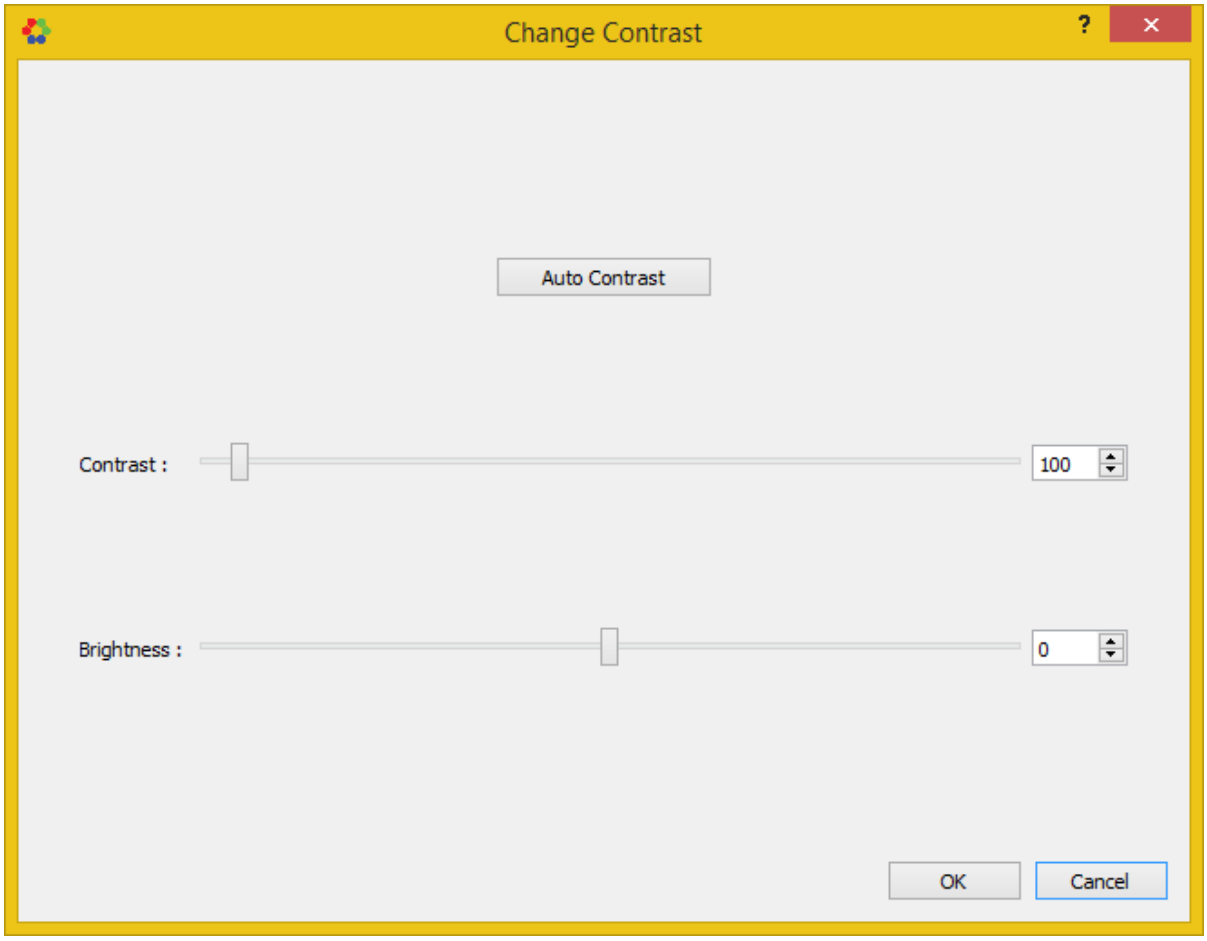
Invert the current image.

Contrast

Auto Contrast: Automatically adjust contrast and brightness of the current image.

Contrast: Adjust contrast and brightness of the current image.

Brightness:



Threshold

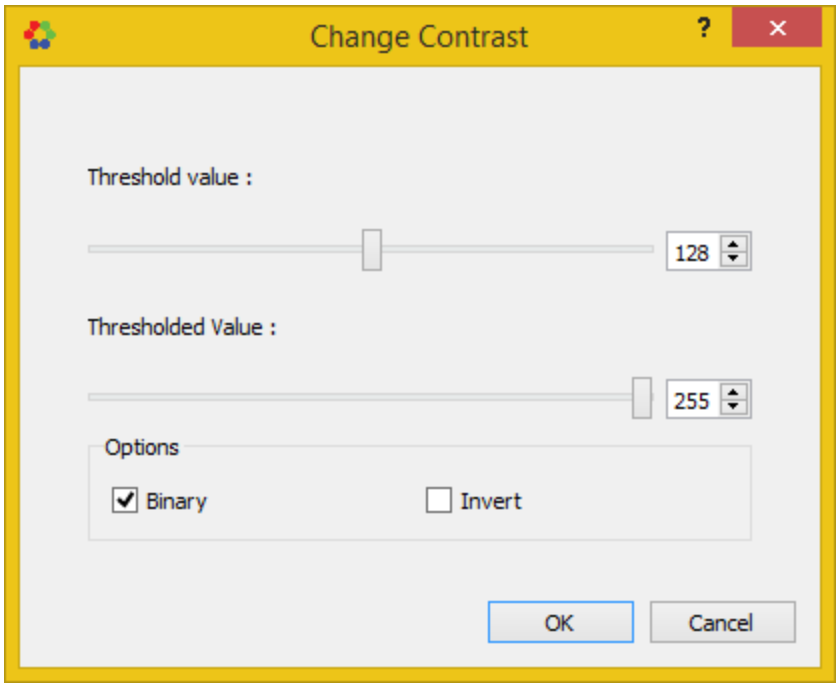
Do Thresholding on the current image.

"Threshold value" adjusts images by converting all colors and shades of grey to either black or white. use the adjustment to create stark, high-contrast images.

"Thresholded value" decides a value that if

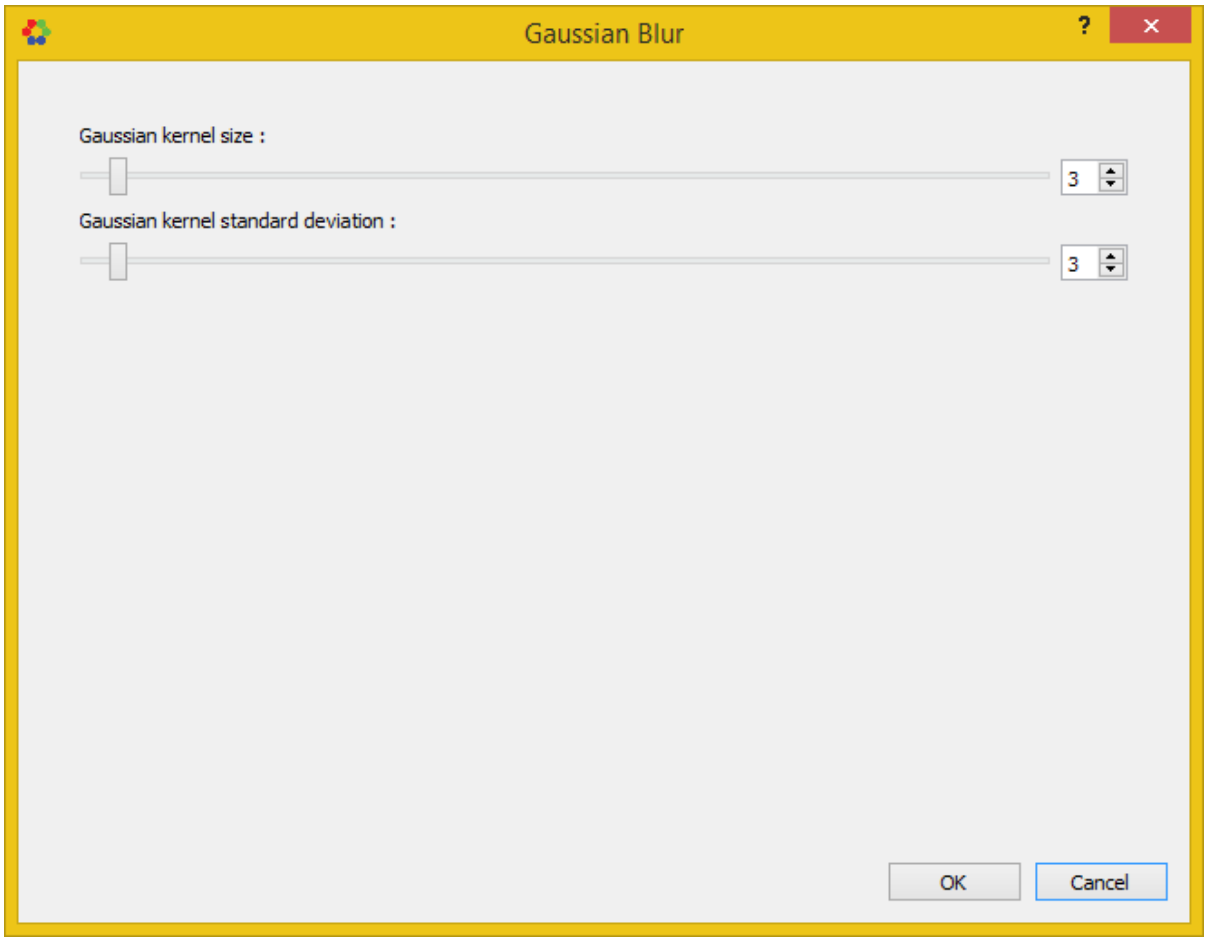
- "Threshold value" is smaller than it, the pixel value will be assigned to 0 (black).
- "Threshold value" is larger than it, the pixel value will be assigned to 255 (white).

Choosing "Binary" to make current image as binary image (black and white); "Invert" is used to invert the current image.



Gaussian

Blur the current image using a Gaussian filter.

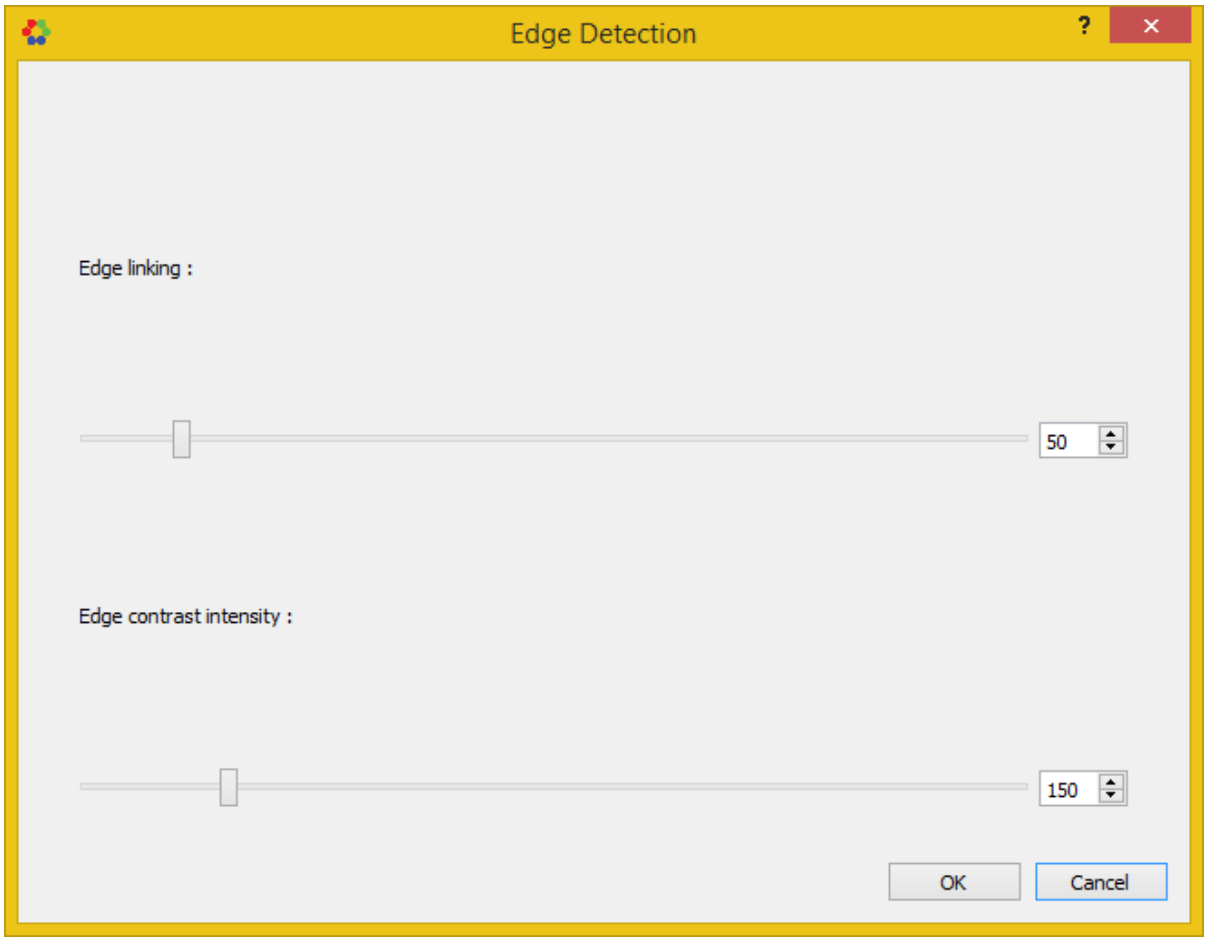


Sharpen

Sharpen the current image.

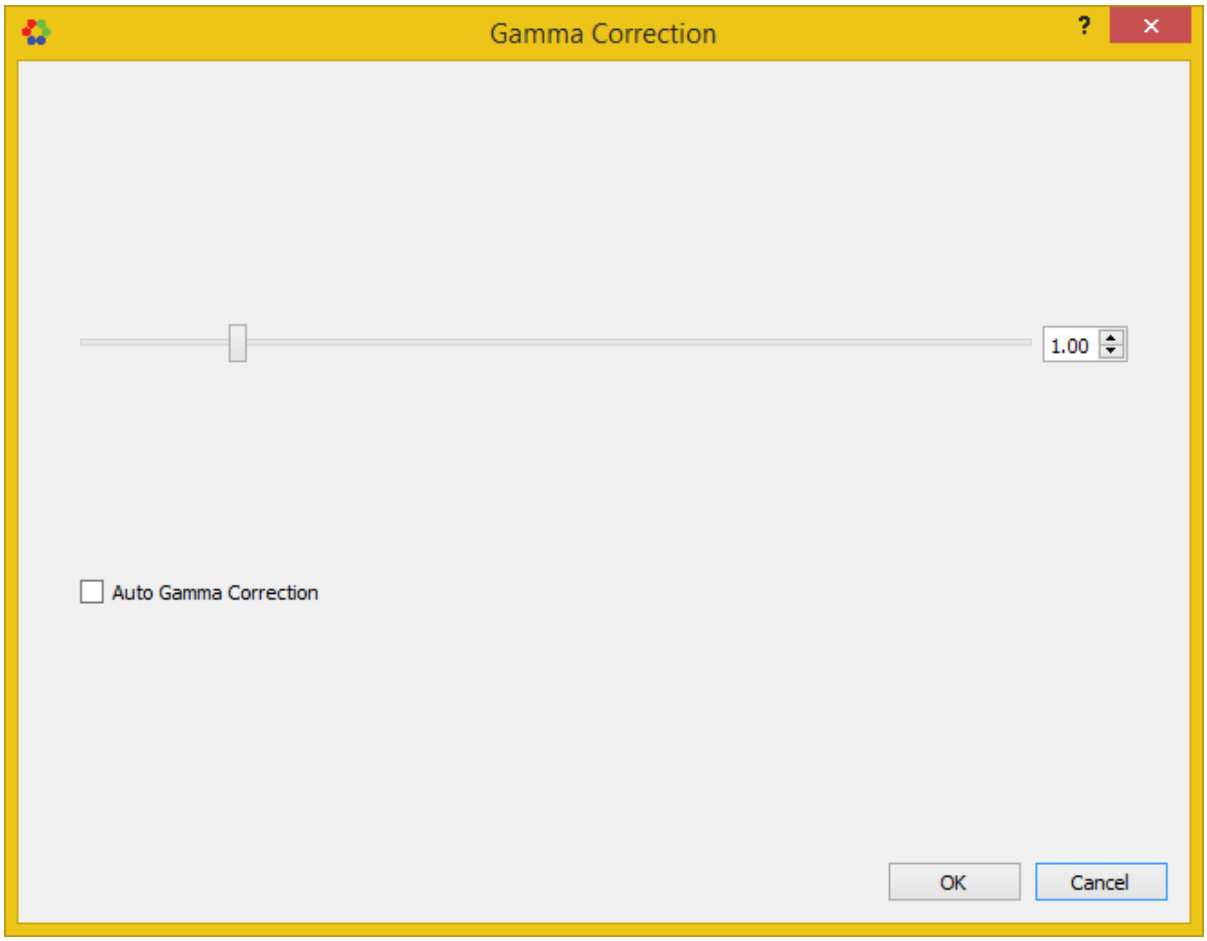
Edge Detection

Find edges in the current image using Canny edge detection algorithm.



Gamma

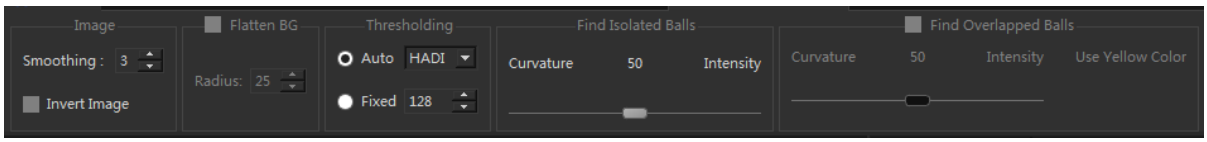
Gamma Correction enables user to adjust how an image is displayed on the monitor. Gamma correction only adjusts the dark tones.


Gamma Correction
1.00
Auto Gamma Correction
OK
Cancel

4 Inspection

4.1 BGA DETECTION

Click on Toolbar "BGA DETECTION", the following toolbar will be shown



BGA DETECTION Toolbar (1/2)

Image

Smoothing

Defines the Gaussian smoothing iterations. Default value is 3.

Invert Image

HADI default will try to find out Black Balls on White Background. In case user has white balls on black image, user needs to check this option.

Flatten BG

If the background is inhomogeneous, please check this option.

Radius

The radius is usually set as twice as the Ball diameter.

Thresholding

Auto

Default Option is “HADI”, Which is an adaptive Thresholding algorithm developed by HADI team. It can cover most cases.

User can also try to use “OSTU” adaptive Thresholding in some case.

Fixed

In the very noise image, auto(Adaptive Thresholding) may not work.

User can give a Fixed Thresholding value to do segmentation.

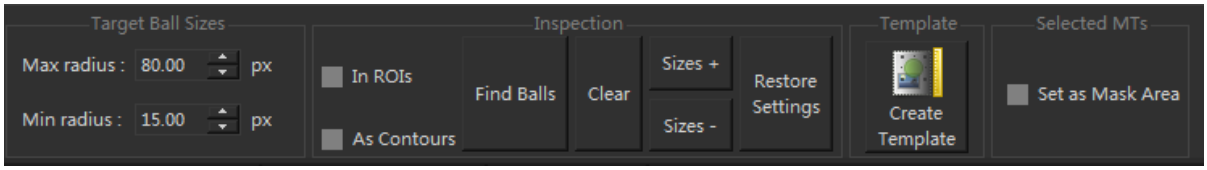
When adjust this parameter, the image will have an overlay to show the segmentation area. If the segmentation roughly OK, click "Find Balls" to find BGA.

Find Isolated Balls & Find Overlapped Balls

The two slider bars in "Find Isolated Ball" and "Find Overlapped Ball"are designed for finding balls as contour. it defines the balance between ball curvature and intensity.

User doesn't need to change them, and that make sure the value to be 50 is OK.

Please see tutorial "BGA Detection" to get more information.



BGA DETECTION Toolbar (2/2)

Target Ball Sizes

Set the ball minimum size and maximum size.

Roughly setting the range will bring more accurate result, so setting ball radius limitation is very important.

Default value of Minimum radius and Maximum radius of a ball are 15 pixels and 80 pixels, respectively.

- If ball size is larger than 80, user needs to change "Max Radius" to a proper value.
- User can use Line Tools 98 to measure a Ball size

Inspection

In ROIs

- Check "In ROIs"
- Put one or more rectangle, and set it as "Tool3 (BGA Detection) 87"

Then algorithm will only find balls inside the ROIs.

As Contours

- Check this option, all the balls will be displayed as Polygon 98 (Contour).
- Uncheck this option, all the balls will be displayed as Circle 96.

Find Balls

Click this button to find Balls.

It will first remove all the detected balls, then find out balls with current parameters.

Clear

Remove all the detected balls by clicking "Clear" button.

Size+

Increase radius of all the selected balls with value 1.

Size-

Decrease radius of all the selected balls with value 1.

Restore Settings

Restore all the parameter settings as default.

Template

User can create a Template 57 with current displaying parameters.

Click any Template will apply the parameters inside Template to UI.

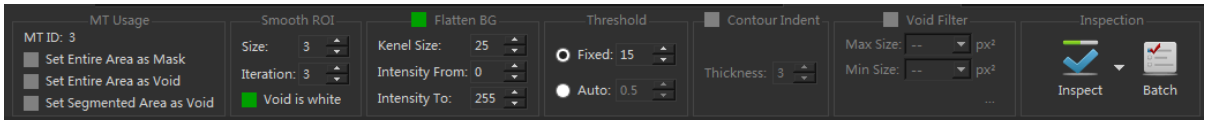
See tutorial "Template" to get more information.

Selected MTs

Check "Set as Mask Area", HADI will set all selected ROIs (Rectangle, Polygon, and Circle) as Mask, which means the balls inside the Mask area will be removed automatically.

4.2 VOID INSPECTION

Click on Toolbar "MEASURE", the following toolbar will be shown



VOID INSPECTION Toolbar 1/2

Note: All above parameters are acting on **selected** closed-shape 95 Measurement Tools 94 with usage "Void Inspection" 87

MT Usage

Set the usage of selected Measurement Tool.
NOTE: HADI supports MT Usage 85 definition that assign each MT a explicit usage.

To do Void Inspection, the usage for a MT should be Void Inspection Usage 87.
By default, any closed-shape MT is assigned as Void Inspection Usage.

MT ID

Show ID of selected Measurement Tools.

Set Entire Area as Mask

Set entire area as No Void Area

Set Entire Area as Void

Set entire area as Void Area

Set Segmented Area as Void

Set segmented area as Void Area

Smooth ROI

Smooth the ROI with Gaussian smoothing algorithm

Size and Iteration:

Defines the Gaussian kernel size and smoothing iteration.

Void is white

By default, HADI tries to find out Void (air) that is brighter than the
(object).

Uncheck this option If user wants to find out dark object.

Flatten BG

Flatten Background that helps the foreground segmentation on Inhomogeneous background.
See "Background Processing for Void Inspection"

Kernel Size

Defines the maximum Void object radius.

Intensity From

Defines an the intensity value that background flatten start from.

HADI usually ignore the surrounding pixels that intensity value < Intensity From.

Intensity To

Defines an intensity value that background flatten end to.

HADI usually ignore the surrounding pixels that intensity value > Intensity To.

Threshold

Do the foreground segmentation.

Fixed

Use fixed Thresholding value to do segmentation.

- If "Flatten BG" is checked. Thresholding will be applied to background processed image.

  The Thresholding value is quite different from original image.

  After background processing, the background pixels become 0, the foreground pixels starts from

1.

It means user should set value start from 1.

In general, user can set the Thresholding value to 5 ~15 to do the foreground segmentation.

- If "Flatten BG" is not checked. Thresholding will be applied to smoothed image.

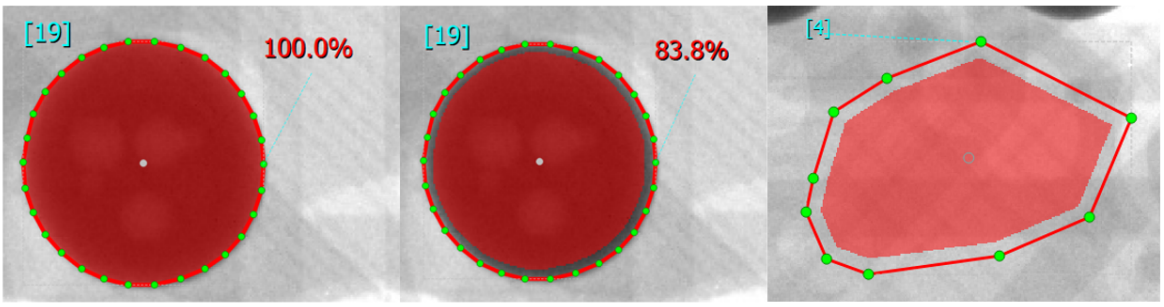
  The Thresholding value is almost exactly same with the original intensity value.

Auto

Use auto Thresholding value to do segmentation.
User can use the “Offset” value slightly tuning the Thresholding results.

Contour Indent

Remove the Void pixels that adhere to the inner Measurement Tool shape.
The “Thickness” define that how many pixels from the border should be removed.



Thickness = 0 Thickness = 6 Thickness = 10

Void Filter

If enabled, HADI will only keep the Voids that the area size located in range Min to Max.

Max Size

defines the maximum void size in the selected MT. If a Void area size larger than this value, it will be removed.

Min Size

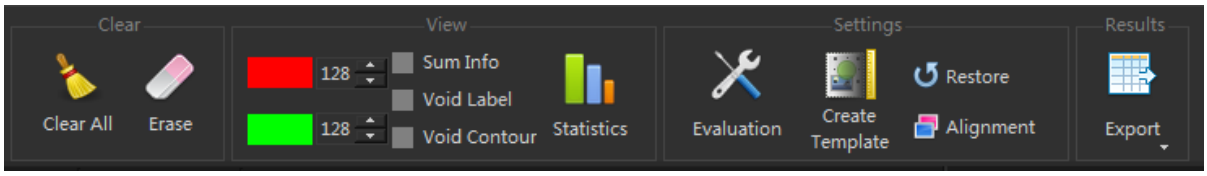
defines the minimum void size in the selected MT. If a Void area size smaller than this value, it will be removed.

Inspection

Inspect current displaying image.

Batch

Invoke the Batch Processing Tool 73. It is a simulation tool for inline inspection.



VOID INSPECTION Toolbar 2/2

Clear

Clear All

Clear all Voids in the current displaying image.

Erase

Click this button, the mouse cursor will be changed to "Cross". Click on any Void to remove it.

Click this button again to exist erasing status.

View

Voids can be evaluated as Defect and Non-Defects according to the Evaluation Settings. .

Defects Color

Define the Defect color for current image.

Non-Defects Color

Defines the Non-Defect color for current image.

Sum Info

Show summary info in the Main window. (will be abandoned)

Void Contour

Show the Voids as contours.

Note: This option is a global option that applied to all displaying Voids.

Statistics

Show Void Statistics Plotting 91 dock panel.

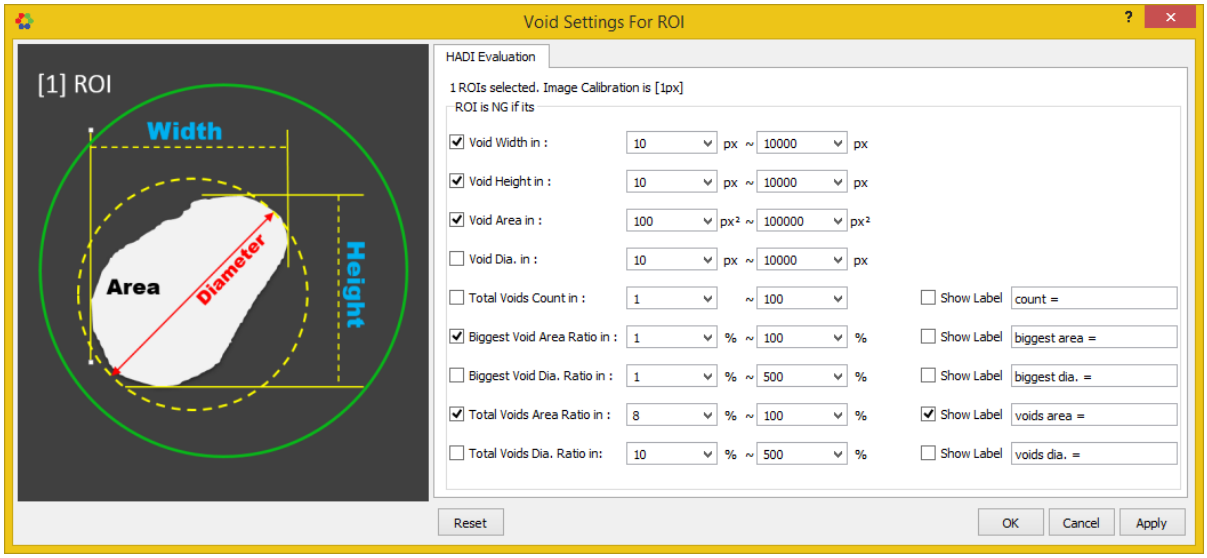
Settings

Evaluation

Show the Void Evaluation Settings Dialog.

- The settings will apply to all selected Measurement Tools
- When creating a new Void Inspection Tool 87, the last Void Evaluation Settings will be applied to it.

All the settings are defining NG conditions for selected Void Inspection Tool 87.



Void Width in

If the width of a Void is in the defined range,

- The Image is NG.
- The Void Inspection Tool is NG.
- The Void is marked as Defect Color 42.
- The Tool border is marked as Defect Color 42.

Void height in

If the height of a Void is in the defined range,

- The Image is NG.
- The Void Inspection Tool is NG.
- The Void is marked as Defect Color 42.
- The Tool border is marked as Defect Color 42.

Void Area in

If the area of a Void is in the defined range,

- The Image is NG.
- The Void Inspection Tool is NG.
- The Void is marked as Defect Color 42.
- The Tool border is marked as Defect Color 42.

Void Dia. in

If the diameter of a Void is in the defined range,

- The Image is NG.
- The Void Inspection Tool is NG.
- The Void is marked as Defect Color 42.
- The Tool border is marked as Defect Color 42.

Total Voids Count in

If the total Voids count in selected ROI is in the defined range,

- The Image is NG.
- The Void Inspection Tool is NG.
- The Tool border is marked as Defect Color 42.

Biggest Void Area Ratio in

If the area ratio of the biggest Void of the Void Inspection Tool is in the defined range,

- The Image is NG.
- The Void Inspection Tool is NG.
- The biggest Void is marked as Defect Color 42.
- The Tool border is marked as Defect Color 42.

Biggest Void Dia. Ration in

If the diameter ratio of the biggest Void of the Void Inspection Tool is in the defined range,

- The Image is NG.
- The Void Inspection Tool is NG.
- The biggest Void is marked as Defect Color 42.
- The Tool border is marked as Defect Color 42.

Total Voids Area ratio in

If the area ratio of the total Voids of the Void Inspection Tool is in the defined range,

- The Image is NG.
- The Void Inspection Tool is NG.
- The Tool border is marked as Defect Color 42.

Total Voids Dia. ratio in

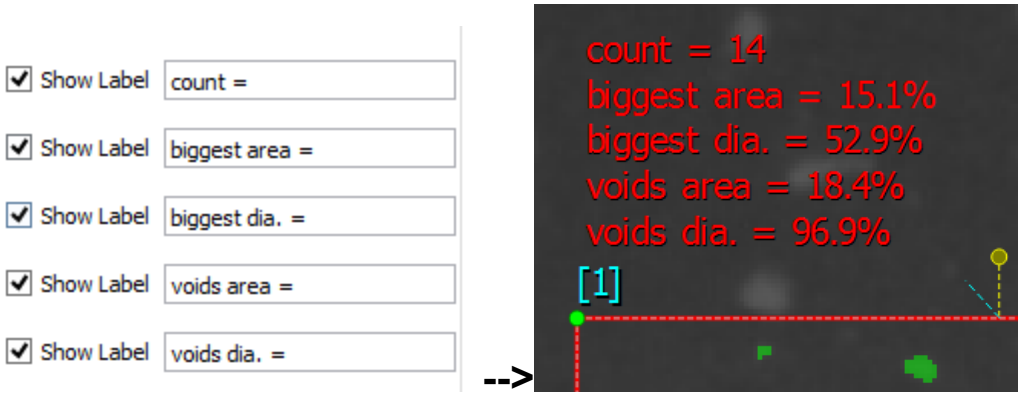
If the diameter ratio of the total Voids of the Void Inspection Tool is in the defined range,

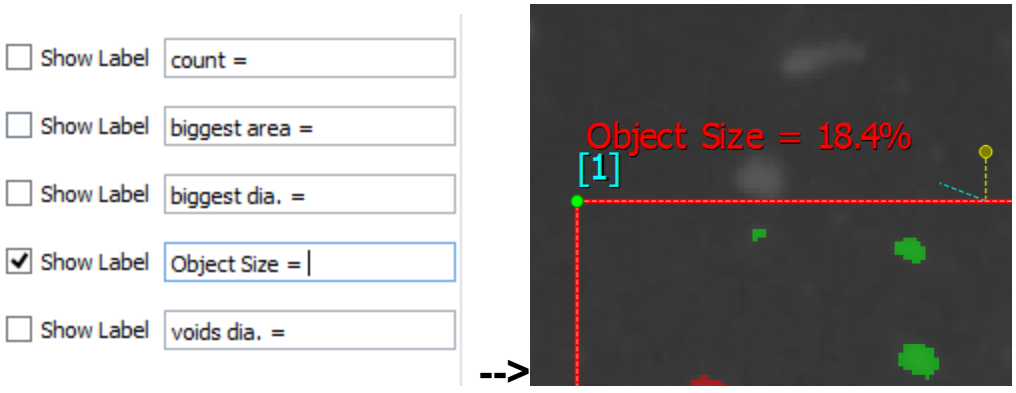
- The Image is NG.
- The Void Inspection Tool is NG.
- The Tool border is marked as Defect Color 42.

Show Label

Show the annotation prefix on MT's annotation area.

For example .





Create Template

Create a Template 57 with current displaying image.

Alignment

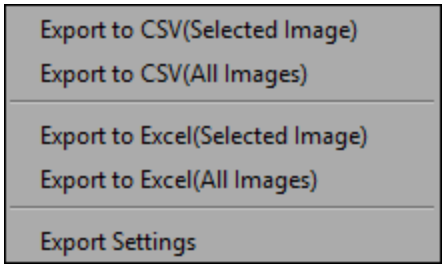
Show "Image Alignment 62" dialog. It only shows the Alignment settings for selected Template(s).

Restore Parameters

Restore Void inspection parameters of selected Measurement Tools as default.

Results

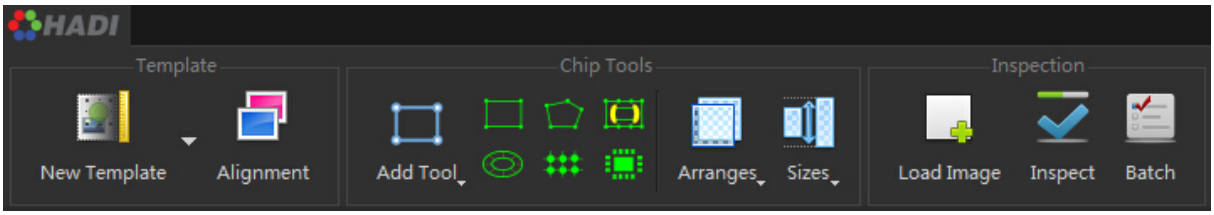
Export



- Export to CSV format (Selected Image)
  - will be abandoned
- Export to CSV format (All Images)
  - will be abandoned
- Export to Excel (Selected Image)
- Export to Excel (All Images)
- Export Settings
  - See "Export Settings 84" in dock "MT Info 82".

4.3 PCB INSPECTION

Click on Toolbar "PCB INSPECTION", the following toolbar will be shown



Template

New Template

- Create a new iBoard Template through loading an image.
- Create a new Template from current displaying image.

Alignment

Select a Template, then user can set alignment parameters for it.

See"Template-based Inspection 11" to get detail parameter description on Image Alignment.

Chip Tools

Add Tools

Add Chip Tools 101 to the current displaying image(can be Template).

Arrange and Sizes

Adjust Chip tool 101 layouts, arrangements and sizes of selected Chip tools.

Inspection

Load Image

- Select a Template first, and then load an image with this button to inspect it.

  It will first do the image alignment between the image and Template. The alignment process will do transformations on image to match the template.
- The second process is mapping all ROIs in Template to the image.
- Now the image is ready to do inspection.

Inspect

Inspect current image with selected Template.

Every time clicked on "Inspection", all the ROIs in the current image will be removed. All the ROIs in Template will be mapped to current image again.

The alignment process doesn't repeat. So if user change Alignment settings, the image needs to be loaded again to perform alignment with new alignment parameters.

Batch

Invoke the batch processing tool, a tool that can simulate inline inspection.

See more details in "Batch Processing Tool 73".

View

Properties

Show "iBoard Tool Properties" window, in which user can adjust the parameters for each selected ROI.

ID

Show/Hide ID of selected Chip tools.

NAME

Show/Hide Name of selected Chip tools.

Fix Viewport

Fix the viewport of current image, the incoming new images will have same Translation and Scaling with the current Viewport.

It is a convenient function that focusing on a certain area of an image.

Set as Mask

Set a selected Measurement tool as Mask.

Put a Measurement Tool on current display image and set it as Mask.

See more details in "Mask Tool".

Focus

During the inspection, the viewport will be focused on a Chip tool. User can select the target Chip type by the dropdown menu.

Review

Enter review mode. The auto inspection process performs in the background, and user can review inspected images.

Current Template

Show the current selected Template name.

Reults

Export

User can generate report or export images and Templates.

See more details in "Exporting 55".

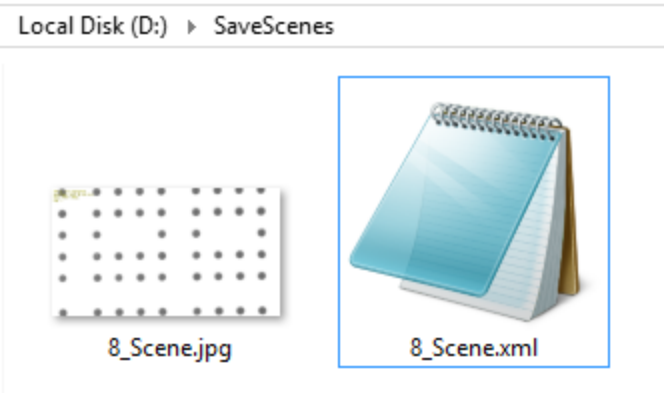
5 Get Start

5.1 General

5.1.1 General - Work With Scenes

When user editing an image in HADI.

The current working scene can be saved as XML file. and the image also saved in the same name.

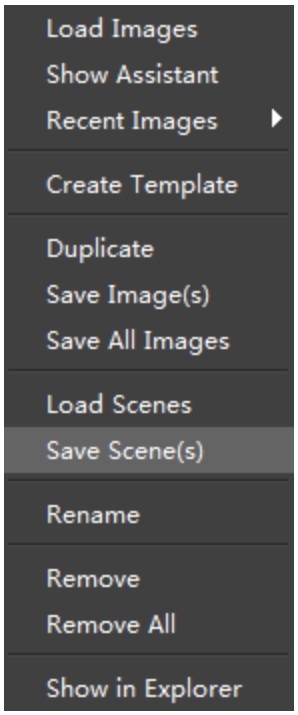


The XML file contains,

- Measurement Tools (position, color, pen etc.).
- All Parameters belong to the Measurement Tool.
- All Parameters belong to the Image.

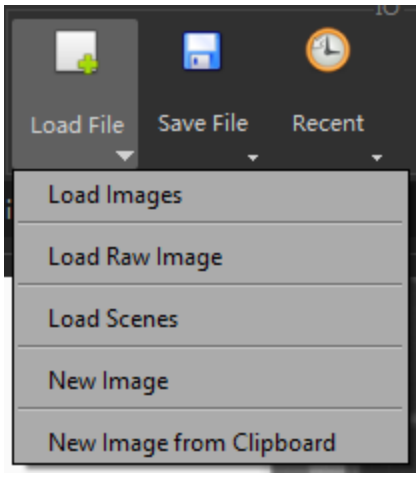
Save Scenes

- Click "FILE" -> "Save File" -> "Save Selected Scenes" or
- Click "FILE" -> "Save File" -> "Save All Scenes" or
- Right Click dock panel "Images" -> "Save Scene(s)"



Load Scenes

- Click "FILE" -> "Load File" -> "Load Selected Scenes" or
- Click "FILE" -> "Load File" -> "Load All Scenes" or
- Right Click dock panel "Images" -> "Load Scenes"

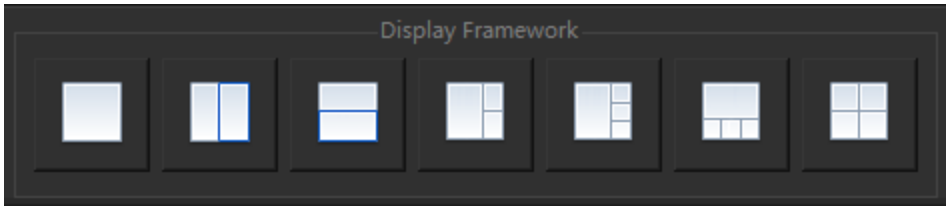


5.1.2 General - Multi-View Display

HADI support multiple view display, user can see two or more images at the same time.

By default, HADI shows only one view to display image.

Goto toolbar "VIEW" -> "Display Framework" to set the display framework to multiple view display.



 shows one view

 shows two vertical views

 shows two horizontal views

 shows one main view and two small views

 shows one main view and three small views vertically

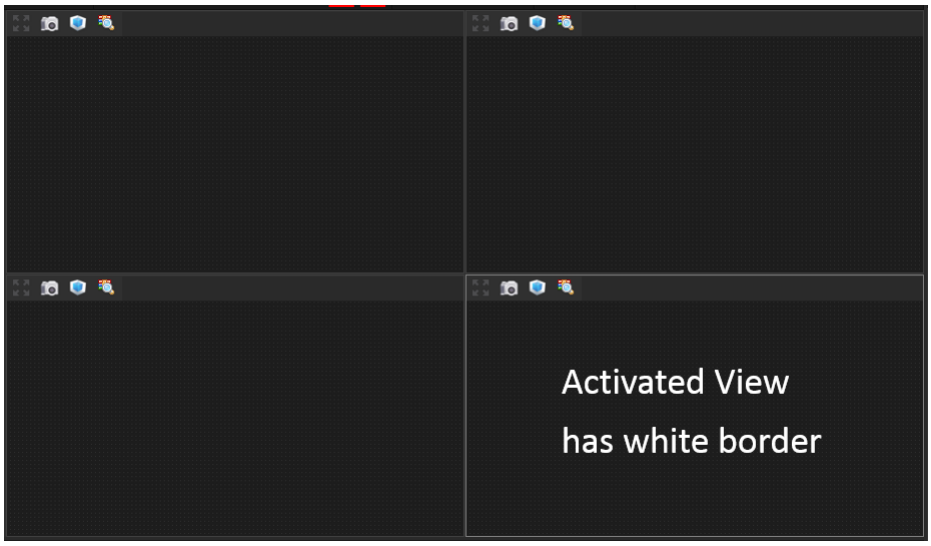
 shows one main view and three small views horizontally

 shows 4 views

Activated View

The activated view has a white border that different with other views.

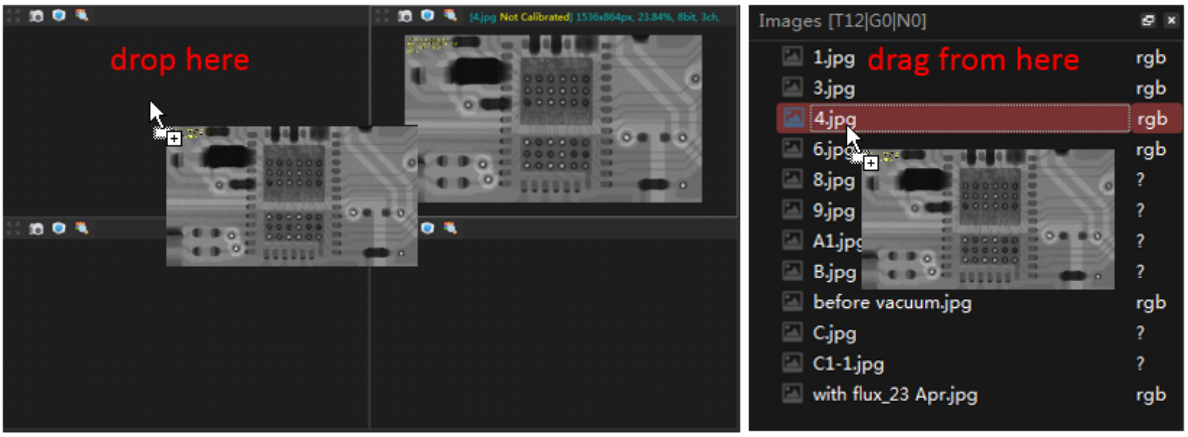
User can click on the view to active it.



How to show images in multiple view

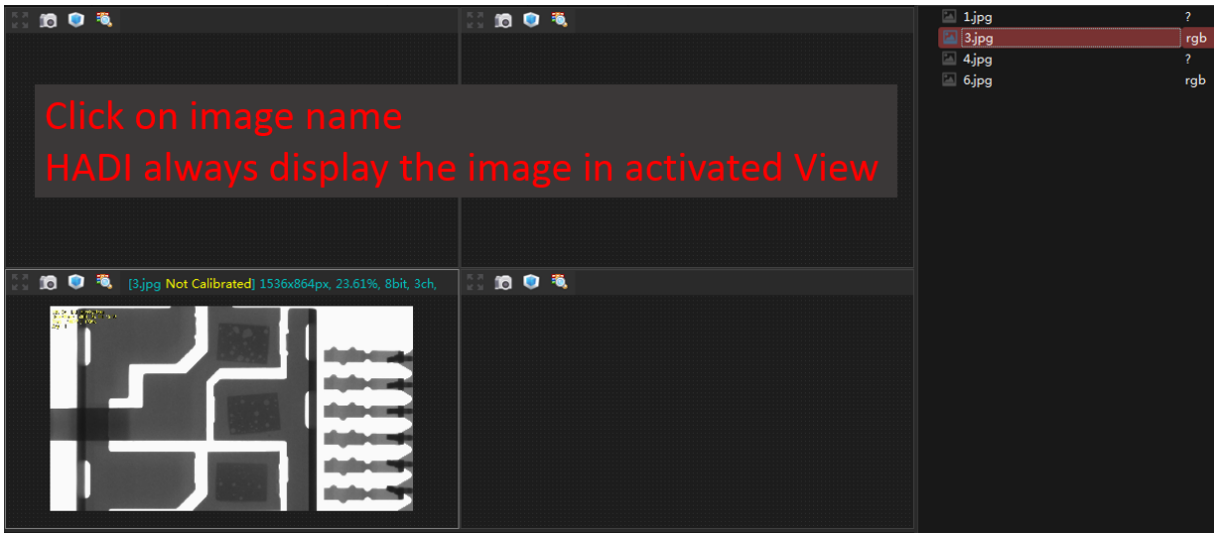
Method 1

- User can use Alt + Left Mouse to Drag image from dock panel "Images 79" into a view.



Method 2

- Active a view by click on the view first , then click on Image name, the image will be displayed to the activated view.

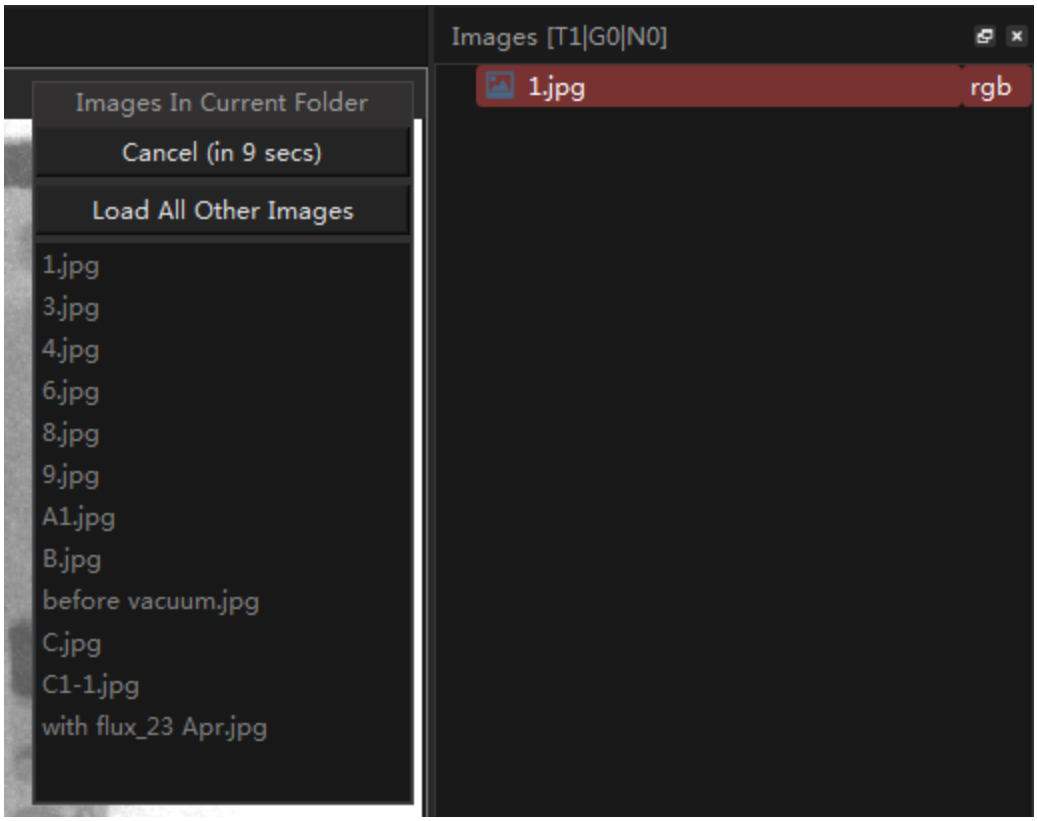


5.1.3 General - Image Loading Assistant

When user load images into HADI, an Image Loading Assistant window pop-up.

It shows all image files in that directory, user can

- Cancel : ignore it.
- Load All Other Images : Load all image files in that directory to HADI, no duplicate loading.
- Click on an image name to load image: this loading is duplicate loading.



5.1.4 General - Export Results

HADI has following functions

- Save Images 14
- Save Working Scenes 14
- Capture Image 16
- Capture Screen 17
- Print Images 15
- Export Inspection Results as PDF 16
- Export Inspection Results as CSV/Excel 46

5.1.5 General - Supported File Formats

- HADI supports loading PNG, XPM, JPG, BMP GIF, TIFF formats.
- The TIFF file can be 16-bit. 23
- HADI also support loading RAW files.
- HADI saves the working scene 50 as XML file. So user can also load XML scene files 50.

5.1.6 General - HADI Terminology

Name	Description
NG	Not Good, used in inspection and evaluation
GOOD	Good, used in inspection and evaluation
Void Inspection Tool	A Measurement Tool that the usage is Void Inspection 87.
Measurement Tool	HADI provided all tools are Measurement Tool, user can assign different usage 85 for MTs.
Closed-Shape MT	Tools like Circle, Rectangle, Polygon are closed-shape MTs 95.
Non-Closed-Shape MT	Tools like Angle, Line, Distance are non-closed-shape MTs 98.
Image Alignment	Alignment incoming image with specified Template. See "Image Alignment 62"

5.1.7 General - Improve Performance

User is able improve performance by settings.

Improve Image Alignment Speed

In "Alignment Settings 46" -> "General" -> "Set Alignment Speed".
Choose X4 means the image alignment speed is 4 times faster than original.
Choose X16 means the image alignment speed is 16 times faster than original.

In general, X4 is reasonable. Alignment two 1000x1000 image will take about 200 ms in i7 CPU.
If user choose X16, the alignment probably lose some accuracy.

Improve Inspection Speed

- Turn off the "Capture Resulting Image After Inspection" will improve inspection speed. (see below "Improve Memory Usage").
- Choose X16 for the image alignment. (see above "Improve Image Alignment Speed").

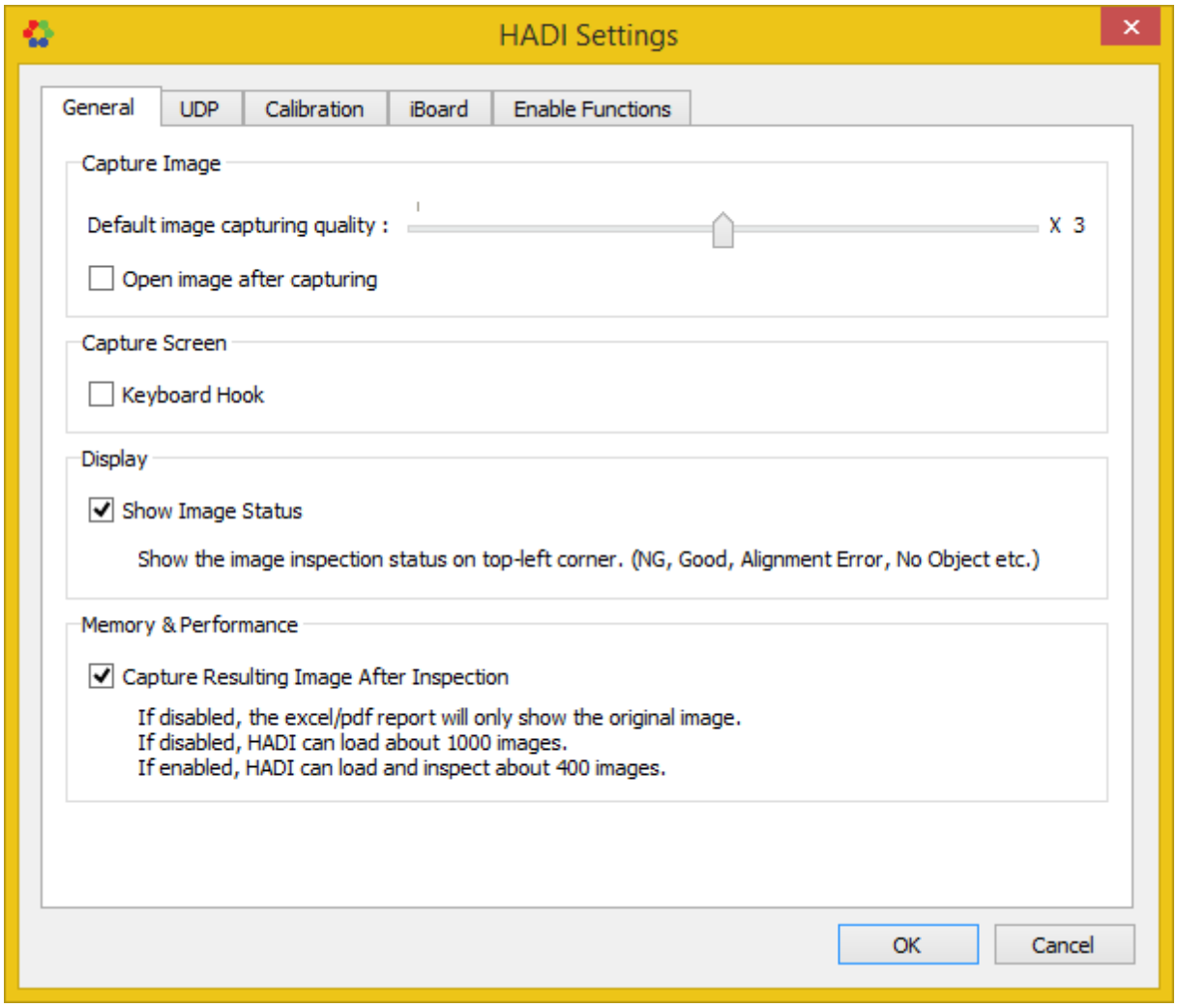
Improve Memory Usage

To generate report with inspected images. HADI keeps inspected image after inspection.

The image is 3 channel RGB image, so it takes huge memory.

User can turn it off by unchecking "Global Settings" -> "General" -> "Memory & Performance".

But, the reporting will no have inspected image, instead, the original image is contained. (This issue will be improved soon).



5.2 Automated and Template based Inspection

5.2.1 Create Template

Create a Template from an Image File

Method 1. Goto toolbar "VOID INSPECTION" -> "Create Template"
Method 2. Goto toolbar "PCB INSPECTION" -> "Create Template"
Method 3. Goto dock panel "Templates" -> right click to pop-up menu -> "New Template(s)"

Create a Template from Current Displaying Image

Method 1. Goto toolbar "PCB INSPECTION" -> "Create Template" menu -> "From Current Image"
Method 2. Goto dock panel "Templates" -> right click to pop-up menu -> "New Template(s) From Current"

5.2.2 Teach a Template

- **Show a Template**
- **Edit a Template**
- **Teaching Experience**
  - BGA Teaching
  - Void Inspection Tool Teaching
  - iBoard C-Chip Teaching
  - iBoard BGA Teaching

Show a Template

Double click on a Template item in dock panel "Templates 76" will show that Template.

Edit a Template

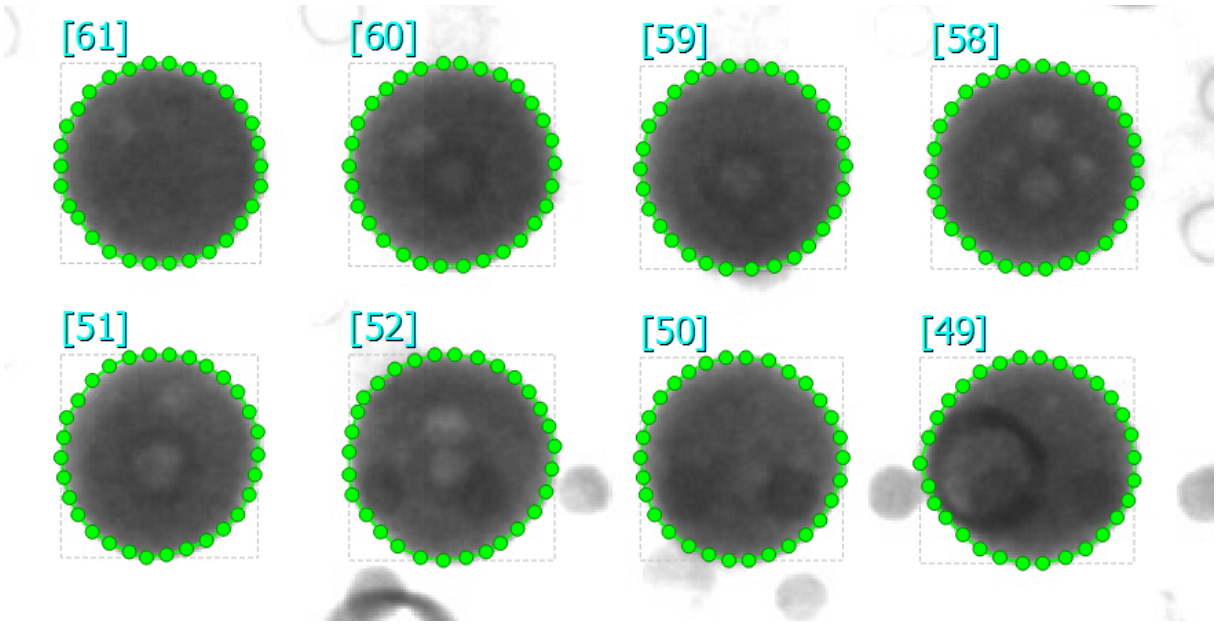
User can put Measurement Tools and tuning parameters directly on the Template.

Each action on the Template will be automatically saved.

Teaching Experience

BGA Teaching

Circles or Polygons should be exatly match the Ball



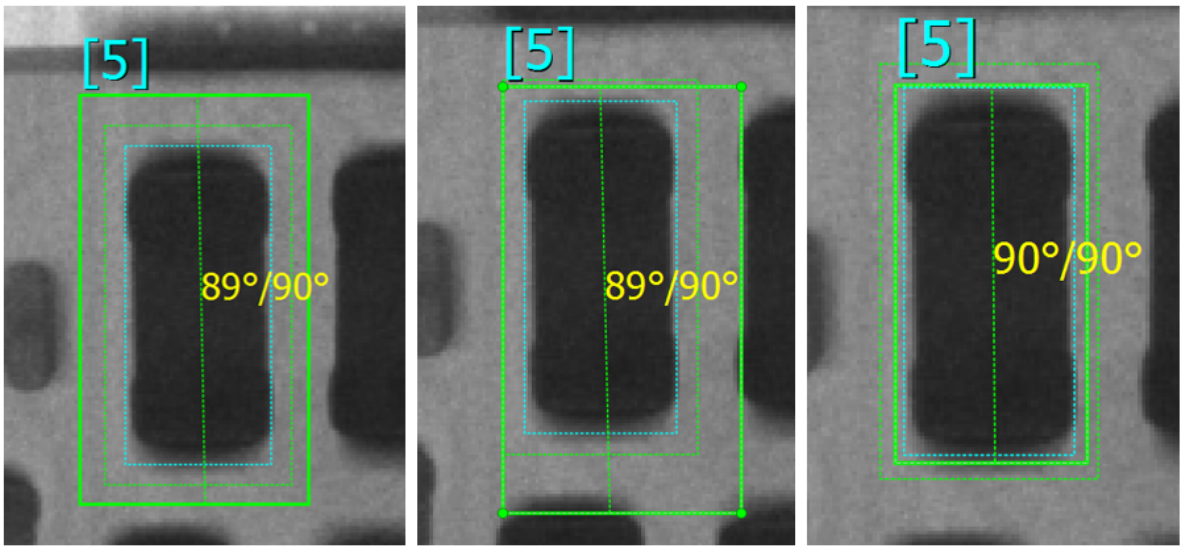
Void Inspection Tool Teaching

Free teaching

iBoard C-Chip Teaching

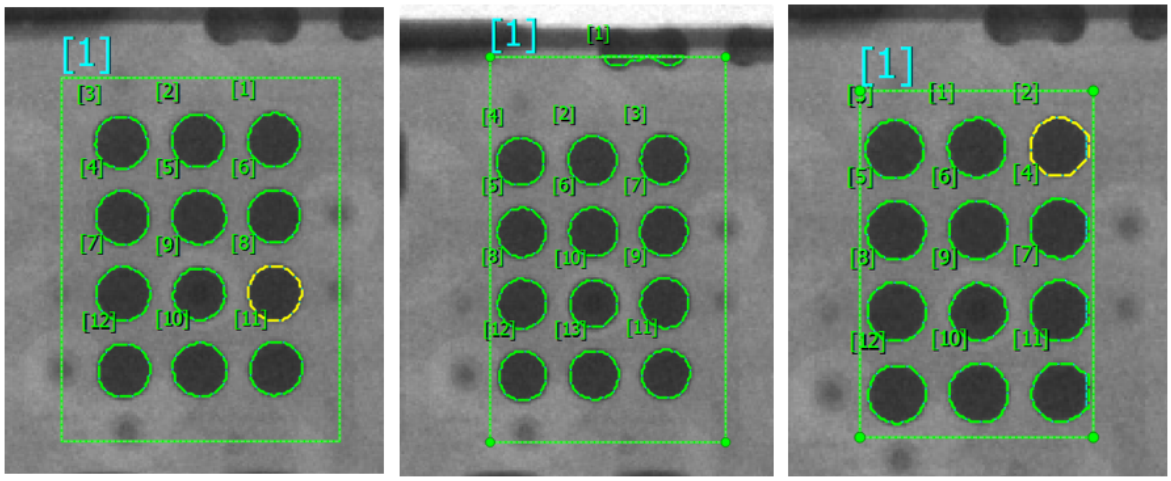
The MT boundary should larger than the C-Chip itself. And do not touch with other chip-sets.
If the MT boundary too small,

- the "Check Boundary" may have problem.
- the Segmentation may have problem.



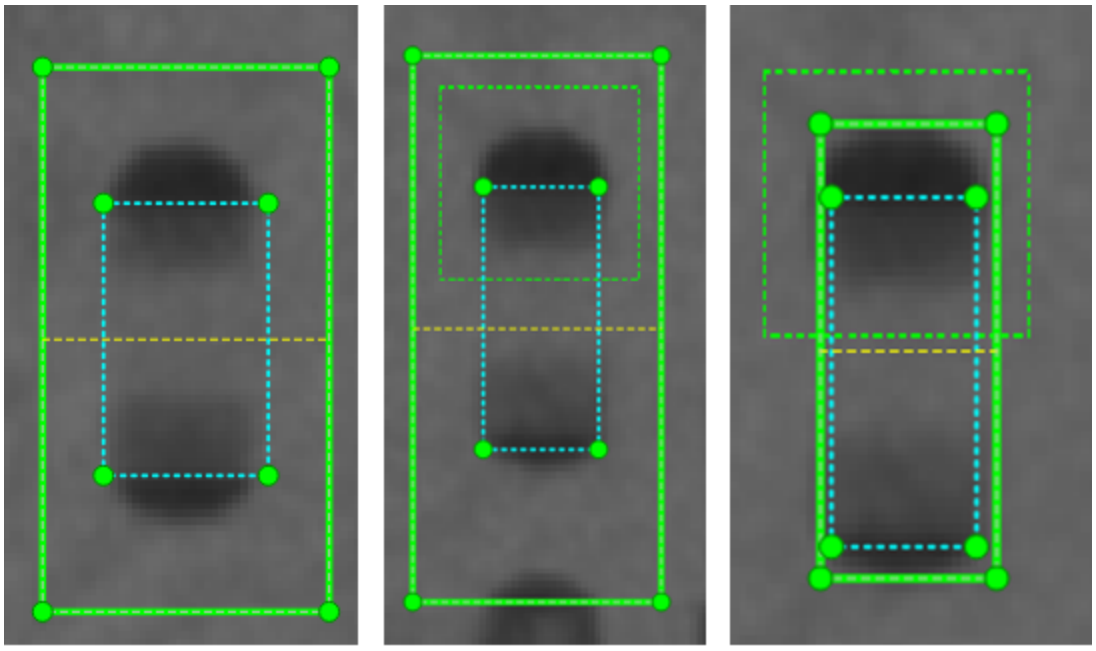
Good Teaching | Wrong Teaching | Wrong Teaching

iBoard BGA Teaching



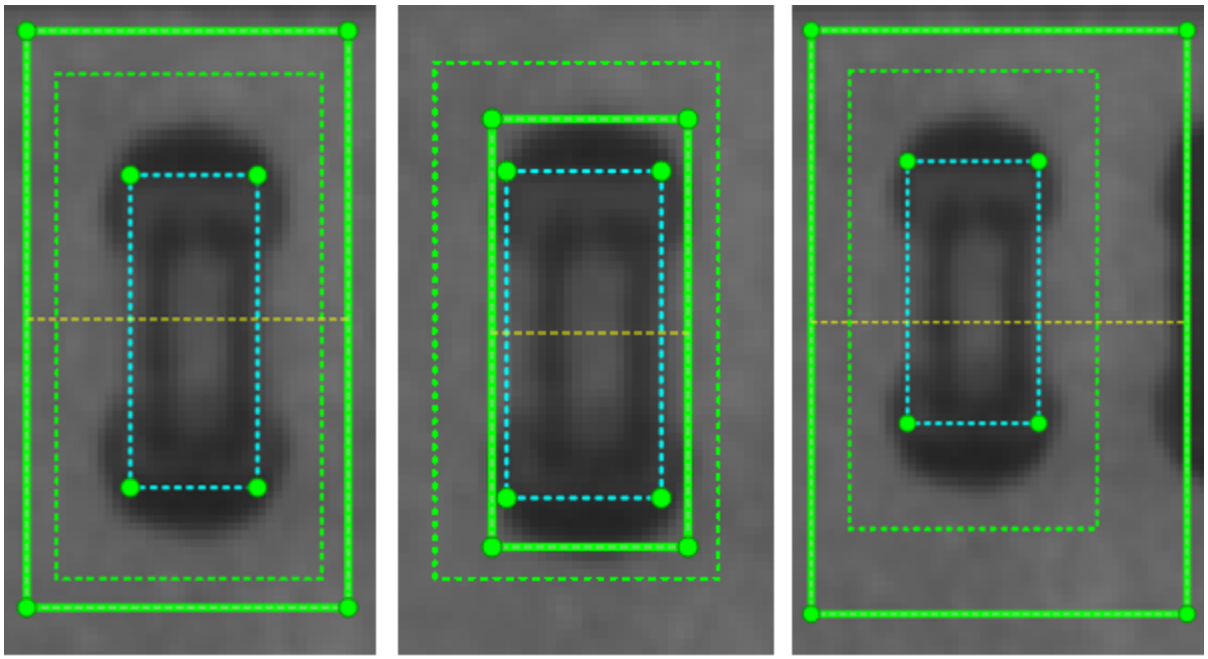
Good Teaching Wrong Teaching Wrong Teaching

iBoard R-Chip Teaching

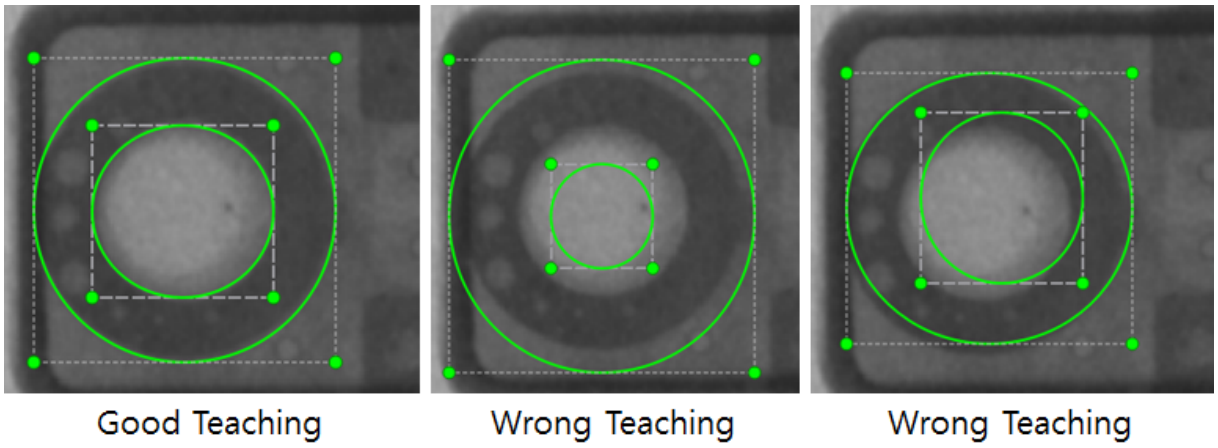


Good Teaching Wrong Teaching Wrong Teaching

iBoard L-Chip Teaching



iBoard MIC Teaching



5.2.3 Image Alignment

To do the Template-based Image Inspection 11 or Inline Inspection, image alignment is necessary.

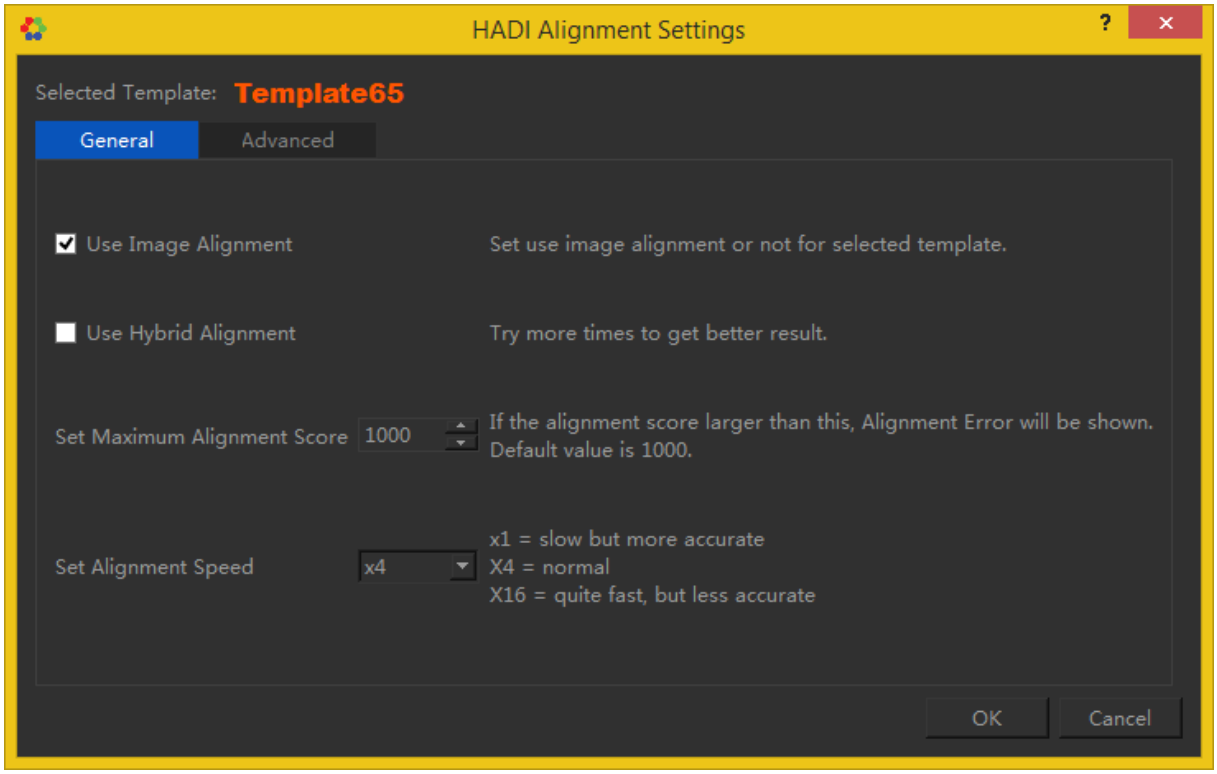
HADI uses full image to do alignment.

Open Image Alignment

Select Template(s) in the dock panel "Templates 76".

- In HADI - Inspection Pro, click button "Alignment" in toolbar "VOID INSPECTION".
- In HADI - iBoard, or iBoard Pro, click button "Alignment" in toolbar "PCB INSPECTION"

General Settings



Use Image Alignment

User can choose to use the image alignment or not.

Use Hybrid Alignment

If this option enabled, HADI will try few more times to make sure the alignment works.

Set Maximum Alignment Score

For each alignment iteration, a score will be calculated.

After alignment process done, a score which calculates the sum of intensity differences between image and Template is grained.

If the score lower than defined score, the alignment process is succeed, or else, "Image Alignment Error" will be displayed in the main window.

The default score value is 1000. In 1000 x 1000 resolution images, if

- the brightness doesn't change much and
- the translation less than 200 pixels and
- the rotation less than 30 degrees.

The alignment score value is about 500~1000.

For larger image like 1500 x 1000, the score can over 1000, about 1500.

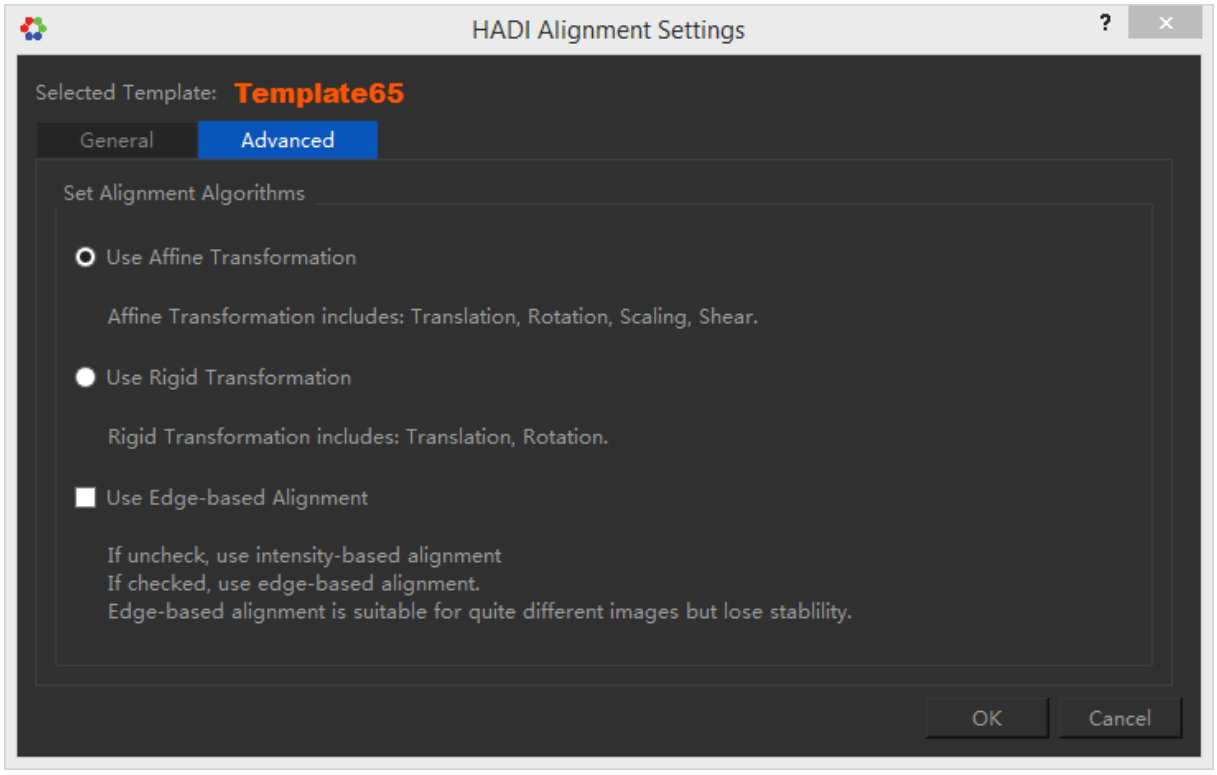
Set Alignment Speed

Set the alignment speed, default is 4 times faster than normal.

Obviously, set higher speed will cause less accuracy.

See "Improve Performance 56" to speed up alignment or inspection

Advanced Settings



Use Affine Transformation

Use affine transformation to align incoming image and Template(image).

The affine transformation supports image translation, image Rotation, image scaling and image

shearing.

The image alignment process will consider all the above transformations.

Use Rigid Transformation

The image alignment process will only consider Translation and Rotation between incoming image and Template.

Use Edge-based Alignment

The default image alignment is using image intensities as the major factor.

In some case, the brightness and contrast between incoming image and Template changes a lot.

Since the alignment score is sum of intensity difference between incoming image and Template, it will become abnormal even the image structure(object layout) are exactly same.

So for the image that have the similar structures with Template but brightness is quite different, use edge-based alignment would be better.

The edge information shows the structure while ignoring the intensity values.

The brightness differences can be ignored.

5.2.4 Image Calibration

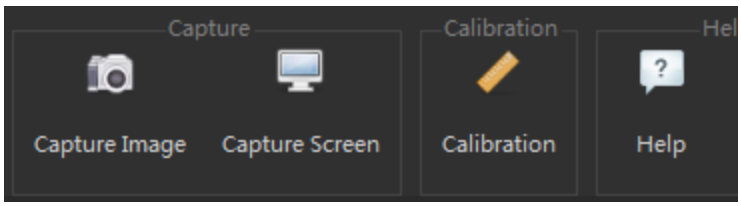
Image Calibration is trying to make connection between Pixel Size and Real World Size.

- Open Calibration Window 64
- Remove Calibration Info 66

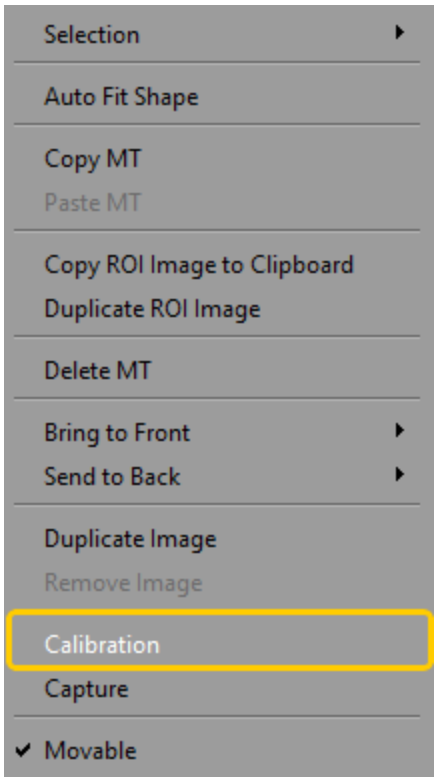
Open Calibration Window

To do calibration for a loaded image user can

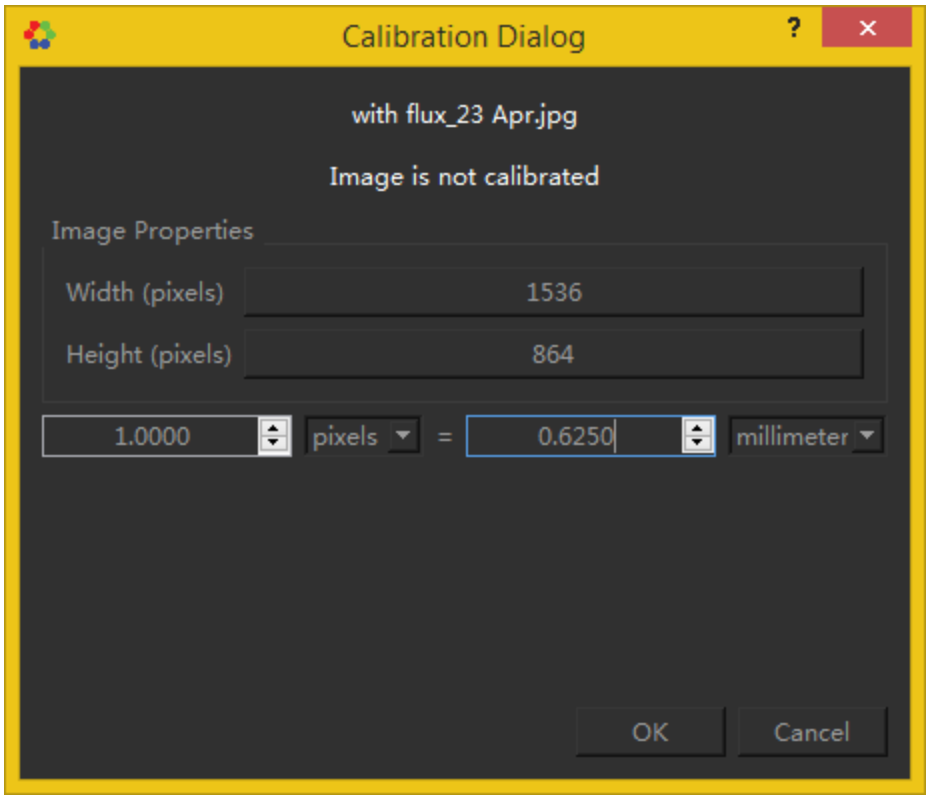
- Click "Calibration" button on toolbar "FILE"



- Click "Calibration" item on right menu of View.



the calibration window will be pop-up.



- If user right click on Image, the calibration window shows the image properties.
- If user right click on Measurement Tool, the calibration window shows the MT properties.

User can edit how many pixels = how many mm etc. HADI support
- centimeter
- millimeter
- micrometer
- nanometer.

Remove Calibration Info

Set 1 pixel = 1 pixel, will remove the calibration information of an image.
or just set pixel = pixel is OK.

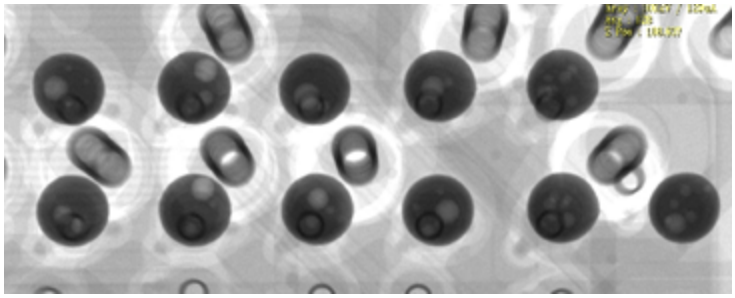
5.2.5 Automated BGA Detection

To find out BGA in a Image, user need to switch to toolbar "BGA DETECTION 36".

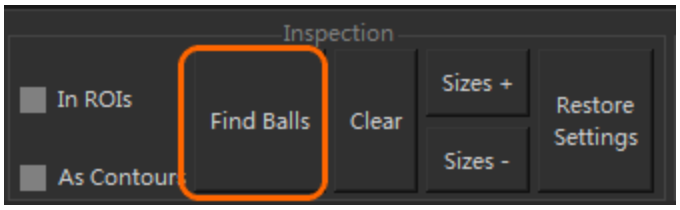
- General BGA Detection Procedure 66
- If Failed... 67
- Ball Representations 69
- Advanced BGA Detection 69
- Find Overlapped Balls 69
- Set Mask Area 70

General BGA Detection Procedure

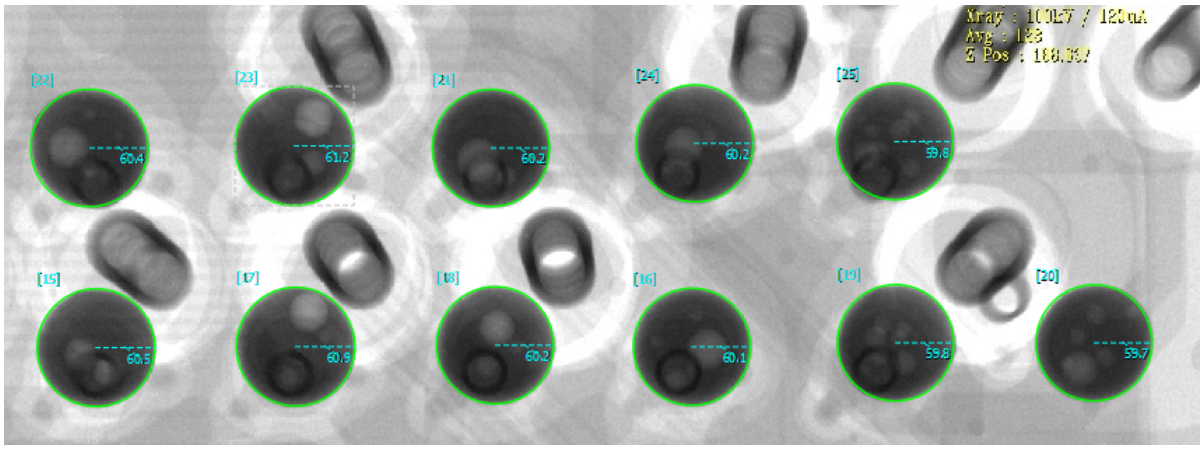
1. Load a BGA Image.



2. Click on "Find Balls" button.



In general, BGAs in the image will be detected and shows like following image.
Balls are shown as Circle MT, the ball radius is shown as a label.



If Failed...

Try following methods.

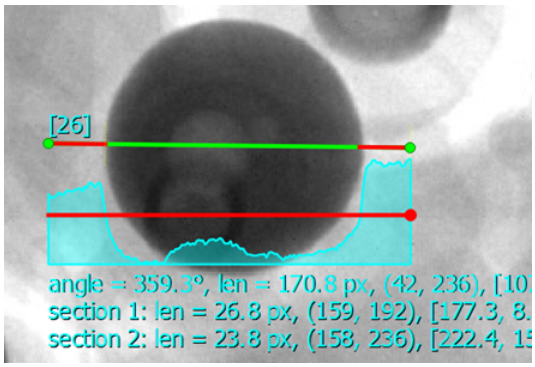
- **Reset Parameter**

  Reset the BGA detection parameters, click "Restore Settings", and then "Find Balls" again.

- **Change Target Ball Sizes**

  If the Ball sizes are not located in the defined default range (15px ~ 80px), HADI will ignore the Ball.

  So defining a suitable Ball radius is very important.
  User can measure the Ball radius by Line Tools



- **If the Ball is White**

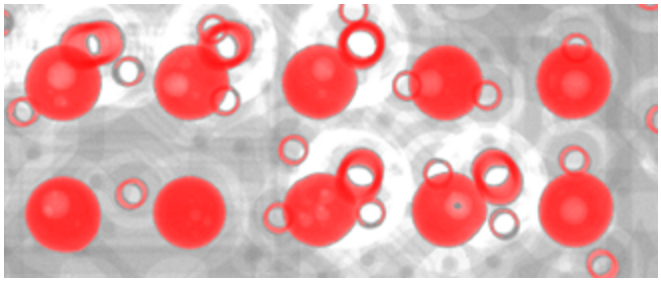
  HADI tries to find out dark Balls by default, in some cases, the Balls is white.
  User needs to check the "Invert Image" option is the ball is white

- **Use Fixed Threshold**

  HADI uses auto (adaptive) Thresholding segmentation to segment the Balls by default.
  If the background is very complex, the auto Thresholding probably doesn't work.

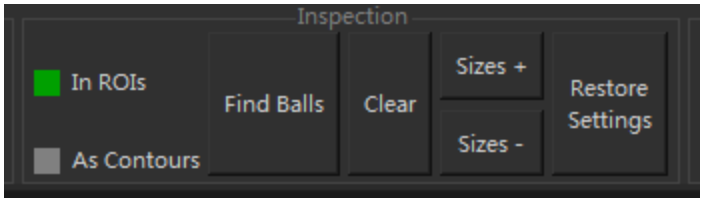
  User need to adjust the fixed Thresholding value to show the segmentation overlay to make sure the segmentation is correct.

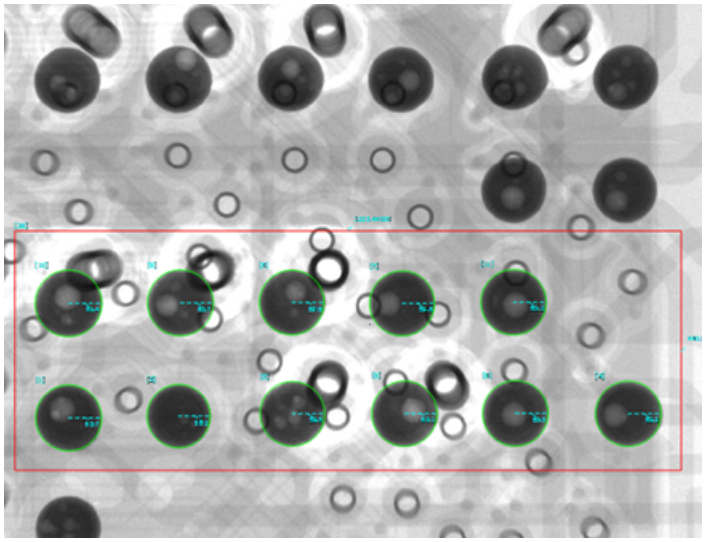
  When tuning the Thresholding value, HADI shows the segmentation overlay.



- **Try find Balls in ROIs**

  Put a Rectangle Tool, and set the usage as "Tool3 (BGA Detection) 87".
  HADI will find out Balls only inside the ROI.
  User can put more ROIs to find Balls.

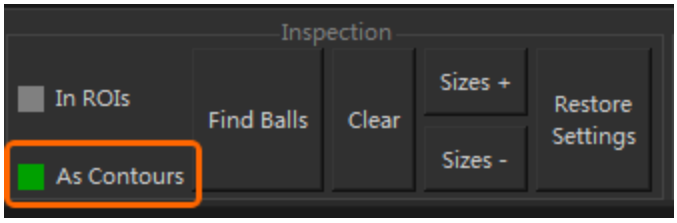


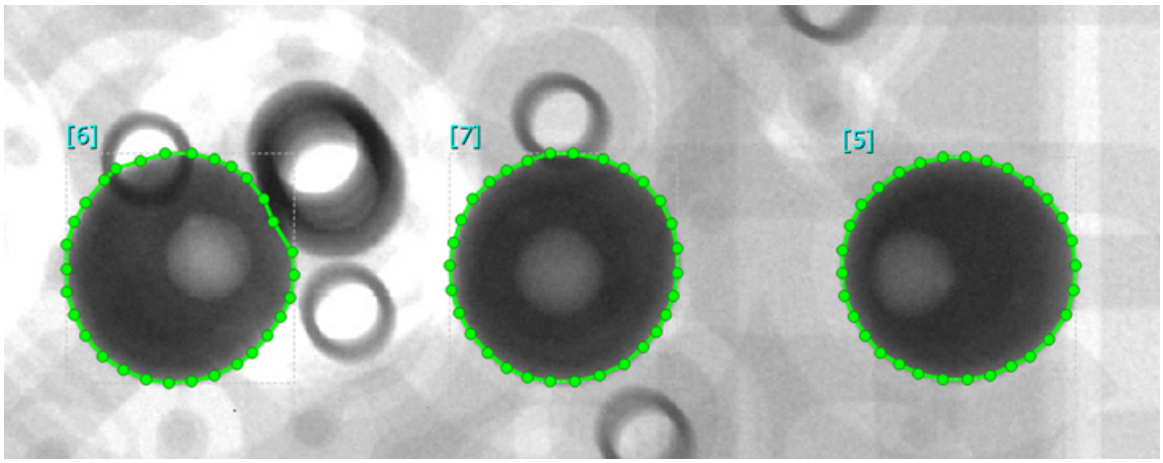


Ball Representations

HADI can display Balls by Circle Tool or by Polygon Tool.

If "As Contours" is checked. HADI will shows the Balls by Polygon Tool.

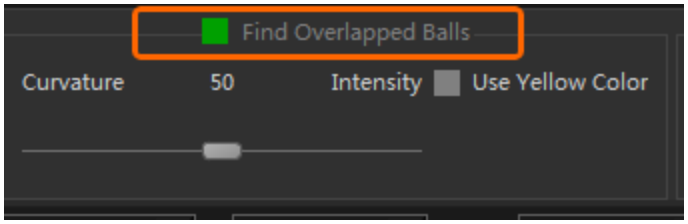


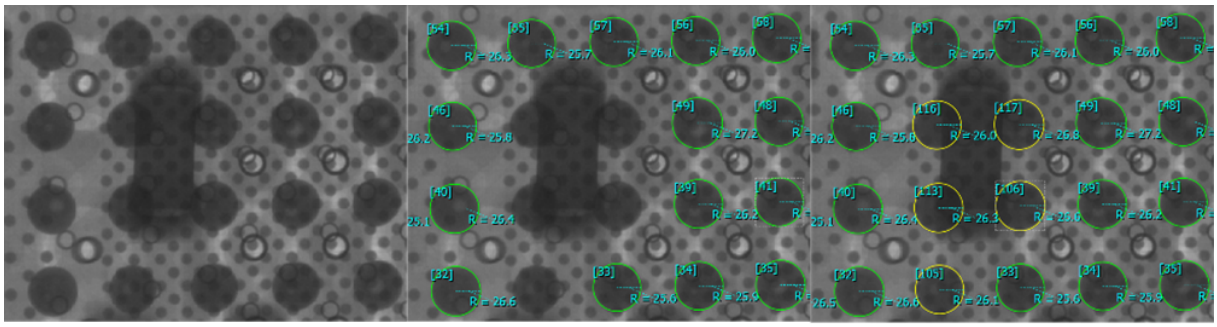


Advanced BGA Detection

Find Overlapped Balls

Check the option "Find Overlapped Balls", HADI will try to find overlapped Balls.



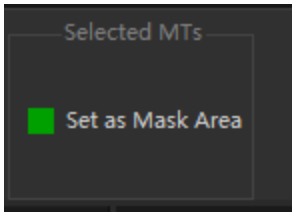


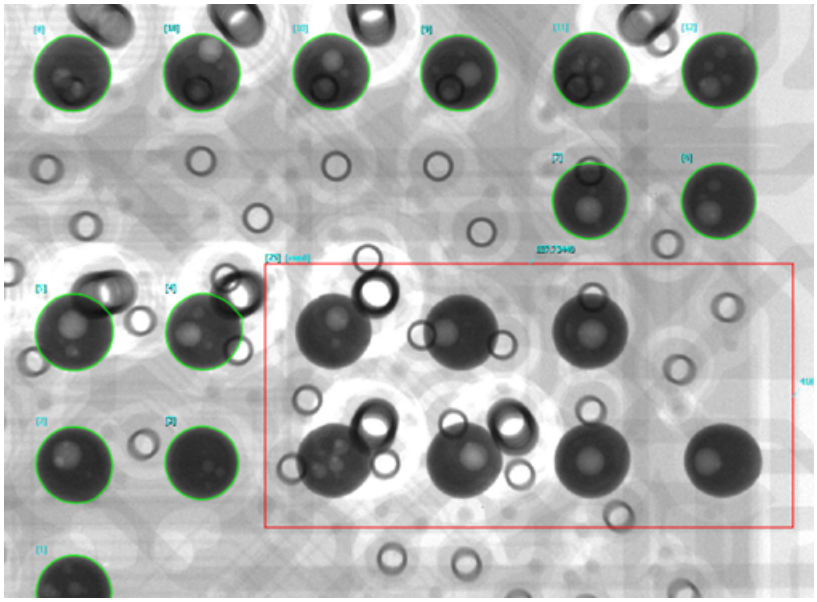
1. Original Image 2. Find Isolated Balls 3. Find Isolated and Overlapped Balls

Set Mask Area

Put a Rectangle tool and set as Mask Area.

HADI will not find Balls inside the mask area.



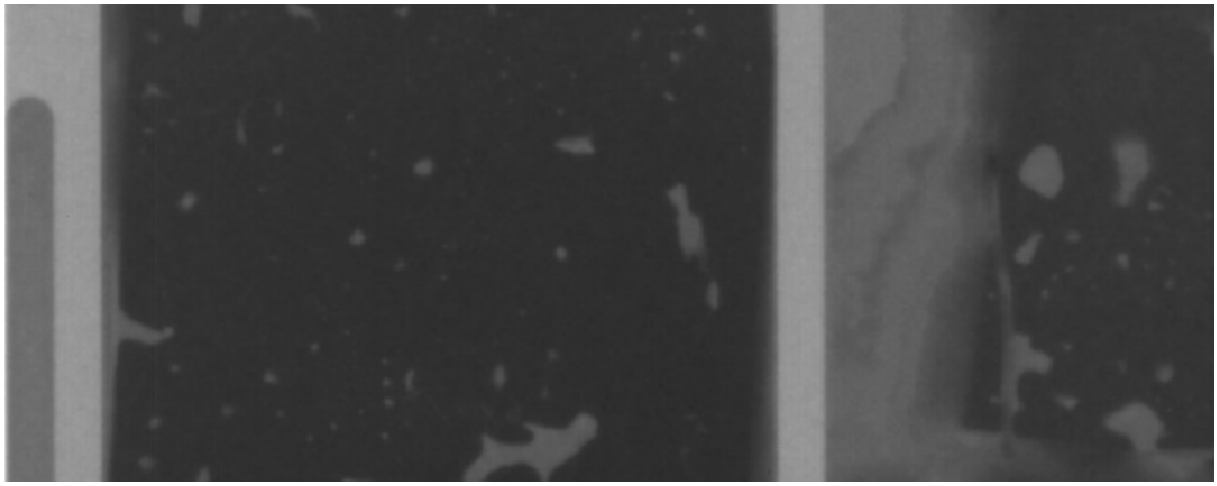


5.2.6 Automated Void Inspection

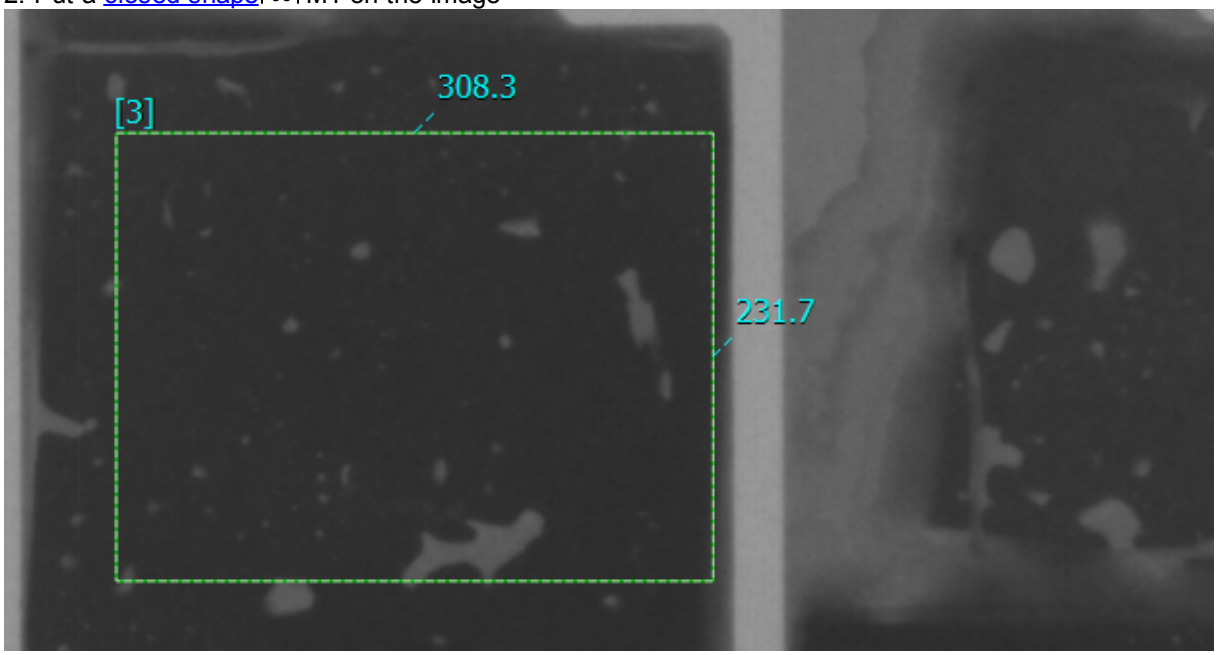
To do Void Inspection in a image, user needs to switch to "VOID INSPECTION 39"

General Void Inspection Procedure

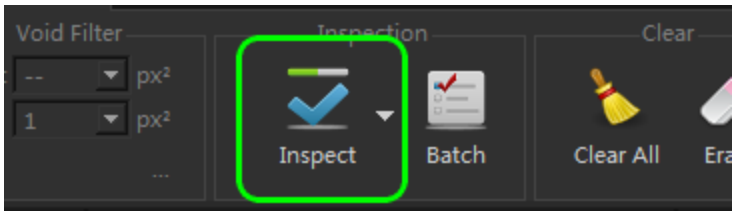
1. Load an Image



2. Put a closed-shape 95 MT on the Image



3. Click button Inspection



If Failed...

First, make sure you are adjusting parameters with **SELECTED** Measurement Tools.

1. Check the tool is closed-shape 95 or non-closed shape 98.
HADI can only do Void Inspection in closed-shape MTs.

2. Check the tool's usage in dock panel "MT Usage 85"
HADI can only do Void Inspection in tool with usage "Tool2 (Void Inspection) 87"

3. Check the Void Color
If the Voids are white color comparing to background, make sure "Void is white" is checked.
If the Voids are dark color comparing to background, make sure "Void is white" is unchecked.

4. Check the "Flatten BG 40" parameters.
See "Background Processing" to know more about Flatten BG.

5. Check the "Thresholding 40" parameters.

6. Check the "Void Filter"
Void filters are calibration 17 enabled. So if the image is calibrated, make sure the Void filter doesn't remove everything.

Show Voids as Contour

Check the "Void Contour 42" option.

Void Evaluation

To decide a Void is defect or not, user needs to set the Evaluation parameters.

Click on "Evaluation 43" to show the evaluation settings for selected MTs.

Create a Template with Current Image

If all the inspection works well, the current image is ready to make a Template.

User can create a Template 57 by click on "Create Template 45".

Export Results

User can
1. Export PDF results by click "Report 16" button on toolbar "FILE 12".
2. Export Excel results by click "Export 46" menu on toolbar "VOID INSPECTION 39"

5.2.7 Inspection - Batch Processing Tool

HADI supports Batch Processing Tool to simulate X-Ray inline inspection.
From an image data-set, user can conveniently do batch processing in HADI.

To do batch inspection, user needs to
1. Open Batch Processing Tool
2. Create a Configuration File
3. Match the image name with Template Name
4. Click Inspection.

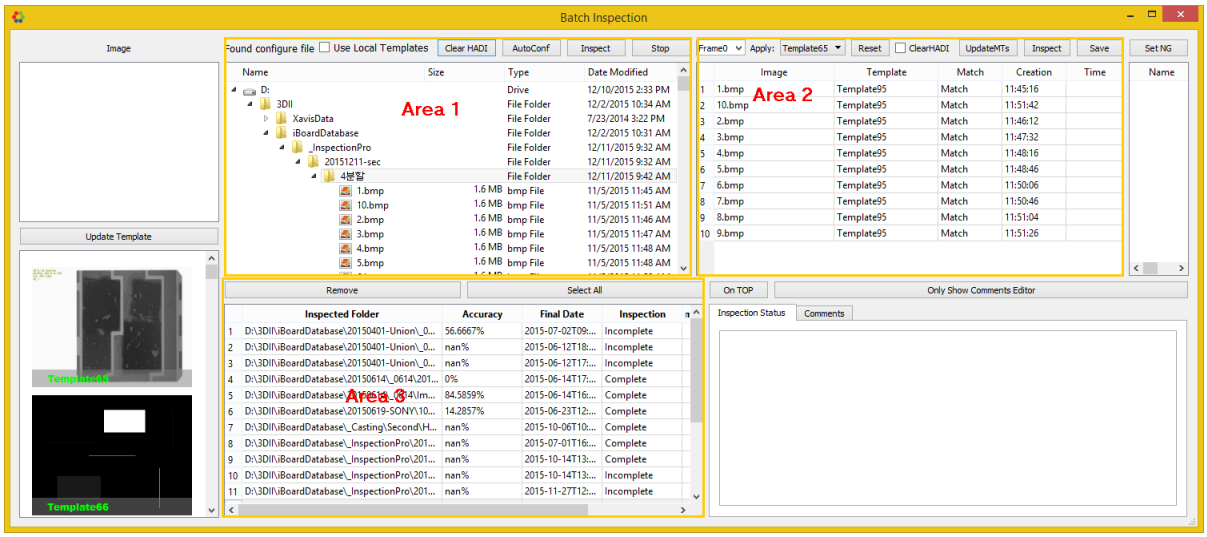
Open Batch Processing Tool

- **In HADI - Inspection Pro**

Click button "Batch" in toolbar "VOID INSPECTION"

- **In HADI - iBoard**

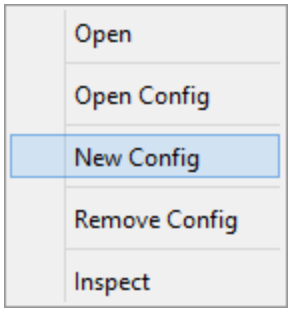
Click button "Batch" in toolbar "PCB INSPECTION"



Create a Configuration File

Suppose that user has created Template(s) to inspect a folder.

Right click on that folder, a context menu pop-up.



- **Open:** open the folder or image
- **Open Config:** the configuration file (the zoo.ini file in that folder)
- **New Config:** create a configuration file that match image name with Template name.
- **Remove Config:** remove the configuration file.
- **Inspect:** inspect the folder.

User needs to create a new config first to inspect the folder.
The configuration file saved in that folder and named as **zoo.ini**.
The configuration file contains a match relationship between image name and Template name.
When start inspection, HADI will load an image and find the right Template to do inspection.

The following figure shows

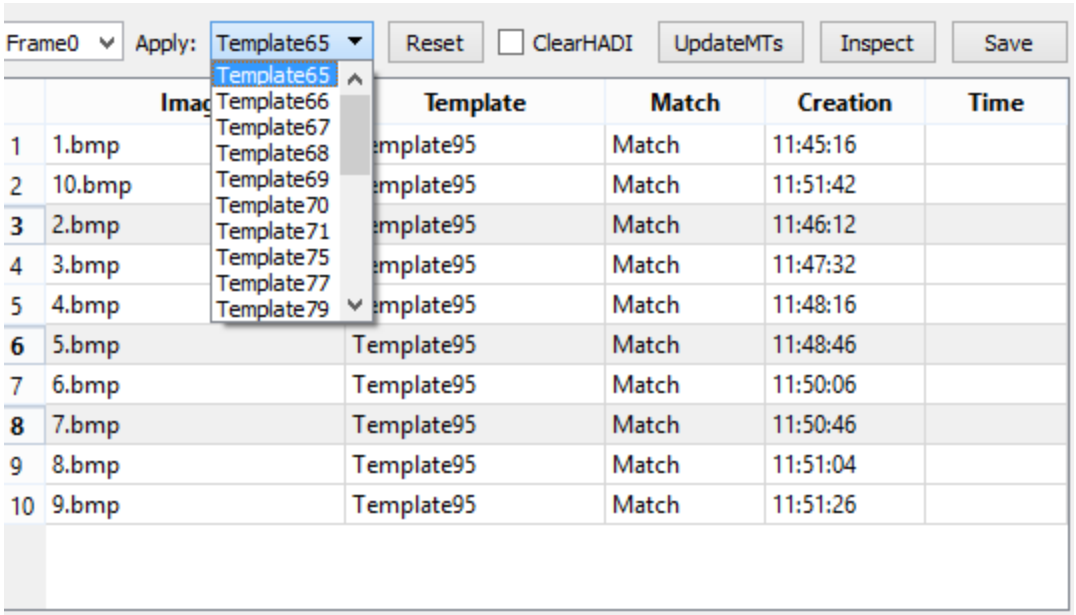
- the image 1.bmp will be inspected with Template95.
- the image 10.bmp will be inspected with Template95.
- the image 12.bmp will be inspected with Template95.

```
[1.bmp]
Template=Template95
Path=D:/3DII/iBoardDatabase/_InspectionPro/20151211-sec/4\xbd84\xd560
Chips=

[10.bmp]
Template=Template95
Path=D:/3DII/iBoardDatabase/_InspectionPro/20151211-sec/4\xbd84\xd560
Chips=

[2.bmp]
Template=Template95
Path=D:/3DII/iBoardDatabase/_InspectionPro/20151211-sec/4\xbd84\xd560
Chips=
```

Configuration file that matches image name and Template name.

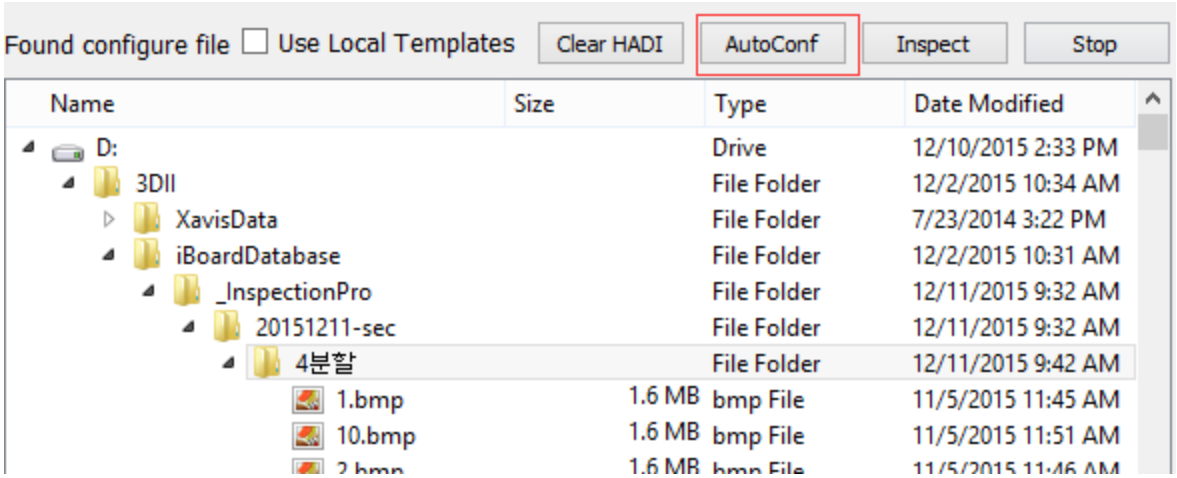
Match the image name with Template Name

- User can manually select images in "Area 2" of Batch Processing Tool, and click the drop-down menu to set Templates.



- User can also use Auto Configuration method that automatically find out the match between image and Template.

If you have many Templates loaded in HADI, this process will be very slow.
So please try to unload non-necessary Templates when do Auto Configuration.



Click Inspection.

If the matching process between image name and Template name is complete.

- User can click "Inspect" in Area 1 to do inspection in whole folder.
- User can also click "Inspect" in Area 2 to do inspection with selected image items.

Others

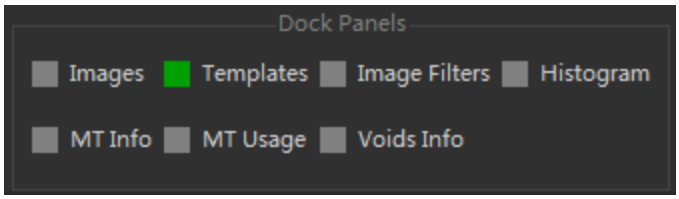
...

5.3 Dock Panels

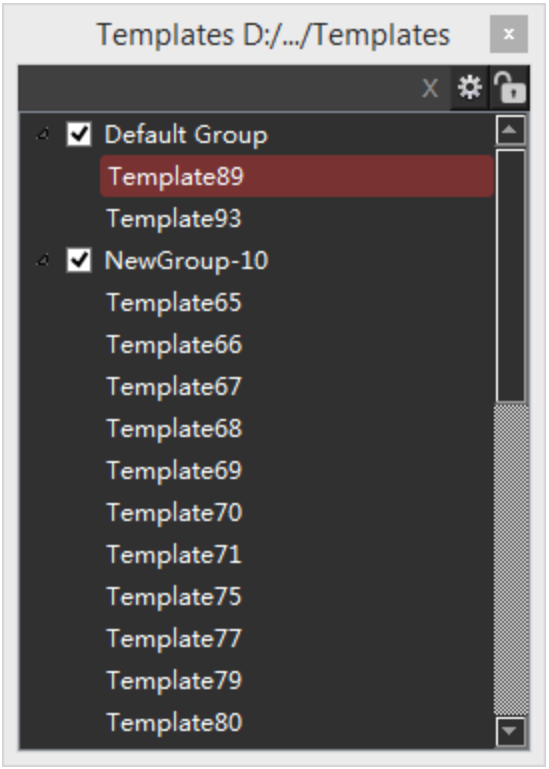
5.3.1 Templates

Show Templates Dock Panel

To display the Templates dock panel, user needs to check the item "Templates" on Toolbar "VIEW".

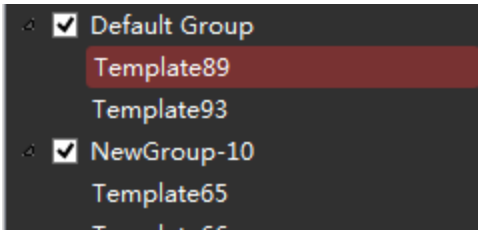


By default, the Templates dock panel appears on the bottom-right corner of HADI window.



UI Elements and Mouse Behavious

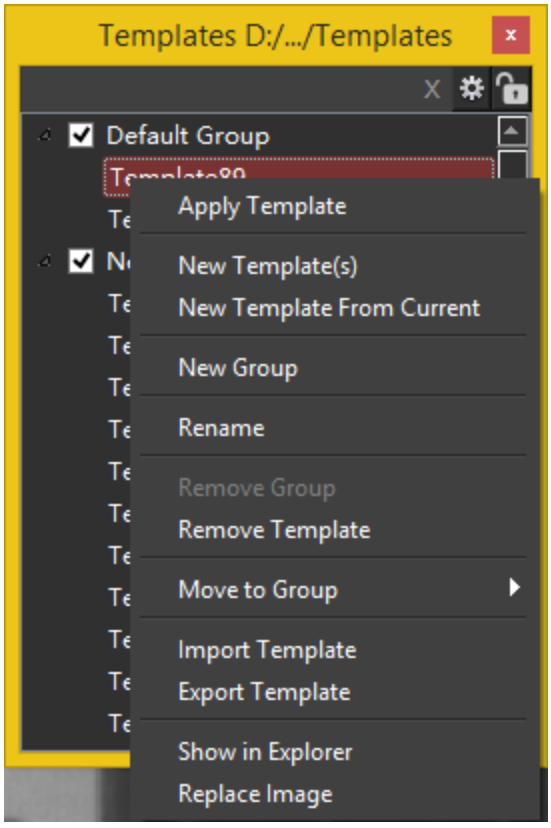
- **Search Window :** search template by keyword text.
- **Clear Search Text :** clear text.
- **Settings :** Template path settings.
- **Lock :** lock/unlock Template management, the default password is "3DII".



- **Grouping checked :** HADI will load all Templates in that group after restart.
- **Grouping unchecked :** HADI will not load Templates in that group after restart.
- **Mouse on Template :** Single click to select a Template, Double click to display a Template.

Context Menu

Right click on Templates dock panel, the context menu appears.



- **Apply Template**

  Apply Template to current display Image.

  Note: Do not apply Template to itself, or else, you will have duplicated MTs.

- **New Template**

  Create a Template by loading a new image from disk.

- **New Template From Current**

  Create a Template from current displaying image, all the MTs and parameters will be copied.

- **New Group**

  Create a new group.

- **Rename**

  Rename a group or a Template

- **Remove Template**

  Remove selected Template(s), or remove selected group.

- **Move to Group**

  Move selected Template(s) to other group.

- **Import Template**

  Import Template(s) (XML file) into HADI. The Template will be copied to current Template directory.

- **Export Template**

  Export Template(s) into disk.

- **Show in Explorer**

  Show the Template in window explorer.

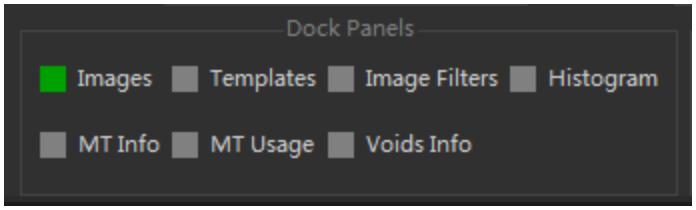
- **Replace Image**

  Replace Template image with new loading image.

5.3.2 Images

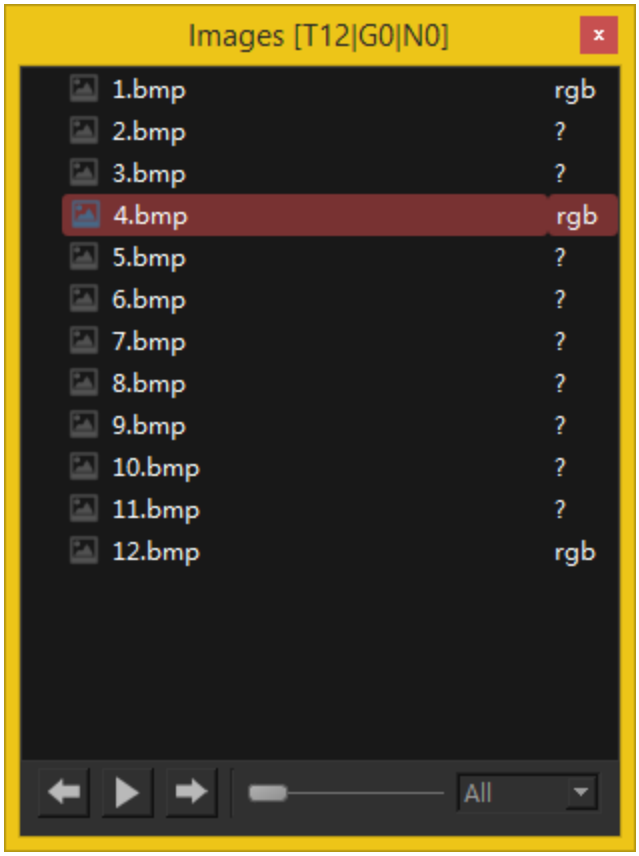
Show Images Dock Panel

To display the Images dock panel, user needs to check the item "Images" on Toolbar "VIEW".



If an image is loaded but never showed, HADI will not initialize it to save memory 56.

- For the uninitialized images, HADI shows the format as "?" in the second column of Images dock pane.
- For the initialized images, HADI shows the image format 55 like "rgb", "rgba", "8u" etc.



UI Elements and Mouse Behaviors

- **Title :** T = Total Image Count, G = Good Image Count, N = NG Image Count
- **Red Item :** shows selected Item. Single click on image item, the image will be displayed in the main view.
- **First Column :** shows the image display name.
- **Second Column :** shows the image format 55.
- **Click-Drag :** multiple selection.
- **Alt + Click-Drag :** drag image into different view 51.
- **Ctrl + Click :** select multiple images.
- **Shift + Click :** select multiple images.

Bottom Toolbar

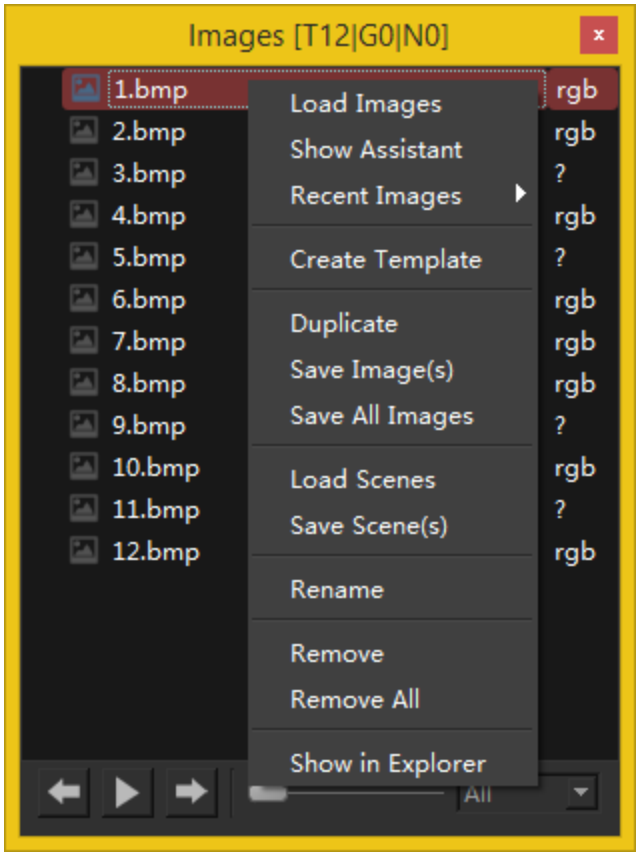
1. Click to show previous image.
2. Click to play image, the slider bar represents the interval time.
3. Click to show next image.
4. Set the interval time when playing image.
5. Set play "All Images", or "Good Images", or "NG Images".

Context Menu

Right click on Images dock panel, the context menu will be pop-up.

- **Load Images :** load images.
- **Show Assistant :** show the image loading assistant 54.
- **Recent Images :** load recent images or directories.
- **Create Template :** create a Template 57 from selected image.
- **Duplicate :** make a copy of selected image(s).
- **Save Image(s) :** save selected image(s).
- **Save All Images :** save all images.
- **Load Scenes :** load a working scene 50.
- **Save Scene(s) :** save selected images as scenes 50, individually.
- **Rename :** rename current displaying name.
- **Remove :** remove selected image(s) from HADI.

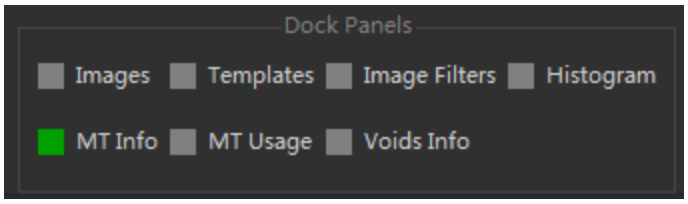
- **Remove All :** remove all images from HADI.
- **Show in Explorer :** show disk path of selected image.



5.3.3 MT Info

Show MT Info Dock Panel

To display the MT Info dock panel, user needs to check the item "MT Info" on Toolbar "VIEW".



The MT Info shows the information and properties of Measurement Tools 94 in the current displaying image of main view 51,

The column,

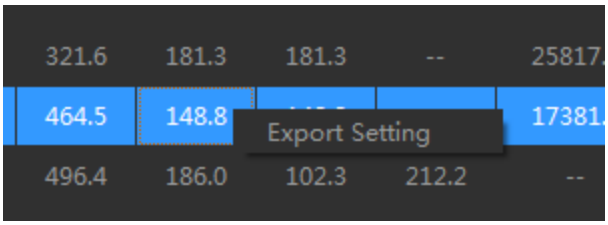
- **ID :** shows the Measurement Tool ID.
- **Type :** shows the Measurement Tool Type.
- **Usage :** shows the usage of a Measurement Tool 85.
- **Name :** shows the name of a Measurement Tool.
- **X :** shows the left position of a Measurement Tool on the image.
- **Y :** shows the top position of a Measurement Tool on the image.
- **W :** shows the width of a Measurement Tool.
- **H :** shows the height of a Measurement Tool.
- **Len :** shows the length of a non-closed-shape Measurement Tool.
- **Area :** shows the area of a closed-shape Measurement Tool
- **V. Area :** shows the total void area ratio 72 of a MT (Measurement Tool).
- **V. Dia** 71**. :** shows the total diameter ratio 72 of a MT.
- **V. Count :** shows the void count of a MT.
- **Status :** shows the evaluation status 72 of a MT (Good = "Good", NG = "NG", Pending = "Not Inspected", -- = "Not Inspectable").
- **Comments :** shows additional comments (or properties) of a MT. (e.g. Starting point and Ending point of a Line Tool)

Measurement Tools (in before vacuum.jpg)

ID	Type	Name	X(px)	Y(px)	W(px)	H(px)	Len(px)	Area(px²)	V. Area(%)	V. Dia.(%)	V. Count	Status	Comments
1	Rectangle		400.4	359.7	232.5	182.8	--	42487.1	8.9	60.0	6	NG	NG Definition: Width(10px~10...
2	Circle		188.9	321.6	181.3	181.3	--	25817.2	13.8	109.2	4	NG	NG Definition: Width(10px~10...
3	Circle_Cen...		29.6	464.5	148.8	148.8	--	17381.2	0.0	0.0	0	Good	NG Definition: Width(10px~10...
4	Line		198.4	496.4	186.0	102.3	212.2	--	--	--	--	--	Start Point (198.4,496.4), End P...
5	Horizontal...		663.7	502.2	221.6	0.0	221.6	--	--	--	--	--	Start Point (663.7,502.2), End P...
6	Chord		693.3	392.5	110.0	110.0	--	4753.8	0.2	0.0	2	Good	NG Definition: Width(10px~10...

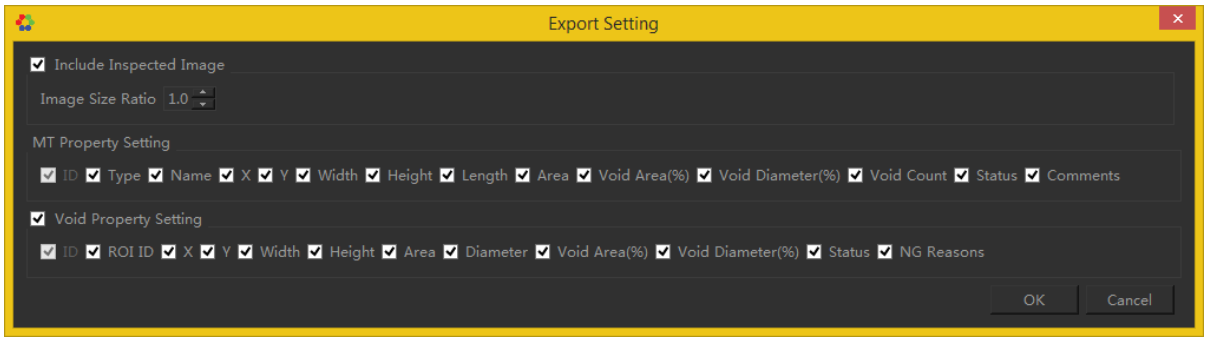
Export Settings

Right click on MT Info dock panel, the export settings pop-up.



The Export Settings has following options:

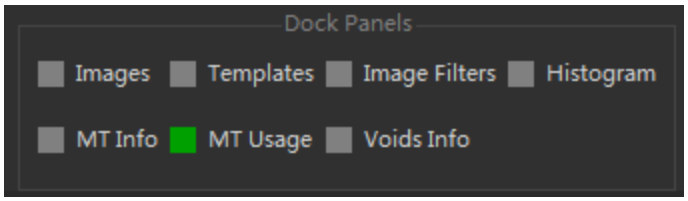
- **Include Inspected Image :** include the inspected image screenshot in the exporting file 55
- **MT Property Settings :** check/uncheck to show/hide columns of MT Info.
- **Void Property Settings :** check/uncheck to show/hide columns of Void Info 89.

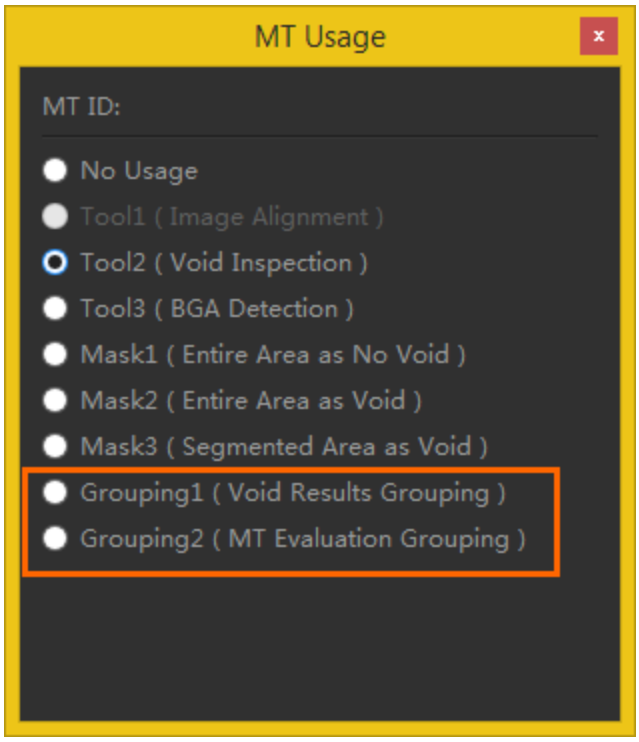


5.3.4 MT Usage

Show MT Usage Dock Panel

To display the MT Usage dock panel, user needs to check the item "MT Usage" on Toolbar "VIEW".





When create a MT 94 from Measurement Tool panel, by default it is

- "Void Inspection Tool 71" for closed-shape MT 95.
- "No Usage" for non-closed-shape MT 98.

MT Usages

HADI support various MT usages for different products 6,

- **No Usage**

  No usage assigned to MT. Most non-closed-shape MT has no usage. User can also set closed-shape MT as no usage.

- **Tool1 (Image Alignment)**

  Set selected MT as image alignment tool.

  By default, HADI usage whole image information when doing the image alignment 62. It takes about 300ms for the image resolution size 1000x1000 .

In some cases, if the image resolution is pretty high, user probably want to only use a certain area as alignment area to improve performance 56.

Therefore, user can set a Rectangle Tool 97 as an alignment tool for a Template.

Notice that,

- The tool size should not be too small. it needs as much information to do image alignment.
- One image can only has one image alignment tool. If you create more, the image alignment result is unexpected.

- **Tool2 (Void Inspection)**

  Set selected MT as Void Inspection 71 tool, the MT should be closed-shape 95 MT.

- **Tool3 (BGA Detection)**

  Set selected MT as BGA Detection tool, the MT should be closed-shape 95 MT.

- **Mask1 (Entire Area as No Void)**

  Set entire area of selected MT as No Void area. see Mask Tools.

- **Mask2 (Entire Area as Void)**

  Set entire area of selected MT as Void area. see Mask Tools.

- **Mask3 (Segmented Area as Void)**

  Set segmented area of selected MT as Void area. see Mask Tools.

- **Mask4 (X-Ray Attenuation Mask)**

  Set selected MT as X-Ray Attenuation Mask. see Mask Tools.

- **Grouping1 (Void Results Grouping)**

  Set selected MT as Void Results grouping tool. see MT Grouping.

- **Grouping2 (MT Evaluation Grouping)**

  Set selected MT as MT Evaluation grouping tool. see MT Grouping.

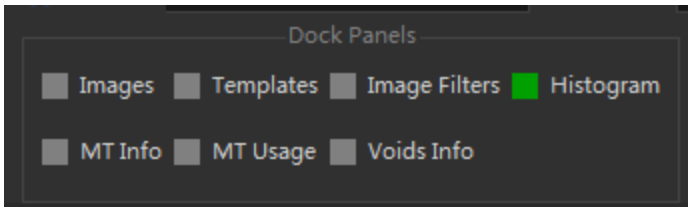
- **Grouping3 (PCB Evaluation Grouping)**

  Set selected MT as PCB Evaluation grouping tool. see MT Grouping.

5.3.5 Histogram

Show Histogram Dock Panel

To display the Histogram dock panel, user needs to check the item "Histogram" on Toolbar "VIEW".



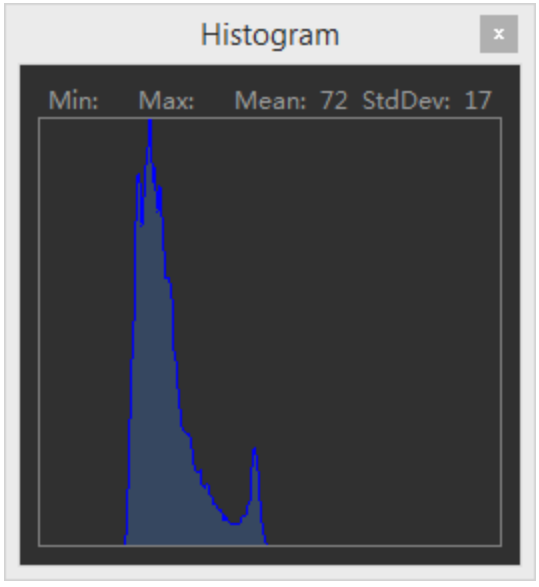
Histogram and Profile

The Histogram appears in the bottom-right corner of HADI main window.

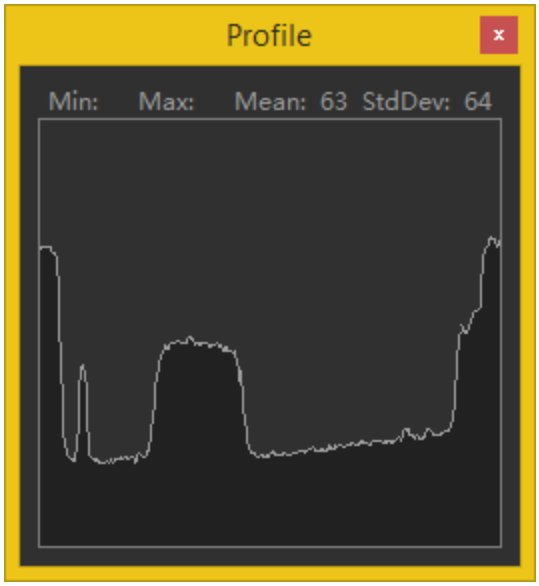
The Histogram dock panel shows the histogram of

- current selected ROI if it is closed shape.
- current image if there is no ROI selected.

The upper label shows the minimum value, maximum value, mean value and standard deviation of current image area of ROI.



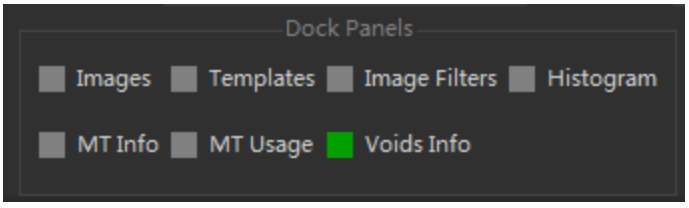
For non-closed-shape MTs like Line, Vertical Line, Horizontal Line etc., it shows the profile of it.



5.3.6 Voids

Show Voids Dock Panel

To display the Voids dock panel, user needs to check the item "Voids" on Toolbar "VIEW".

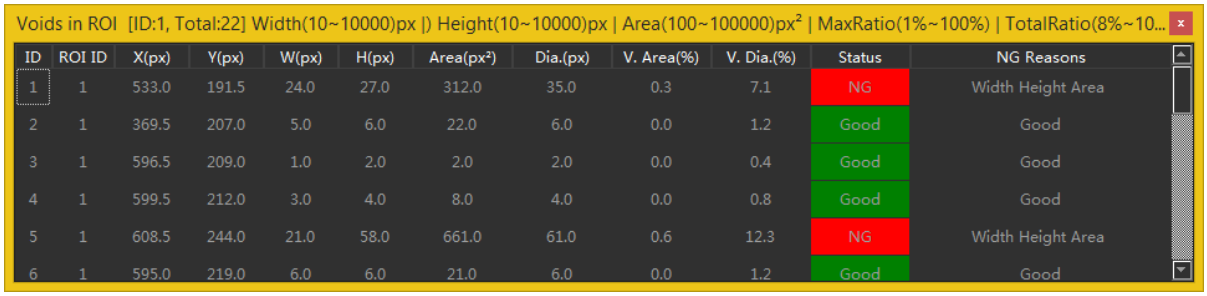


The Voids dock panel shows the properties of Voids in selected Measurement Tool 94 (ROI).

Dock Panel Title: the title shows the selected ROI ID and the Evaluation Definition 72 of the ROI

- **ID :** shows the ID of a Void.
- **ROI ID** : shows the ID of ROI which a Void belong to.
- **X :** shows the left position of a Void.

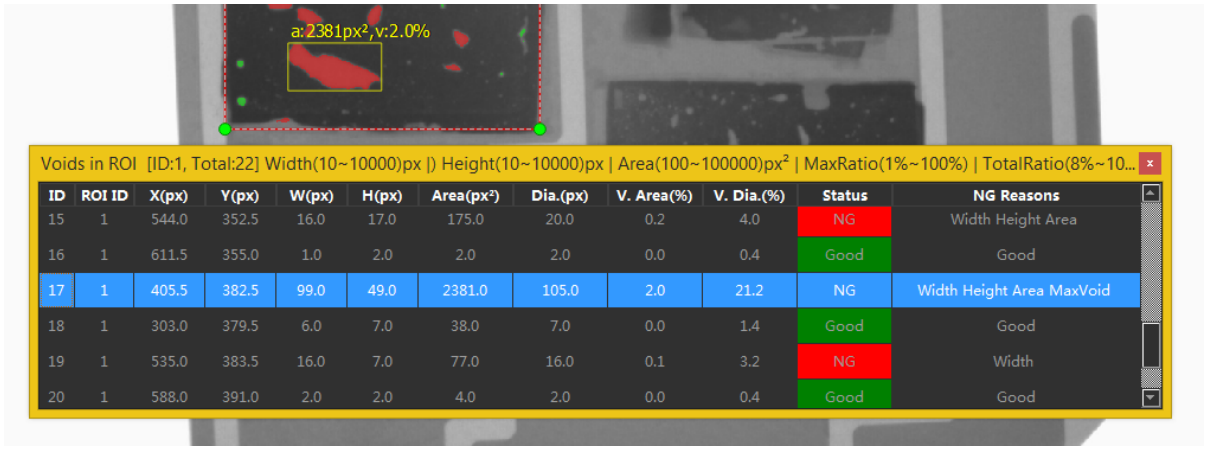
- **Y :** shows the top position of a Void.
- **W :** shows width of a Void.
- **H :** shows the height of a Void.
- **Area :** shows the Void Area.
- **Dia. :** shows the Void Diameter 71.
- **V.Area :** shows the Void Area Ratio.
- **V.Dia :** shows the Void Diameter Ratio.
- **Status:** shows the Void evaluation status after inspection.
- **NG Reasons:** shows the NG reasons if its evaluation is NG.



ID	ROI ID	X(px)	Y(px)	W(px)	H(px)	Area(px²)	Dia.(px)	V. Area(%)	V. Dia.(%)	Status	NG Reasons
1	1	533.0	191.5	24.0	27.0	312.0	35.0	0.3	7.1	NG	Width Height Area
2	1	369.5	207.0	5.0	6.0	22.0	6.0	0.0	1.2	Good	Good
3	1	596.5	209.0	1.0	2.0	2.0	2.0	0.0	0.4	Good	Good
4	1	599.5	212.0	3.0	4.0	8.0	4.0	0.0	0.8	Good	Good
5	1	608.5	244.0	21.0	58.0	661.0	61.0	0.6	12.3	NG	Width Height Area
6	1	595.0	219.0	6.0	6.0	21.0	6.0	0.0	1.2	Good	Good

Mouse Selection

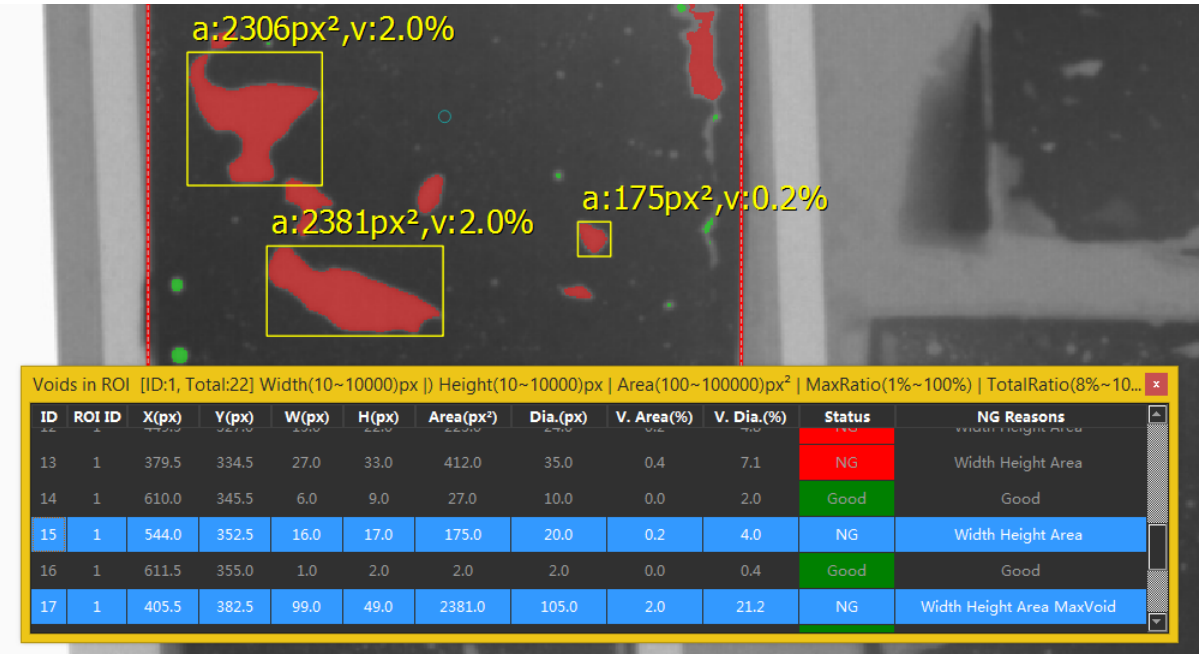
- Mouse click on any cell, the row will be selected, and the Void on displaying image will also be selected.



ID	ROI ID	X(px)	Y(px)	W(px)	H(px)	Area(px²)	Dia.(px)	V. Area(%)	V. Dia.(%)	Status	NG Reasons
15	1	544.0	352.5	16.0	17.0	175.0	20.0	0.2	4.0	NG	Width Height Area
16	1	611.5	355.0	1.0	2.0	2.0	2.0	0.0	0.4	Good	Good
17	1	405.5	382.5	99.0	49.0	2381.0	105.0	2.0	21.2	NG	Width Height Area MaxVoid
18	1	303.0	379.5	6.0	7.0	38.0	7.0	0.0	1.4	Good	Good
19	1	535.0	383.5	16.0	7.0	77.0	16.0	0.1	3.2	NG	Width
20	1	588.0	391.0	2.0	2.0	4.0	2.0	0.0	0.4	Good	Good

- If mouse click on any Void on displaying image, the row in Voids dock panel will also be selected.

- it also supports multiple selection.



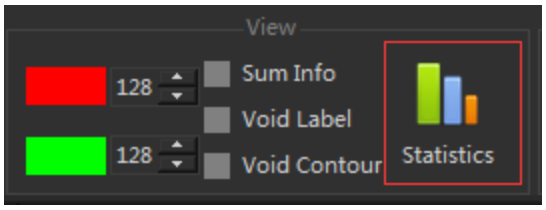
Export Settings

See "Export Settings 84" in dock "MT Info 82".

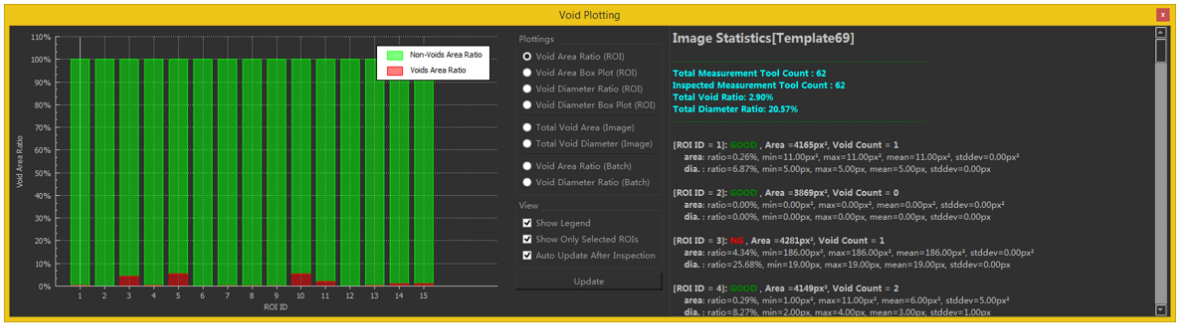
5.3.7 Void Statistics

Show Void Statistics Plotting Dock Panel

To display the Void Statistics Plotting dock panel, user needs to click button "Statistics" on Toolbar "VOID INSPECTION".



The Void Statistics Plotting dock panel will be shown as following



It supports various plotting graphs:

Void Area Ratio Bar Plot (ROI Based)

- This option will plot the Void area ratio for each ROI
- X-Axis shows the ROI ID
- Y-Axis shows the void ratio
  - Void ratio using red bar area.
  - Non-Void ratio using the green bar area.
  - Void ratio + Non-Void ratio = 100%

5.3.8 iBoard Tool Properties

Show iBoard Tool Properties Dock Panel

To display the iBoard Tool Properties dock panel, user needs to check the Button "Properties" on Toolbar "PCB INSPECTION".

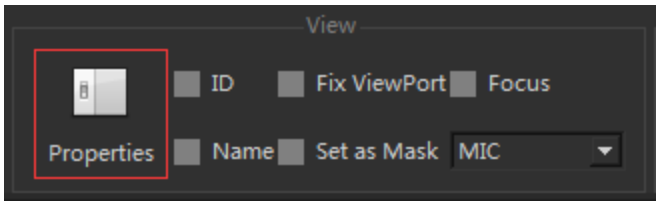


Image and Template Preview Window

- **Template ROI (left window) :** shows the Template ROI image.
- **Current Image ROI (right window) :** shows the Current Image ROI.

- Mouse moving on the item will display the pixel value.
- Double click on the preview window, a bigger window will be pop-up.

Parameter Window

Click on any Chip Tools, the parameter window will be displayed.

Table

The table shows the summary information of Chip Tools.

Table

ID	NAME	TYPE	RESULT	NOTES
1		BGA/Pins	Good	GOOD
3		General(Rect)	Good	GOOD
2		General(Rect)	Good	GOOD
4		General(Rect)	Good	GOOD
5		General(Rect)	Good	GOOD
6		General(Rect)	Good	GOOD
7		General(Rect)	Good	GOOD
8		General(Rect)	Good	GOOD
9		General(Rect)	Good	GOOD
10		General(Rect)	Good	GOOD
11		General(Rect)	Good	GOOD
12		General(Rect)	Good	GOOD
13		General(Rect)	Good	GOOD

5.4 Measurements

5.4.1 Measurement Tools

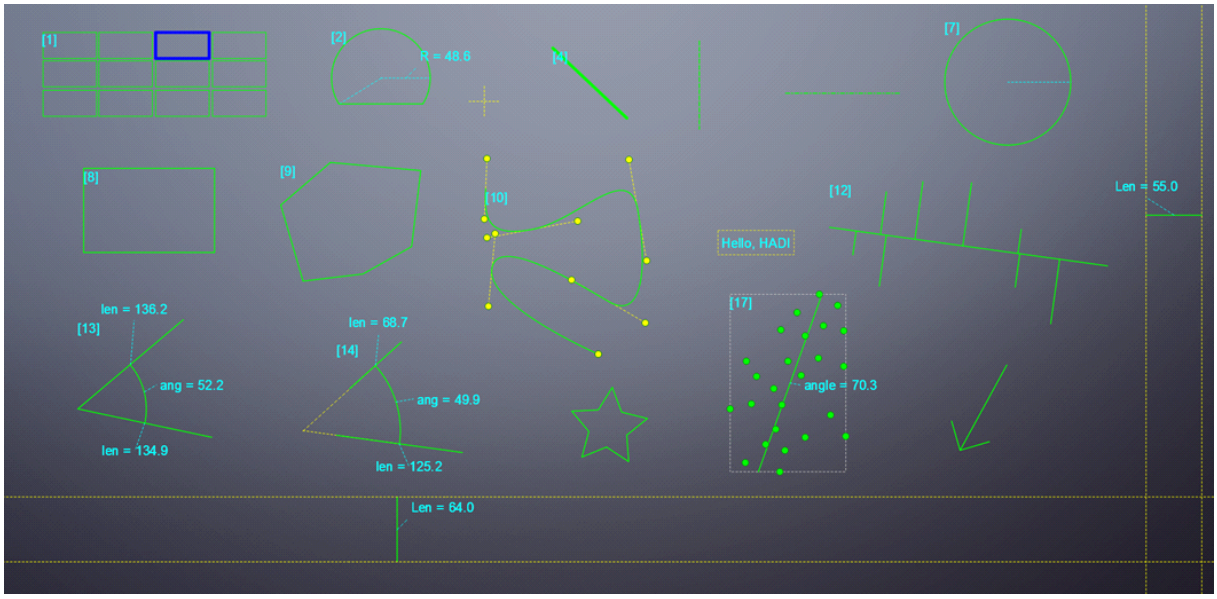
HADI provides a series of Measurement Tools (MT).

Clicking on the MT panel, user can draw MTs on the current displaying image.

User can also measure the calibrated images.

1. Grid	2. Chod	3.Lins	4. Rectangle
5. Angle	6. Text	7. Star	8. Arrow
9. Polygon	10. Spline	11. Circles	12. Parallel Lines
13. Point	14. Perpendicular	15. Curvature	16. Lasso tool

	Lines		



5.4.2 Closed Shapes

Chord

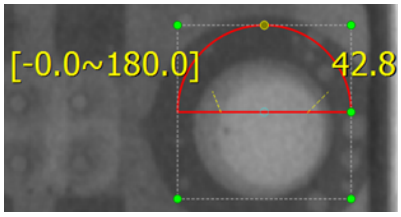
Usage

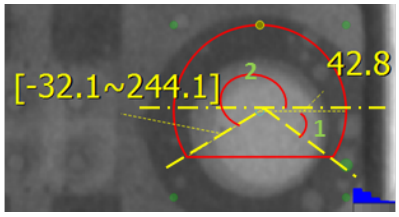
Usually used to inspect void.

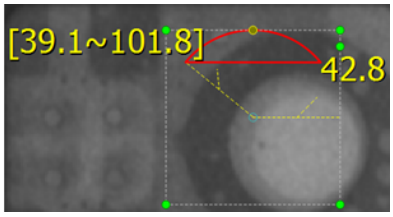
Annotation

Radius: 42.8

In this sample, 42.8 shows the radius of the potential circle.
Angle:[-32.1~244.1]
In this sample, angle 1 = -32.1, angle = 244.1







Circle

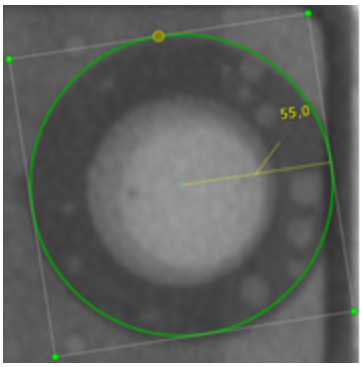
Usage

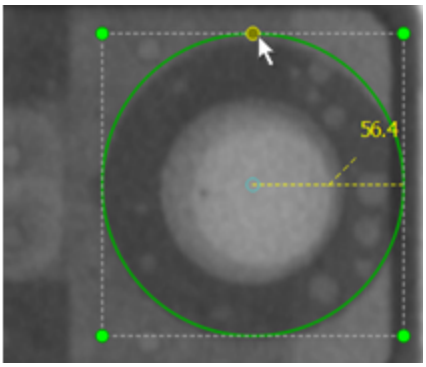
Usually used to inspect void.

Annotation

Radius: 56.4

In this sample, 56.4 shows the radius of the circle.





Circle to Circle

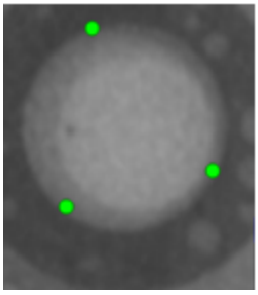
Usage

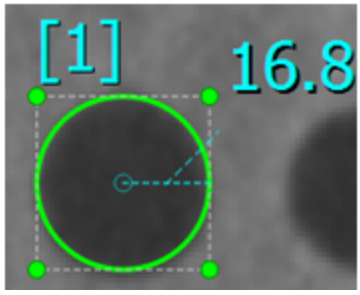
Usually used to inspect void.

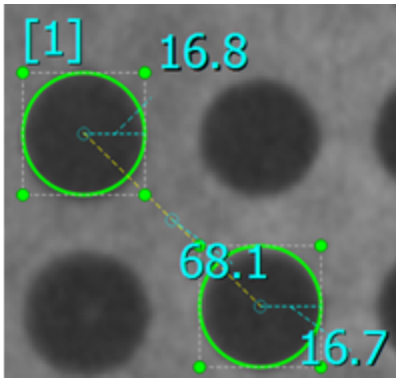
Annotation

Radius: In this sample, 16.8 and 16.7 show the radii of the two circles.

Distance: In this sample, 68.1 shows the distance between two circles(center to center).







Ellipse

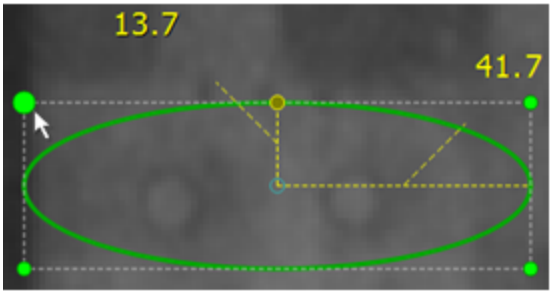
Usage

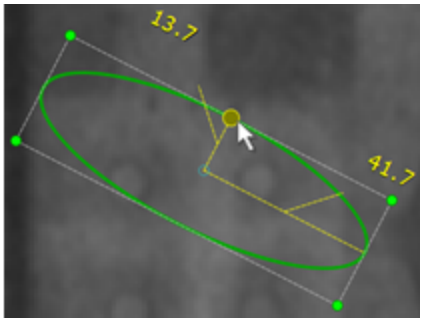
Usually used to inspect void.

Annotation

Major Radius & Short Radius:

In this sample, 41.7 and 13.7 shows the major radius and short radius of the ellipse, respectively.





Rectangle

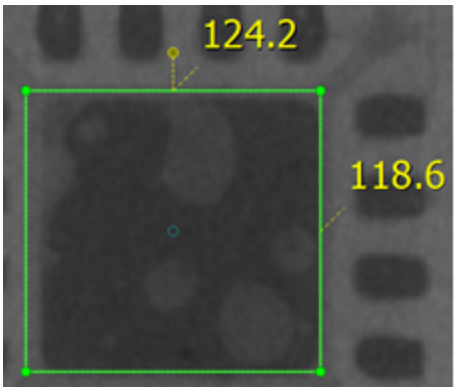
Usage

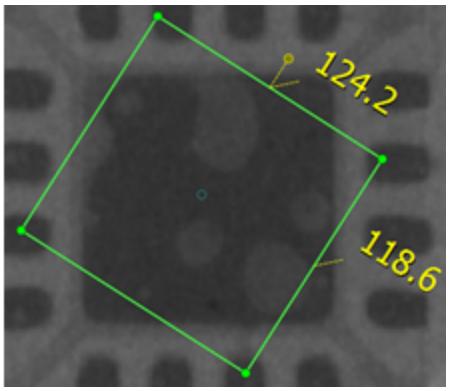
Usually used to inspect void.

Annotation

Length: In this sample, 124.2 shows the length of the rectangle.

Width: In this sample, 118.6 shows the width of the rectangle.

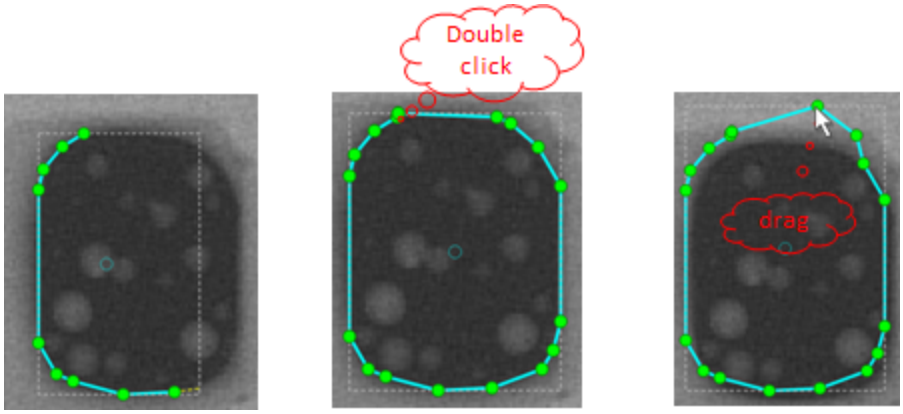




Polygon

Usage

Usually used to inspect void in irregular shapes.



5.4.3 Non-Closed Shapes

Line Tools

Usage

Usually used to measure length or height.

NOTE:
HADI uses RED color and Green color to separate the line into interval sections according to the profile Threshold. If user cannot see the different sections, please try to use other color (not red) as Measurement Tool border color.

Annotation

1. Angle: the degree between horizontal line and the free line(counter-clockwise direction)

2. Length: calculated as pixels

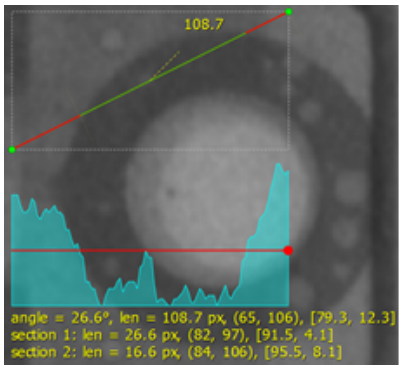
3. Intensity Value: (65,106) and [79.3, 12.3] are the (min, max) and [mean, variance] intensity value of the line.

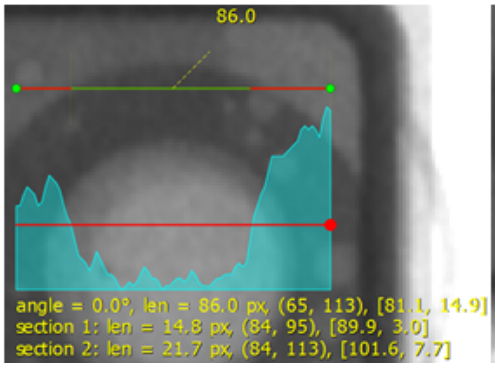
4. Section: length and intensity value of the red part.

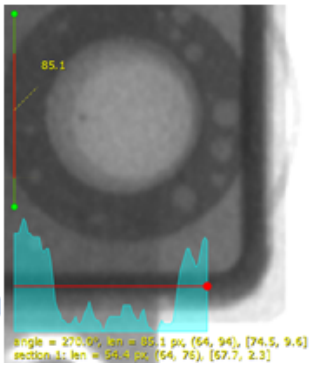
NOTE:

1. Double clicking changes the measure part(shown as red color)

2. Only measure(red part) information is shown in annotation.







Text Tool

Usage

Usually used to insert some information about Measurement Tools.

Ratio Tool

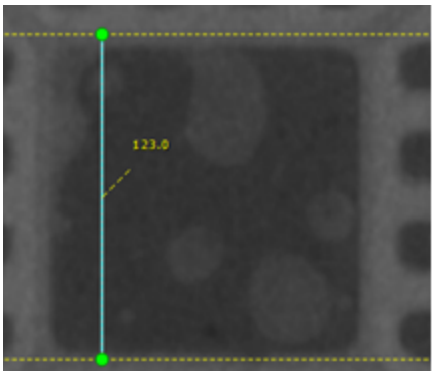
Distance Tool

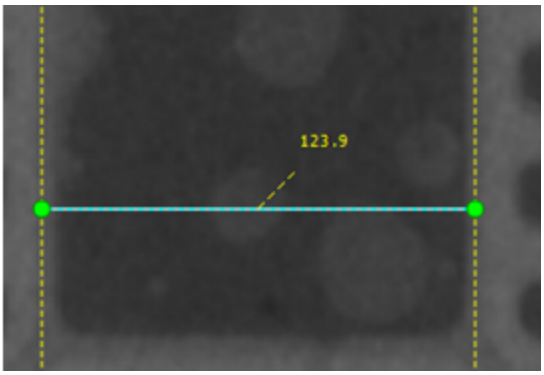
Usage

Usually used to measure length or width of a chip.

Annotation

Length: HADI will measure the length from the start to the end of the ruler and calculated as pixels.





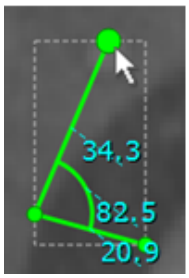
Angle Tools

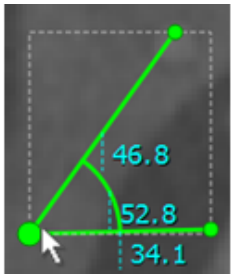
Usage

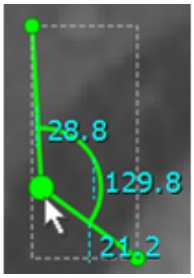
Usually used to measure length or width of a chip.

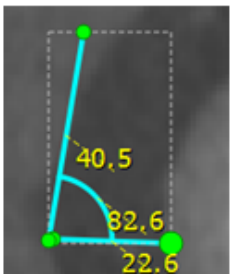
Annotation

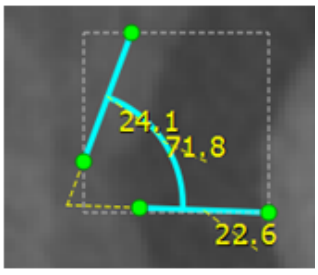
Length: HADI will measure the length from the start to the end of the ruler and calculated as pixels.











Others

5.4.4 MT - PCB

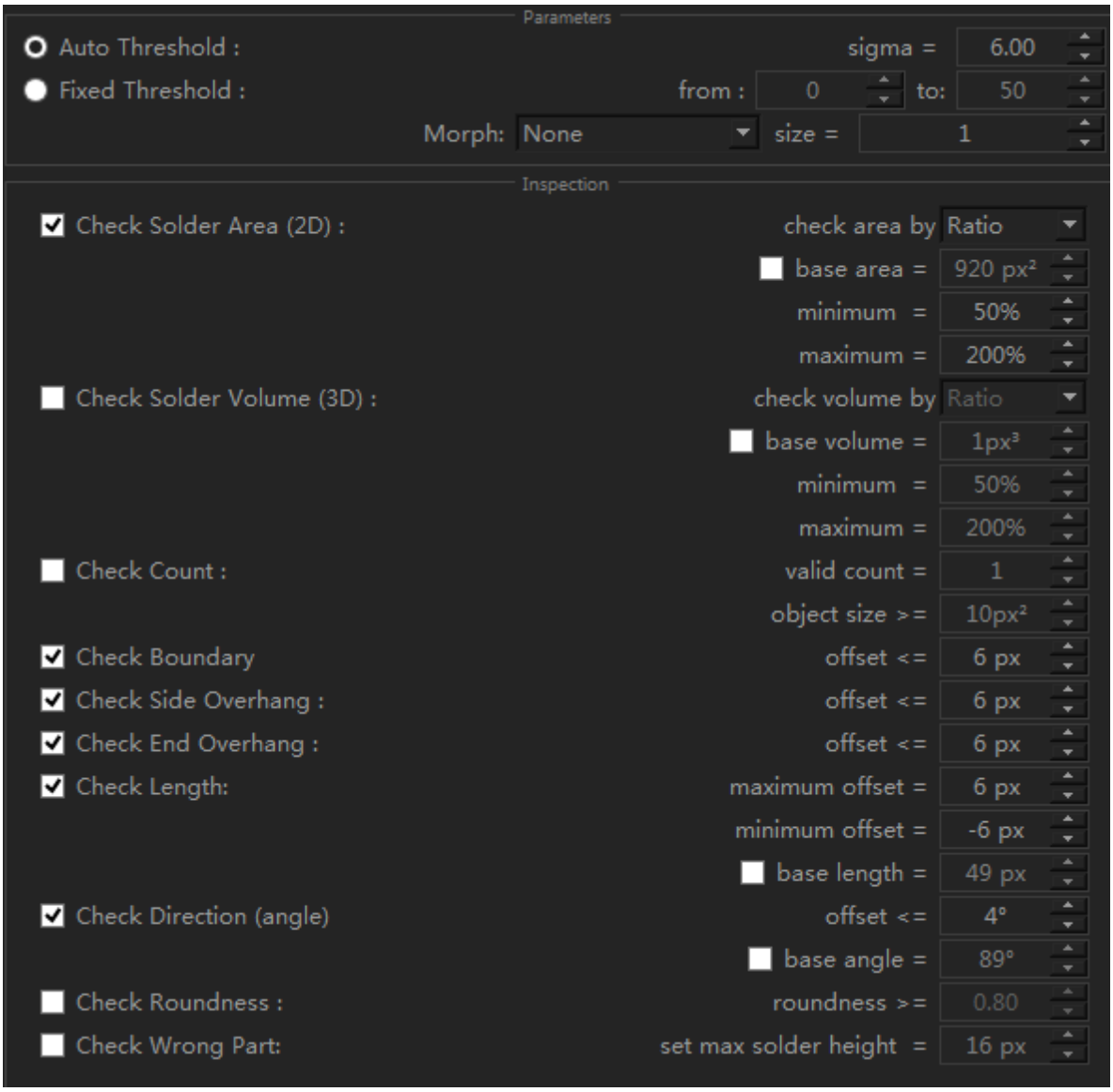
HADI - iBoard has provided a series of Chip tools to help inspecting PCB chips. Now it supports various standard chips and their variations, such as C-Chip, R-Chip, L-Chip, QFP/QFN, BGA, Mic etc.

General Tool

Usage

Usually used to inspect C-Chip. Click icon  to add a General Tool from "PCB INSPECTION" tab.

Also can be used to check some important features of other unknown chips. For example, to check the boundary, angle, object count, length and roundness of some unknown chips.



Parameter Settings

Auto Threshold

Segment the target object automatically by sigma value.The sigma value controls the segmentation area of target object. The sigma also represents the coherence of the target object. Default value is 6. It is similar with the “Standard Deviation of Object Intensity Values”, so if the object has homogeneous intensity values, the Sigma can use smaller value. While the object has inhomogeneous intensity values, its standard deviation can be larger, the Sigma should be larger.

Fixed Threshold

Using fixed threshold to segment the target object. The target object’s intensity value is set from “from value” to “to value”. For example, if we use 30 ~ 50, it means the segmentation intensity values of the object are between 30 ~ 50.

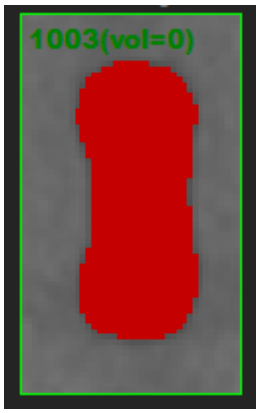
Morph

Apply morphology after segmentation. There are 4 morphology operations with kernel size.

Inspection Items

Check Solder Area

Check the solder area size. The area size is just the segmented RED area shows in the preview window “Current Image ROI”



- The red area is the solder area size. The number 1003 shows the area size, and if checked “Check Solder Volume” option, the volume size will be shown as (vol=#).
- User can also define the Base size.
- Base Value: Base value tries to replace the unstable Template value when calculating the Ratio.
- Check solder area by Ratio
  - If base size checked, Ratio = area size in target image / base size.
  - If base size unchecked, Ratio = area size in target image / area size in Template image.

    NG DEFINITION: Ratio < minimum or Ratio > maximum.
- Check solder area by Pixel count

  NG DEFINITION: Pixel Count < minimum or Pixel Count > maximum

Check Solder Volume

Same as solder area calculation. The difference is that the value is defined from the internal Volume calculation algorithm.

Check Count

Check that how many objects inside the General Tool. Objects size (pixel area size) that less than defined size will be ignored.

NG DEFINITION: Count in image is not equal to defined count.

Check Boundary

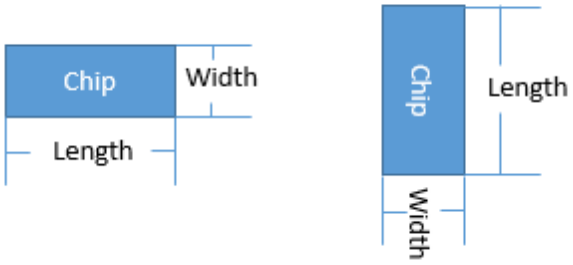
Check that there is no object attached to the boundary border.The boundary offset defines the area that larger than the object size from TOP, LEFT, RIGHT, BOTTOM direction.

NG DEFINITION: Any object that attached to the boundary border.

Check Side Overhang

Check the side overhang. Side overhang evaluates the chip's movement along the width direction. An offset define the maximum allowed movement pixel value.

NG DEFINITION: Overhang > Defined Offset



Check End Overhang

Check the end overhang. End overhang evaluates the chip's movement along the length direction. An offset define the maximum allowed movement pixel value.

NG DEFINITION: Overhang > Defined Offset

Check Length

Check the length offset of a chip in target image comparing to the chip length in Template or defined base length.

NG DEFINITION:

- Use base: Chip length in Image - Base length < minimum offset or
- Use base: Chip length in Image - Base length > maximum offset or
- Not Use base: Chip length in Image - Chip length in Template < minimum offset or
- Not Use base: Chip length in Image - Chip length in Template > maximum offset

Check Direction(angle)

Check the center line direction of a chip.

NG DEFINITION: Angle Offset > Defined Offset

Check Roundness

Check the roundness of the boundary of a chip.

NG DEFINITION: Roundness < Defined Roundness

Check Wrong Part

Check whether there is another kind of chip mounted in this position. Now supports wrong mount among R-Chip, L-Chip and C-Chip.

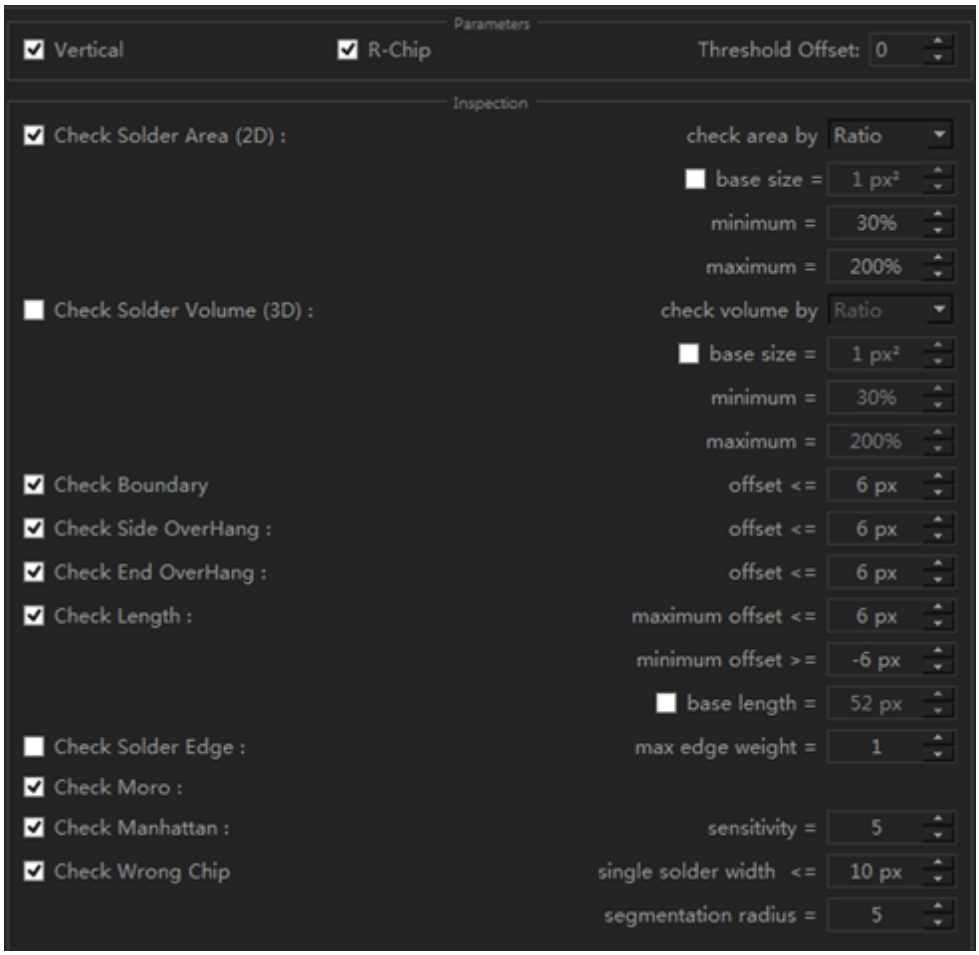
NG DEFINITION: R-Chip or L-Chip mounted in this position.

R/L Chip

Usage

Usually is designed to inspect both R-Chip and L-Chip.

Click icon to add R/L Chip Tool from "PCB INSPECTION" tab.



Parameter Settings

Vertical

Use this check box to define the layout of R-Chip or L-Chip. The direction can be automatically determined by algorithm. In case the direction is wrong, user need to use the checkbox to modify it.

R-Chip

Use this checkbox to define the target chip is R-Chip or L-Chip. The chip type can be automatically determined.

- Unchecked status: Chip is L-Chip.
- Checked status: Chip is R-Chip.

Threshold Offset

The segmentation for the target chip is automated. The “Threshold Offset” will be added to the automatically determined Threshold value.

Inspection Items

Check Solder Area

Check the solder area size. User can define the base size. (See the Discussion on solder area and base in “General Tool”)

- Check solder area by Ratio
  - ➢ If base size checked, Ratio = area size in target image / base size.
  - ➢ If base size unchecked, Ratio = area size in target image / area size in Template image.

  NG DEFINITION: Ratio < minimum or Ratio > maximum.
- Check solder area by Pixel count

  NG DEFINITION: Pixel Count < minimum or Pixel Count > maximum

Check Solder Volume

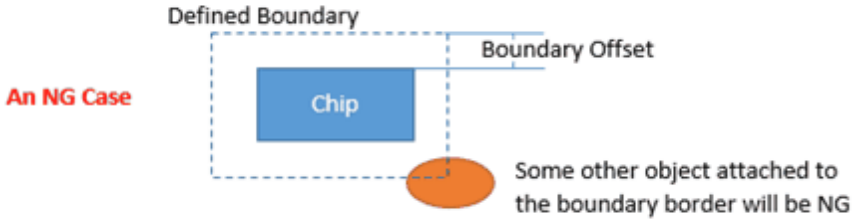
Same as solder area calculation. The difference is that the value is defined from the internal Volume calculation algorithm.

Check Boundary

Check that there is no object attached to the boundary border.

The boundary offset defines the area that larger than the object size from TOP, LEFT, RIGHT, BOTTOM direction.

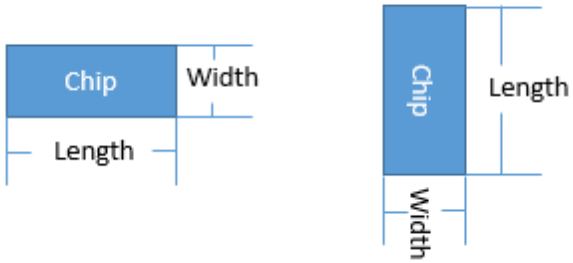
NG DEFINITION: Any object that attached to the boundary border.



Check Side Overhang

Check the side overhang. Side overhang evaluates the chip’s movement along the width direction. An offset define the maximum allowed movement pixel value.

NG DEFINITION: Overhang > Defined Offset



Check End Overhang

Check the end overhang. End overhang evaluates the chip's movement along the length direction. An offset define the maximum allowed movement pixel value.

NG DEFINITION: Overhang > Defined Offset

Check Length

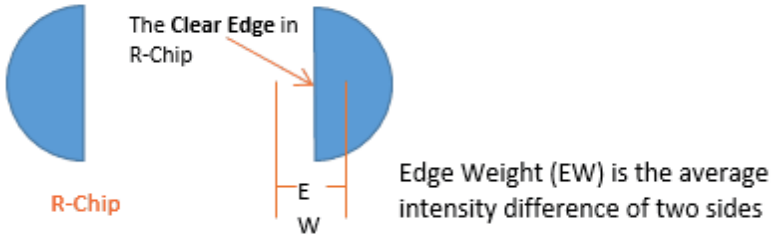
Check the length offset of a chip in target image comparing to the chip length in Template or defined base length.

NG DEFINITION:

- Use base: Chip length in Image - Base length < minimum offset or
- Use base: Chip length in Image - Base length > maximum offset or
- Not Use base: Chip length in Image - Chip length in Template < minimum offset or
- Not Use base: Chip length in Image - Chip length in Template > maximum offset

Check Solder Edge

This option is for R-Chip. It tries to check the intensity value between the Clear Edge.



Check Moro

Check the Moro of a chip. Fully automatic.

Check Manhattan

Check the Manhattan error of a chip. A sensitivity value controls the inspection accuracy. Default value is 5

Check Wrong Chip

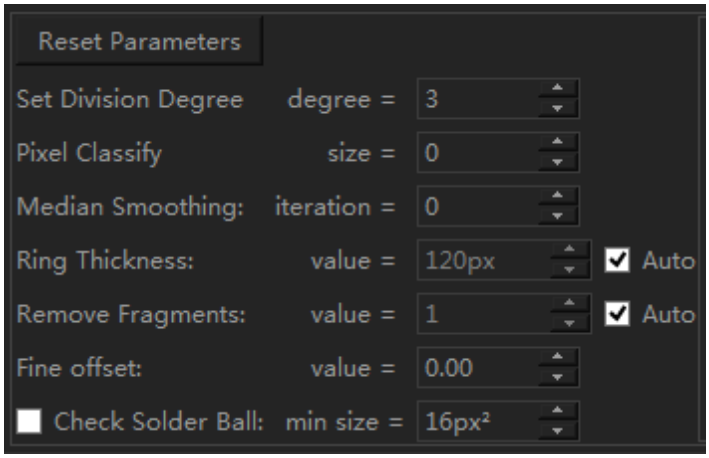
Check whether there is another kind of chip mounted in this position. Now supports wrong mount among R-Chip, L-Chip and C-Chip.

NG DEFINITION: Wrong chips mounted in this position.

Ring Tool

Usage

Usually is designed to inspect Mic. Click on  **to add Ring Tool from "PCB INSPECTION" tab.**



Parameter Settings

Reset Parameters

Reset all parameters to default.

Set Division Degree

The inspection algorithm divide the Ring into a certain blocks. Here the division degree defined how many blocks will be divided. Divided Blocks = 360 / Division Degree.

Default value is 3, the Ring is divided into 120 blocks.

NG DEFINITION: If any block contains no segmented pixel, recognized as Disconnected NG.

Pixel Classify

Deprecated.

Median Smoothing

Deprecated.

Ring Thickness

For the Mic segmentation, please use"Auto".

Remove Fragments

For the Mic segmentation, please use"Auto".

Find Offset

Slightly tuning the mic segmentation result.

- The higher value, the segmentation will be more strictly.
- The lower value, the segmentation will be more loosely

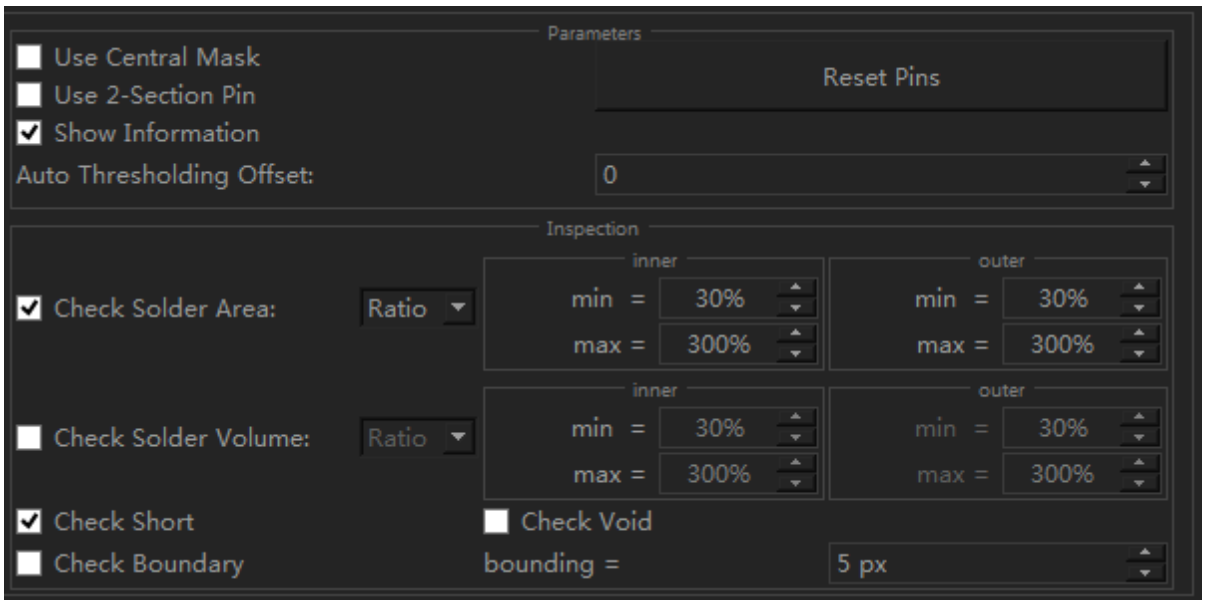
Check Solder Ball

Check the Solder Ball. User need to define the minimum solder ball size.

QFP/QFN Tool

Usage

Usually can be used to inspect QFP-lick Chip. Click icon to add a QFP/QFN Tool from "PCB INSPECTION" tab.



Parameter Settings

Use Central Mask

Use central mask to remove objects inside the central mask ROI. The ROI is using Yellow Dashed rectangle.

Generally, the algorithm will automatically remove the center object of a QFP.

Reset Pins

Reset the Pin shape.

Use 2-Section Pins

In Checked status, each Pin will be divided into two parts. And the evaluation of Area size and Volume size will be separated into inner pin and outer pin.

Show Information

Show the Area and Volume information of each Pin.

Auto Thresholding Offset

QFP tool use full adaptive Thresholding technique. If user set the Thresholding offset, the final thresholding value = Adaptive Thresholding value + Thresholding offset.

Inspection Items

Check Solder Area

Check the solder area size. User can define the base size.

- Check solder area by Ratio
  Ratio = area size in target image / area size in Template image.
  NG DEFINITION: Ratio < minimum or Ratio > maximum.
- Check solder area by Pixel count
  NG DEFINITION: Pixel Count < minimum or Pixel Count > maximum

Check Solder Volume

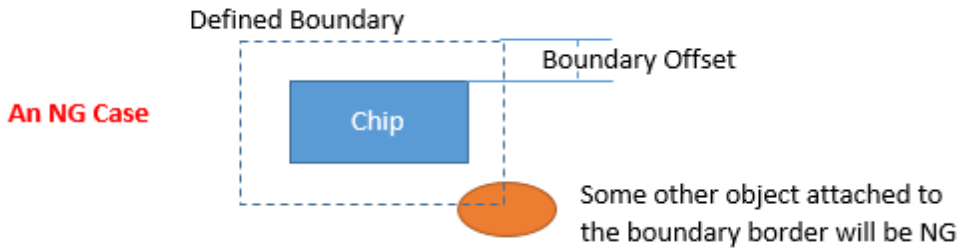
Same as solder area calculation. The difference is that the value is defined from the internal Volume calculation algorithm.

Check Short

Check short among Pins.
NG DEFINITION: Any two pins are connected

Check Boundary

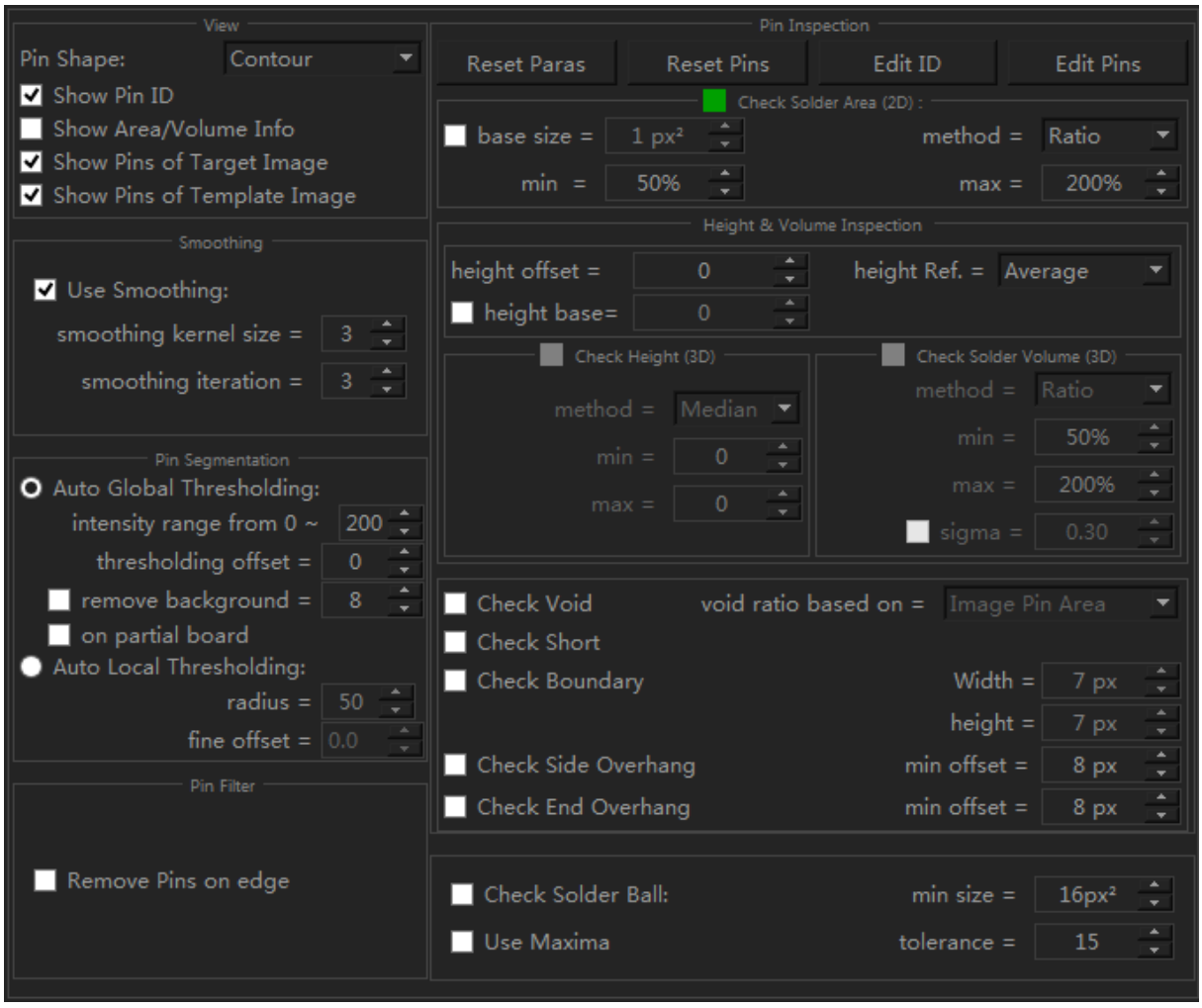
Check that there is no object attached to the boundary border. The boundary offset defines the area that larger than the object size from TOP, LEFT, RIGHT, BOTTOM direction.
NG DEFINITION: Any object that attached to the boundary border.



BGA/Pins Tool

Usage

Usually designed to inspect BGA, QFP and any other chip that contains pins. It is a kind of General tool to inspect chips with pins.



View

Show Pin ID

Show Pin ID inside ROI.

Show Area/Volume Info

Show Area/Volume information of a Pin inside ROI.

Show Pins of Target Image

Show Pin Contour of Target image, its color is same with ROI border color.

Show Pins of Template Image

Show Pin Contour of Template image, its color is Cyan.

Smoothing

Use Smoothing

Check to use Gaussian smoothing.
Gaussian Kernel and iteration can be defined.

Pin Segmentation

Auto Global Thresholding

Check to use adaptive global thresholding.

The adaptive thresholding algorithm will choose a suitable Threshold value between the defined intensity ranges. Now only the maximum value of the range can be defined. For example, default value is 200. It means the adaptive thresholding algorithm will choose a value between 0~200 to separate the background and foreground (object).

The “remove background” option will slightly remove the background.

If the BGA is located on the partial board. Use can check the “on partial board” to make the segmentation more accurate.

Auto Local Thresholding

User can also choose the auto local thresholding to do the segmentation. The radius defines that for each pixel, how many surrounded pixels need to be evaluated. And find offset can tuning the segmentation result slightly.

Pin Filter

Remove Pins on Edge

Check this option to remove any pins that attached on the Tool border.

Pin Inspection

Reset Paras

Reset all parameters as default.

Reset Pins

Reset all pin shapes according to current parameters.

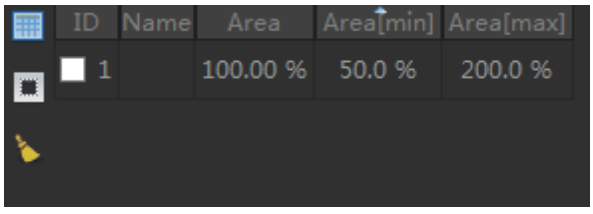
Edit ID

Each Pin ID can be edited by this button.

- Click this button, the ROI goes into Pin-Editing state. User can click each Pin one by one to assign ID from 1.
- Click it again will end Pin-Editing state.

Edit Pins

Click this button, the Pin Editor will appear. Double click each cell, use can edit its value.
User can set different Base value, Size restraint and Name etc.



Check Solder Area

Check the solder area size. User can define the base size.

- Check solder area by Ratio

- If base size checked, Ratio = area size in target image / base size.
- If base size unchecked, Ratio = area size in target image / area size in Template image.

  NG DEFINITION: Ratio < minimum or Ratio > maximum.

- Check solder area by Pixel count

  NG DEFINITION: Pixel Count < minimum or Pixel Count > maximum

Height & Volume Inspection

Check Short

Check short among Pins.

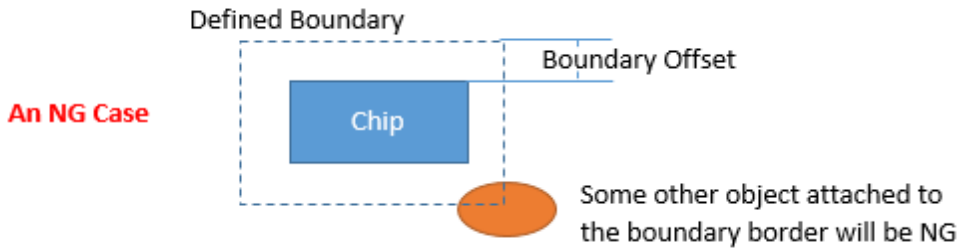
NG DEFINITION: Any two pins are connected

Check Boundary

Check that there is no object attached to the boundary border.

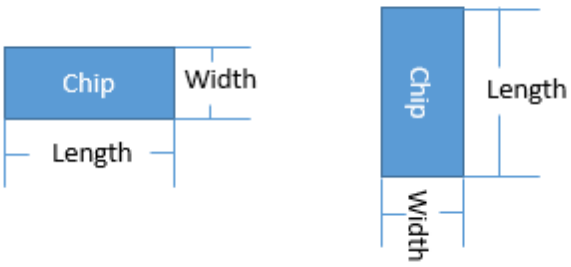
The boundary offset defines the area that larger than the object size from TOP, LEFT, RIGHT, BOTTOM direction.

NG DEFINITION: Any object that attached to the boundary border.



Check Side Overhang

Check the side overhang. Side overhang evaluates the chip's movement along the width direction. An offset define the maximum allowed movement pixel value.



Check End Overhang

Check the end overhang. End overhang evaluates the chip's movement along the length direction. An offset define the maximum allowed movement pixel value.

Check Solder Ball

Check the Solder Ball. User need to define the minimum solder ball size.

5.5 Inline Inspection

5.5.1 Inline Introduction

- Inline Inspection Features 114
- Inline Inspection Approaches 114
- Inline Inspection Conditions 114
- Inline Inspection Performance 115

Inline Inspection Features

HADI supports inline inspection. It has following features

- Support image based intuitive ROI teaching, no need Geber files.
- Support powerful X-Ray attenuation mask tools to do compensation.
- Support various inline inspection approaches.
- Support super fast image alignment function.

Inline Inspection Approaches

Teaching a Template, then user can do inspection for incoming images by
- UDP Communication 121
- Watch Folder Tool 116

Inline Inspection Conditions

For now, HADI only support 8-bit image inspection.

Image Quality Conditions

To make sure the inspection accuracy, user need to provide the same conditions for Template image and Incoming images.
- Take images in same voltage and current
- Take images with same averaging count
- Convert images with same Histogram condition.

Image Alignment Conditions

To guarantee the image alignment works well. user need to make sure that,
- The image rotation should less than 30 degree comparing to Template image.
- The image translation should less than 300 pixels comparing to Template image.
- The image scaling should between 0.9 ~ 1.1 comparing to Template image.

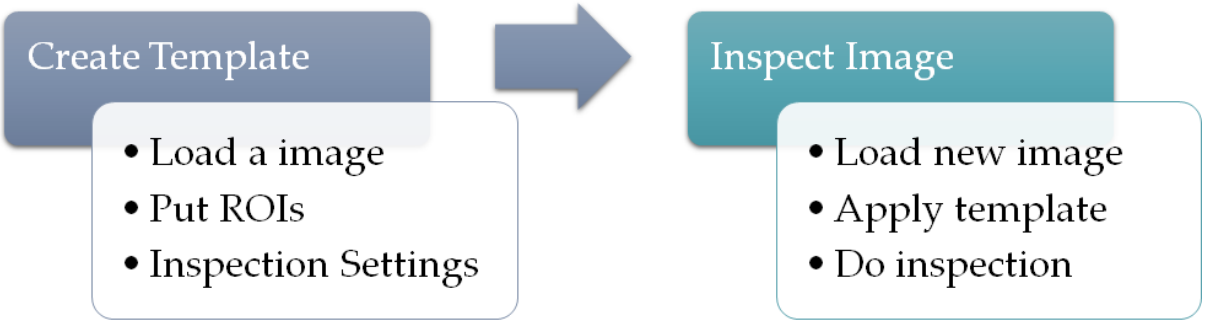
Inline Inspection Performance

- Image loading : > 500 images in 32-bit system. (support 64-bit program)
- Image Alignment < 300 ms for 1000x1000 images.
- Image Inspection < 100 ms for average 7 ROIs.
- Reporting. (Incoming)

5.5.2 Void Inspection Procedure

We support Inline Inspection in HADI-InspectionPro, HADI-iBoard, and HADI-iBoardPro.

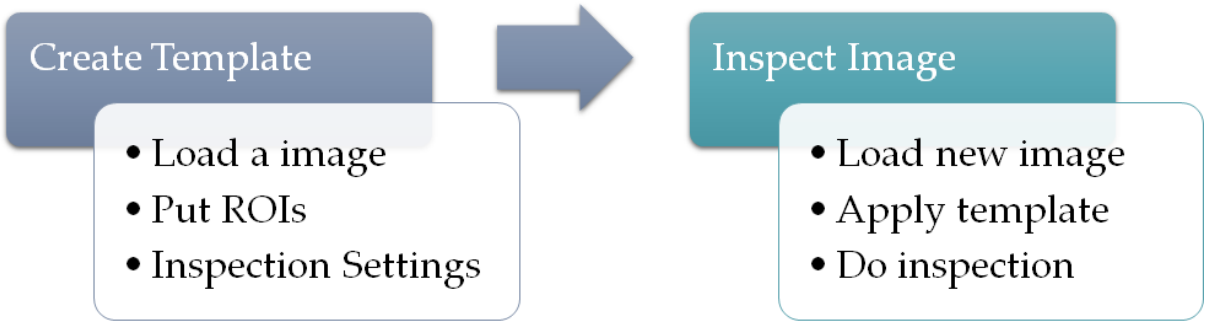
- Create a template 57
- Create ROIs
- Load images into HADI.
- Automatically fit the right template and inspect images.



5.5.3 PCB Inspection Procedure

We support Inline Inspection in HADI-InspectionPro, HADI-iBoard, and HADI-iBoardPro.

- Create a template 57
- Teach a template 58
- Load images into HADI.
- Automatically fit the right template and inspect images.

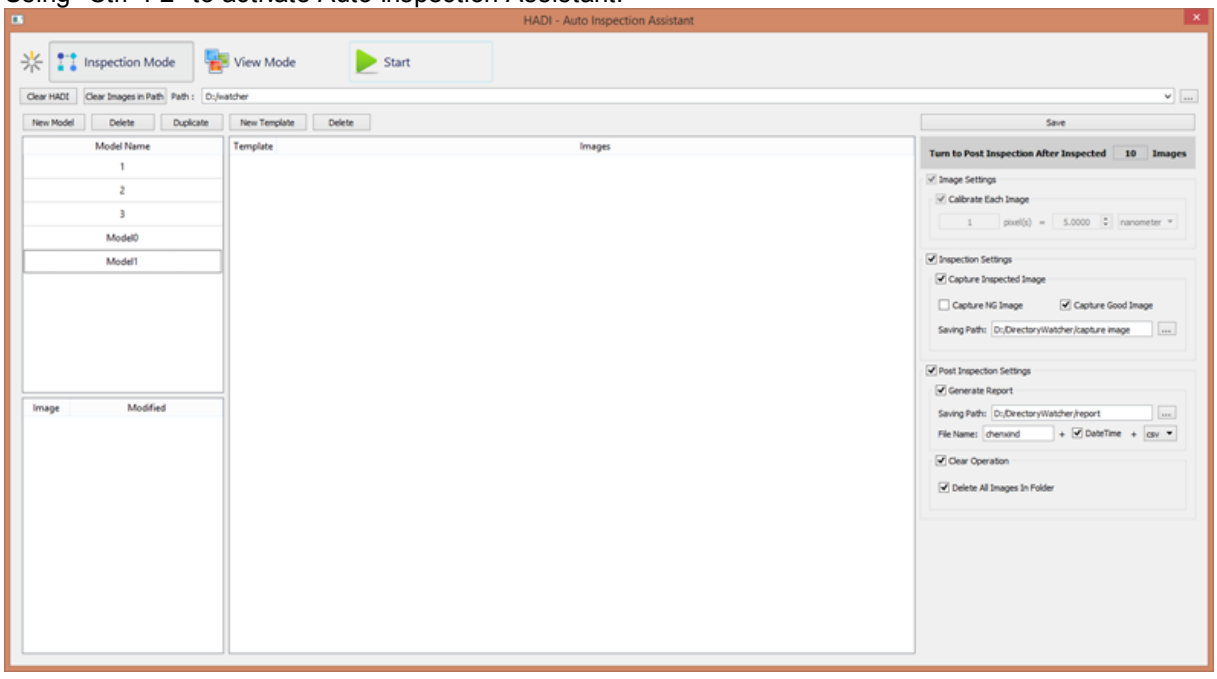


5.5.4 Auto Inspection Assistant

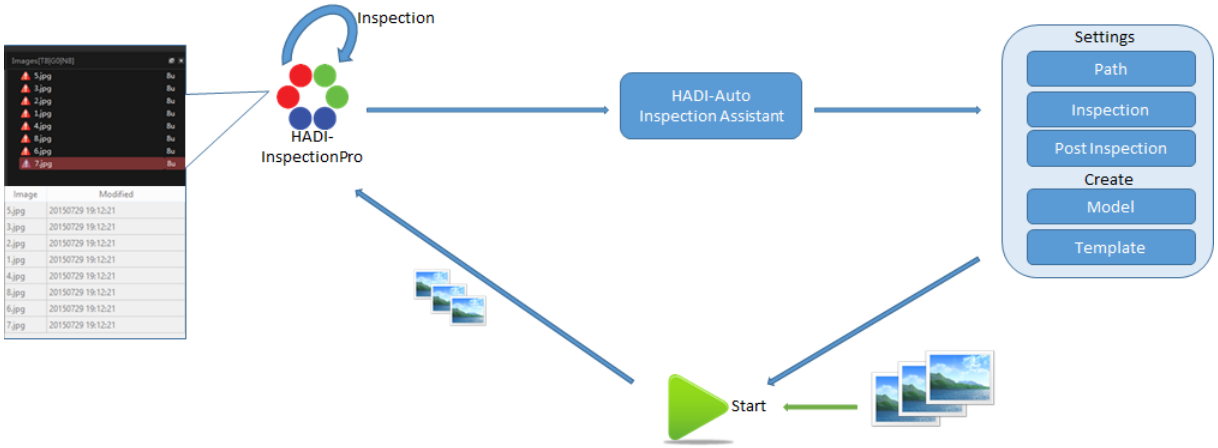
HADI supports a Watch Folder Tool -- Auto Inspection Assistant to automatically inspect images in target folder.

Start Auto Inspection Assistant

Auto Inspection Assistant can only be used when HADI is activated.
Using "Ctrl+F2" to activate Auto Inspection Assistant.



Working Procedure



Working Mode

Auto Inspection Assistant includes two modes

View Mode

- Inspect the images in the target folder according to the inspection settings.
- Images in target folder will be sent to HADI to do inspection.

Inspection Mode

- Images in target folder will be sent to HADI without inspection, only to view.
- View Mode is usually used when user hasn't created the corresponding template yet.

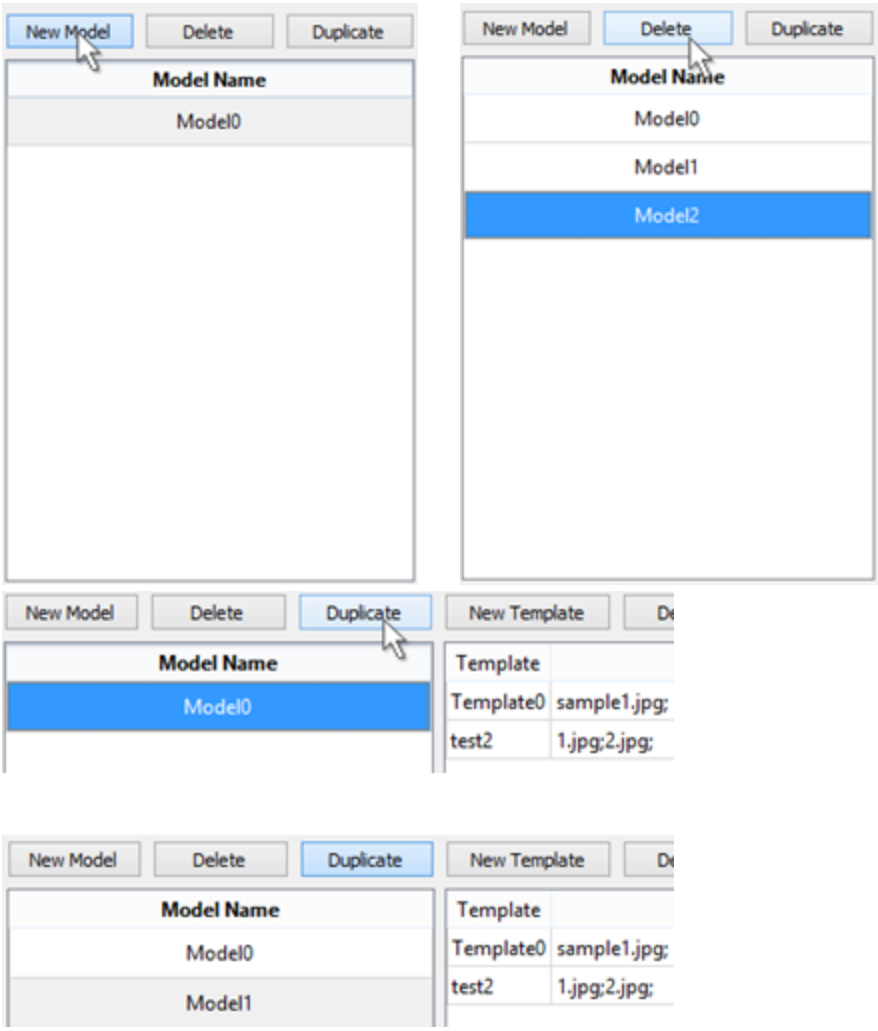
Path and Model

Path

Set the path, HADI supports multiple language of the directory name.(e.g., English, Korean, Chinese, etc.)

HADI will inspect images in the folder that user selected.

Model

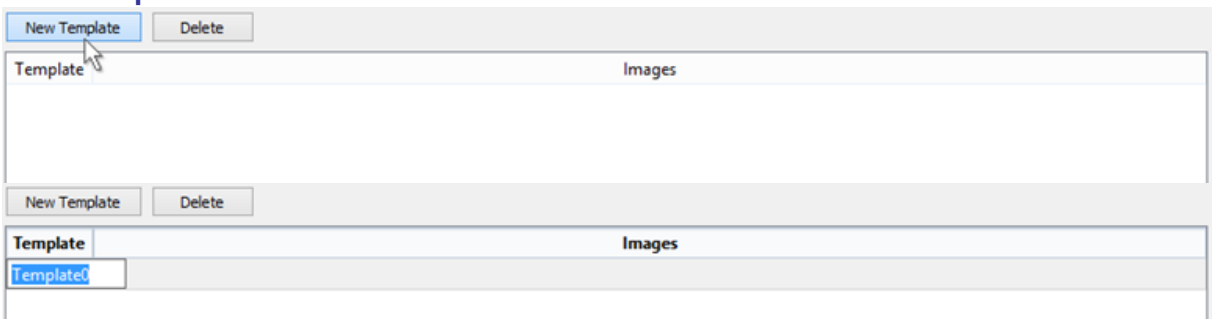


1. Create a model by clicking "New Model"
2. Click "Delete" to delete the selected model.
3. select a model and click "Duplicate", the selected model and all the templates it included will be copied to a new model.

Template

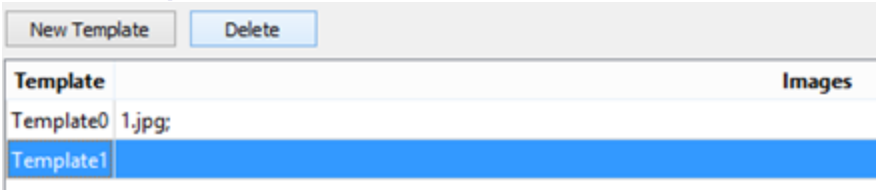
Create multiple templates in a model to inspect a series of images.

New Template



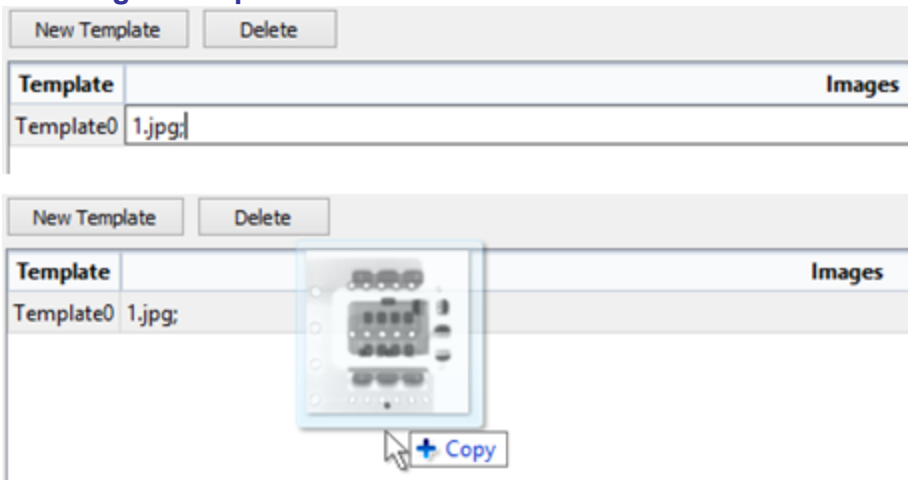
Click "New Template" to create one or more templates in selected model, and click the template name to edit it.

Delete Template



Select a template and click "Delete", the template and all the images included in the template will be deleted.

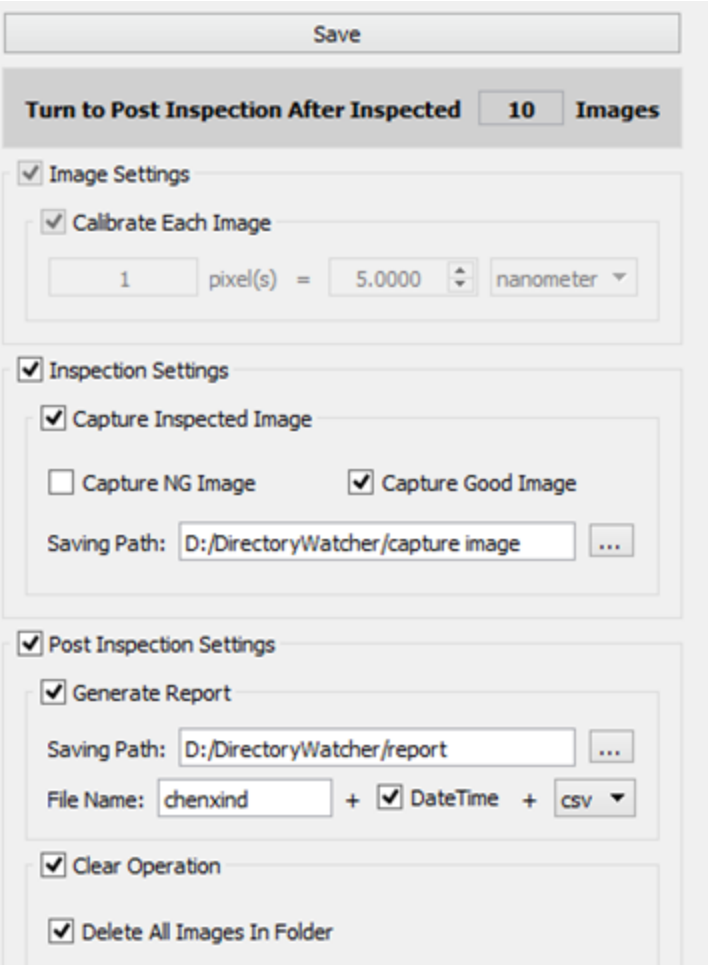
Add images Template



Two methods to add images to the corresponding template:

- manually input images' name(with extensions) by user.
- select a template first, then drag images directly to the selected template.

Inspection Settings



Save

Save the current models, templates and inspection settings.

How many images to inspect each time

In this sample, after every 10 images, HADI turns to Post Inspection state.

Calibration

Only works in View Mode.

Inspection Settings

Only works in Inspection Mode.

Choose to capture the inspected images or not. If captures, select the path to save the captured images(NG Images, Good Images or both of them).

Note: Capture images affects inspection speed.

Post Inspection Settings

Only works after every 10(in this sample) images in Inspection Mode.

Choose to generate report or not. If generates, select the path to save the report. It's able to edit file name and add date and time to the report.

HADI now supports two formats: *.csv, *.xls.

User can find out the reports in the selected path.

Clear Operation

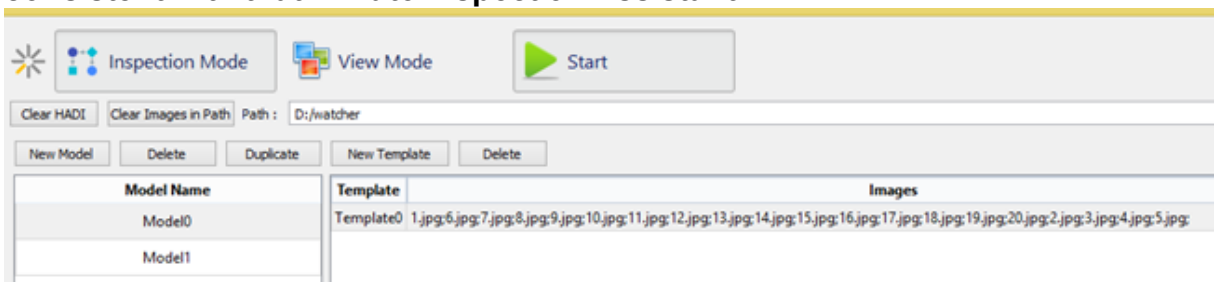
Choose to clear the inspection folder or not. If choose, HADI will delete all the images in the inspection folder every 10(in this sample) images.

Inspection

Start Inspection

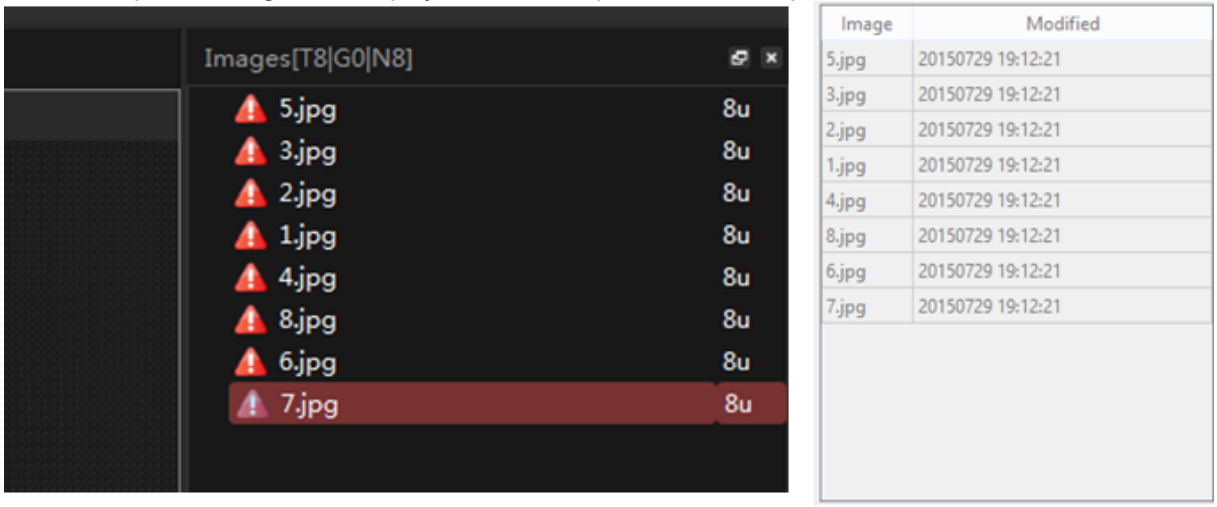
Finishing all the settings, click "Start" to inspect images.

Note: Template name in HADI and image name in folder should be consistent with that in Auto Inspection Assistant.



Inspection Results

Inspected images are displayed on the left panel of Auto Inspection Assistant.



5.5.5 UDP Communication

HADI supports UDP Communication to help user easily control HADI and cooperate with other software.

HADI has an internal server that can receive various UDP commands.

Description

Each command will have a return message to show the execution result, some simple command only have SUCCESS and FAILURE with few text description. While some of them have detail information.

For example

If client sends command HADI_UDP_GET_ROILIST, client need to processed received detail messages.

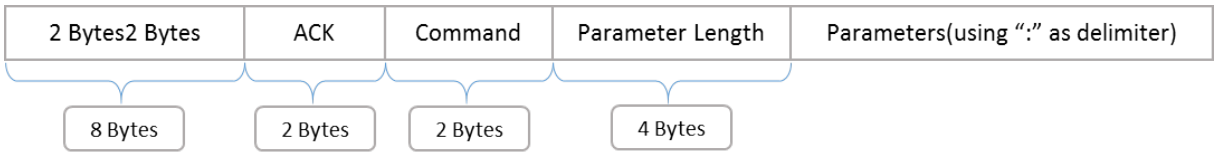
Since UDP doesn't have acknowledgment info, we implement ACK in higher level protocol. ACK is a integer number that make client to know the return message came from which command. For example, if client has sent ACK = 5, ACK = 6, ACK = 7 three commands, later client will only receive ACK = 5, ACK = 7. If client didn't receive ACK=6 for a long time, client probably need to send message again. This is rarely case, but happens.

UDP Communication Protocol

UDP Port

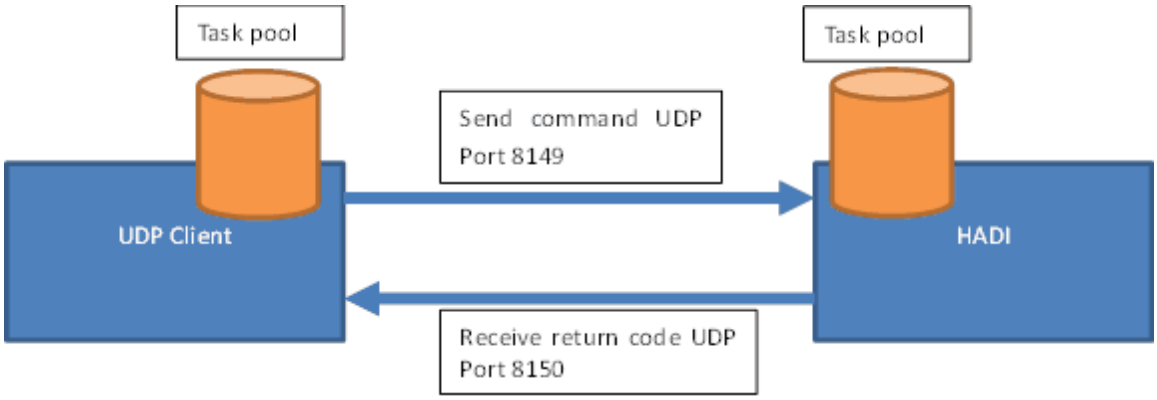
sending 8149, receiving 8150

UDP Protocol Format



Byte	Type	Usage	Detail
0~7	string	Magic Number	"HADI"
8,9	unsigned short	ACK Number	1, 2, 3, 4 ……loop
10,11	unsigned short	Commands	See below table
12~15	int	Parameter Length	See below table

Deployment diagram



UDP Client Implement guide

1. Create a Task Pool to save each task, ACK as unique ID
2. Create a Thread to receive return package from HADI
3. Create a Thread to check each task, if timeout, clean the task

UDP Command

Command Type	Command	Sending Parameters	Return Error code (using 'command' field)	Return Parameter
Client To HADI (Passive)	#define VUDP_ADDIMAGE 100	[string, image path]; [string, image path]; ..., [string, image path]	#define VUDP_RET_SUCCESS 0 #define VUDP_RET_FAILURE 1	[string, image uuid]; [string, image uuid]; ... [string, image uuid]
	#define VUDP_ADDIMAGE_WITHTEMPLATE 101	[string, image path]; [string, template name]	#define VUDP_ERR_PARAMETER 2 #define	[string, image id]; [string, "NG", "GOOD", "AlignmentError", "NoObject"]

Command Type	Command	Sending Parameters	Return Error code (using 'command' field)	Return Parameter
	#define VUDP_REMOVEIMAGE 102	[string, uuid]		
	#define VUDP_REMOVEALLIMAGE 103			
	#define VUDP_INSPECTIMAGE 104	[string, image uuid]; [string, template name];		
	#define VUDP_CALIBRATION 105	[string, image uuid]; [string, x pitch]; [string, y pitch]		
	#define VUDP_SHOWWINDOW 106		VUDP_ERR_MEMORY 3	
	#define VUDP_HIDEWINDOW 107			
	#define VUDP_SHOWIMAGE 108	[string, image uuid]	#define VUDP_ERR_NO_IMAGE 4	
	#define VUDP_GENERATEREPORT 109	[string, image uuid]; [string, report filename]		
	#define VUDP_CAPTUREIMAGE 110	[string, image uuid]; [string, image name]	#define VUDP_ERR_CMD_NOT_SUPPORT 5	
	#define VUDP_ADDIMAGE_WITHCALIBRATION 112	[string, image path]; [string, x pitch]; [string, y pitch]	#define VUDP_ERR_NOT_INSPECTED 6	[string, image uuid]
	#define VUDP_GET_VERSION 200			[string]
	#define VUDP_GET_ALLTEMPLATENAMES 202		#define VUDP_ERR_NO_TEMPLATE 7	[string, template name]; [string, template name]; ... [string, template name];
	#define VUDP_GET_DEFECTINFO 203	[string, image uuid]		[string, "NG" or "GOOD"]
	#define VUDP_GET_ROILIST 204	[string, image uuid]		[id: name: defect ratio: max defect ratio]; [id: name: defect ratio: max defect ratio]; ... [id: name: defect ratio: max defect ratio]
	#define VUDP_GET_ALLIMAEGEIDS 205			[string, image uuid]; [string, image uuid]; ... [string, image uuid]
	#define	[string, image uuid,		

Command Type	Command	Sending Parameters	Return Error code (using 'command' field)	Return Parameter
	VUDP_FEEDBACK_CHANGEINSPECTIONRESULT 900	image name]; [string, "GOOD", "NG"]		
	#define AUTOINSPECTION_START 500			
	#define AUTOINSPECTION_STOP 599			

VUDP_GENERATEREPORT examples:

1. Image_id;c:\3DII\Report1.csv
2. Image_id;c:\3DII\Report2.xls
3. all;c:\3DII\Report3.csv
4. all;c:\3DII\Report4.xls
5. selected;c:\3DII\Report5.csv
6. Image_id;c:\3DII\Report6.pdf