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NcStudio V10 CCD System

Quick Start

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Getting Started

NcStudio V10 CCD System is another high-end control system that is exclusively developed and copyrighted by **WEIHONG Company**. By taking photos in a real-time manner, the control system can recognize marking points or templates and automatically calculate deviations to make corrections to toolpath.

This document guides you how to get started with **NcStudio V10 CCD System** quickly.

For wiring and IO ports configuration, please refer to:

[Wiring and IO configuration](#)

For installation of the camera, please refer to:

[Install camera](#)

For commissioning of CCD, please refer to:

[CCD commissioning](#)

For how to prepare the toolpath, please refer to:

[Prepare toolpath](#)

For how to run the toolpath, please refer to:

[Run toolpath](#)

For frequently-asked questions that you may encounter in your usage, and important terms and parameters, please refer to:

[FAQ](#)

[Terms and parameters](#)

Wiring and IO Configuration

NcStudio V10 CCD System uses **Lambda 3S** controller.

See figure below for wiring and IO ports of **Lambda 3S**:

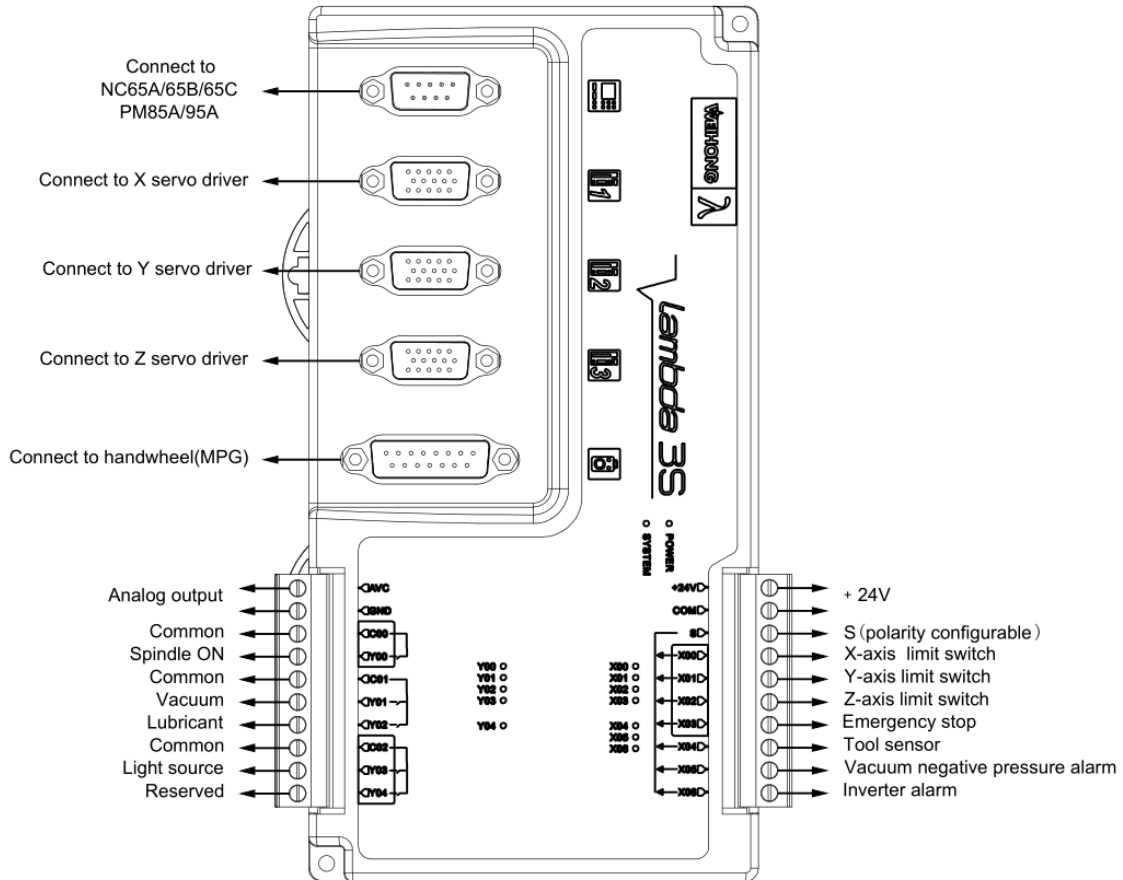


Table below describes details of 7 input and 5 output ports.

- X_ represents input ports
- Y_ represents output ports

PIN	Address	Description
X00	00100	Negative limit in X-axis, also used as origin switch
X01	00101	Negative limit in Y-axis, also used as origin switch
X02	00102	Positive limit in Z-axis, also used as origin switch
X03	00103	Emergency stop
X04	00104	Tool sensor signal
X05	00105	Vacuum pressure alarm signal
X06	00106	Spindle alarm
Y00	10016	Spindle ON
Y01	10017	Vacuum pump
Y02	10018	Lube
Y03	10019	Light source
Y04	10020	Reserved for customization

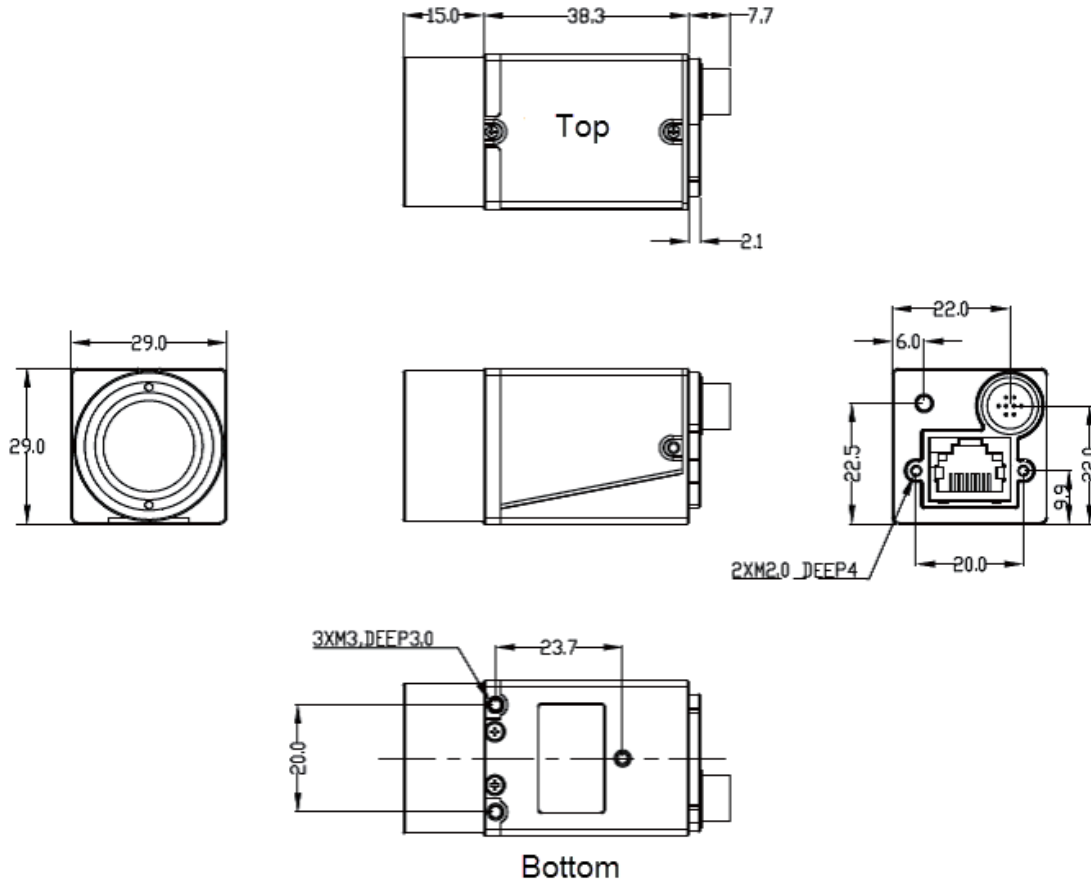
Installing the Camera

Before using **NcStudio V10 CCD System**, the installation of camera is required.

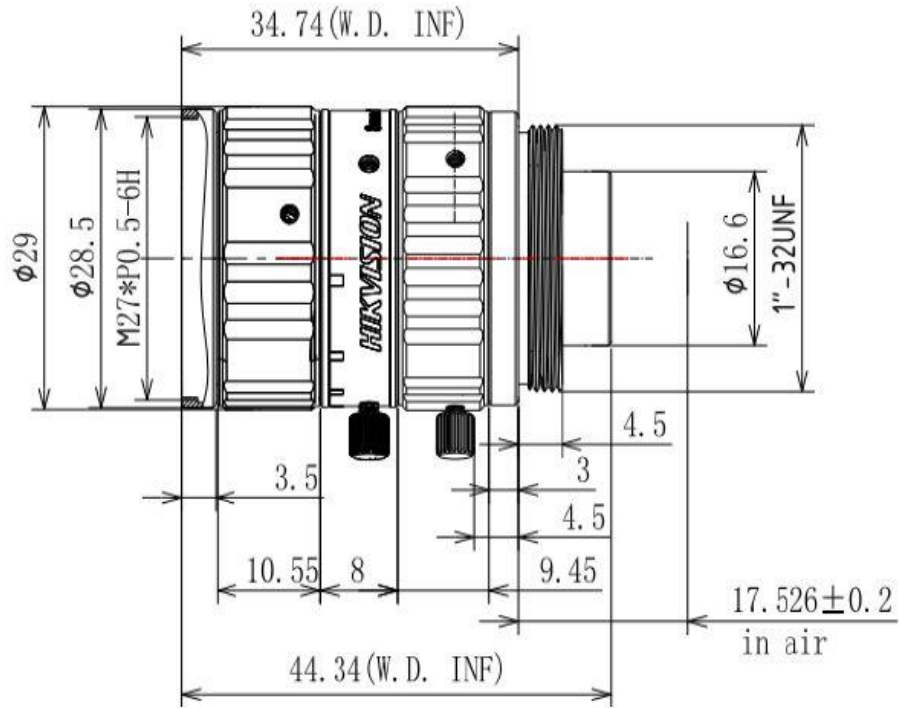
Dimension of the Camera and Lens

Before you install the camera, refer to dimensions of the camera and lens.

See figure below for dimension of the camera:



See figure below for dimension of the lens:



To install the camera, do the following:

1. Connect the camera.
2. Install software of the camera.

Connecting the Camera

Before connecting the camera, prepare the following products:



1. Power extension cord
2. Industrial camera
3. Industrial lens
4. DC stabilized power adapter 12V
5. Industrial gigabit cable

Attention: Please ensure your computer supports gigabit network.

To connect the camera, do the following:

1. Connect the camera to power extension cord:



2. Remove protective cover of camera and industrial lens.
3. Connect the industrial lens to the camera:



4. Connect industrial gigabit cable to the camera and the computer:



Installing Software of the Camera

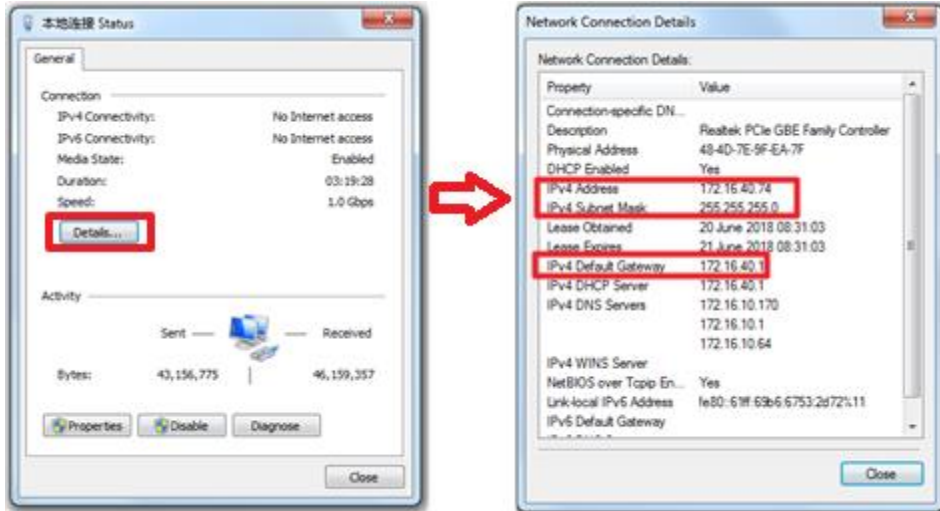
To install software of camera, do the following:

1. Unzip the file **DAHENG_MER_Series_Win_en.rar** to a local directory.
2. Double click **MER_Setup_cn.exe** to initiate the installation procedure.
3. Follow the setup wizard to install the camera driver until end.



After the installation, two icons ( and ) appear on the desktop.

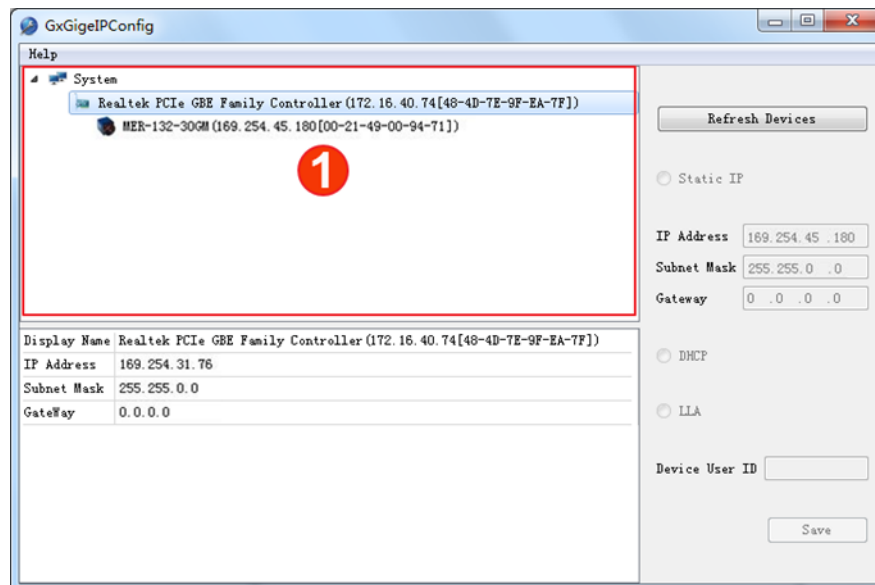
4. Open **Control Panel** → **Network and Internet** → **Network and Sharing Center** → **Local Connection** → **Details** on your computer to check IP address, subnet mask and gateway of your computer:



5. To configure static IP for the camera, do the following:



1. Click **GigE IP Config**. The dialog box **GxGigEIPConfig** pops up.



2. Click **Refresh Devices** to refresh the camera list in area ①.
3. Select the camera in the camera list.
4. Check **Static IP** and modify the IP address of the camera to the IP address which is on the same subnet with your computer.

Attention: The IP address of the camera and your computer must be on the same subnet and cannot conflict with IP addresses of other terminals. Otherwise, communication exception occurs.

5. Click **Save** to save the modification.

Although the system can obtain IP address automatically, it is unstable. It is suggested to manually configure static IP address.

The software is installed successfully. And the system automatically starts the camera driver.

After installing the software, check the status of the camera's indicator lamp:

- No light on: no power supply.
- Orange-red light on: power is on.



- Green light on: communication succeeds.



CCD Commissioning

To make CCD ready for machining, you need to adjust the camera and do some commissioning.

Follow steps below to do the commissioning.

1. Power up and start the NC system.
2. Turn the system to **Homing** mode, and return all machine axes to the machine origin.
3. Turn the system to **Manual** mode, Click **Vision** → **CCD** → **Parameters** → **Manufacturer Param** → **Measure** to switch to **Measure** interface.
4. Use the function **Pick Current** to decide the working plane.
It is recommended to leave distance between the camera bottom to the workpiece surface 125mm.
See Setting CCD Working Plane for details.
5. Adjust the camera, including the **focal length**, **aperture**, etc. to ensure the camera can get a clear sight.
6. **Measure the magnification of the camera.**
7. Move to the shooting position.
8. Camera shoots and **gets marking points.**

Setting CCD Related Parameters

To make CCD ready for machining, you need firstly set related parameters, including parameters of different access.

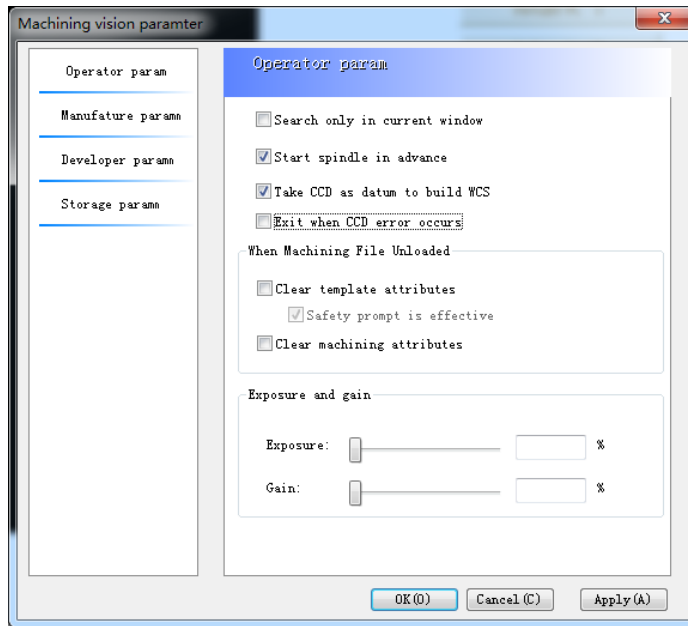
Prerequisite

All machine axes have returned to the machine origin.

Steps

To set CCD related parameters:

1. Click **Vision** → **CCD** → **Parameters**. It opens dialog box titled "Machine Vision Parameter".



2. Click **Operator** (default) on the left side, and set parameters of operator's access on the right.

Following are parameters of operator's access.

Search only in current window

If the box is checked, search only in **CCD** window for templates during automatic machining in Shoot-Cut mode. Otherwise, search the whole camera sight for templates.

Start spindle in advance

If the box is checked, start the spindle in advance once **Start** button is clicked.

Take CCD as datum to build WCS

If the box is checked, take CCD center as the origin to build workpiece coordinate system; otherwise, take the spindle center as the origin to build workpiece coordinate.

Exit when CCD error occurs

If the box is checked, the system will exit machining if there is recognition failure, otherwise, the system will skip the path if there is recognition failure.

Clear template attributes

If the box is checked, templates and parameters of the program file will be removed when the file is removed from the system; otherwise, templates and parameters of the program file remained.

Clear machining attributes

If the box is checked, parameter settings of the program file will be removed when the file is removed from the system; otherwise, parameters of the program file remain.

Exposure

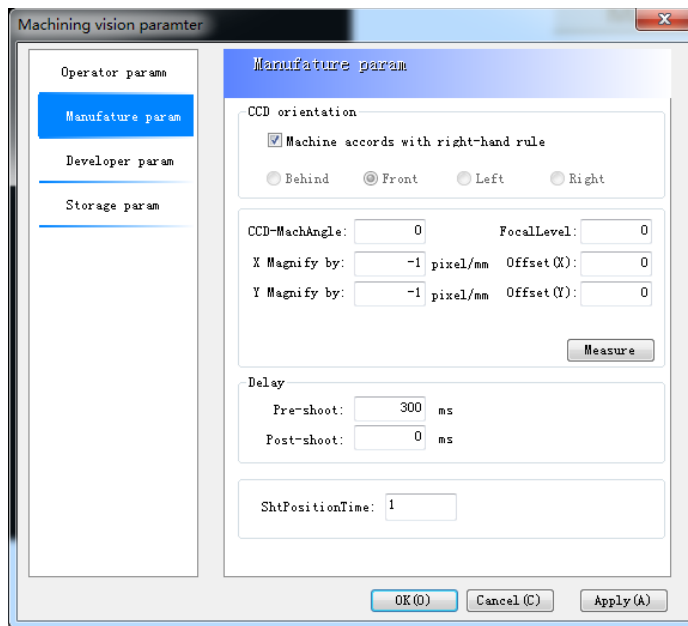
Drag the slide to adjust the exposure of the camera. See [Exposure](#) for its definition.

Gain

Drag the slide to adjust the gain of the camera. See [Gain](#) for its definition.

It is not recommended to set a high value.

3. Click **Manufacturer** on the left side, and set parameters of manufacturer's access on the right.



CCD orientation

Sets the camera position relative to the spindle.

Only Front is supported at present. If you find the camera positions is wrong, discharge the camera and adjust the position.

CCD-Machine angle

It sets the angle between camera and the spindle. The angle comes from the misalignment of camera and the machine.

Magnification factors

It includes magnification factors in X-axis and Y-axis.

CCD offset

It sets distances between the camera and the spindle in X-axis and Y-axis.

Focal Level

It sets the height in Z-axis when the camera takes clear photos.

Pre-shoot delay

It sets the delay time to stabilize the camera before taking a photo.

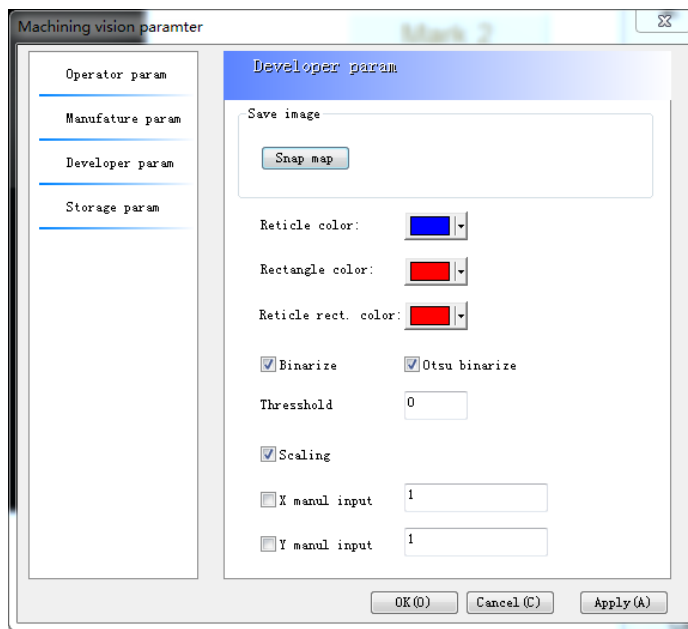
Post-shoot delay

It sets the delay time after the camera takes a photo.

Shoot times

It sets how many times the camera takes photos at a shooting position.

4. Click **Developer** on the left side, and set parameters of developer's access on the right.



- Click **Snap image** button to take photos at current position.
- It is recommended to check the box **Scaling** for **Three-point shooting**.

Setting CCD Working Plane

CCD working plane refers to the XY plane at focal height. To set the working plane is to set the focal height in Z-axis.

Prerequisite

Well adjust focal length and aperture of the camera lens. See [camera lens](#) for details.

Steps

1. Turn the system to **Manual** mode, Click **Vision** → **CCD** → **Parameters** → **Manufacturer Param** → **Measure** to switch to **Measure** interface.

2. Adjust Z-axis height and fine tune the knob on the camera.
3. When the photo in camera sight becomes enough clear, click **Get Current**. The system records the current height.

It proves that when the magnification factor sets to 15X, the camera gets the best adjusting result. In this case, working distance needs to be within 120mm~130mm.

Once the working plane is set, it will be the height for Z-axis in the processes of measuring magnification factor, CCD-spindle offset, picking template and shooting. In addition, the height is independent to workpiece coordinate system.

Setting CCD Magnification Factor

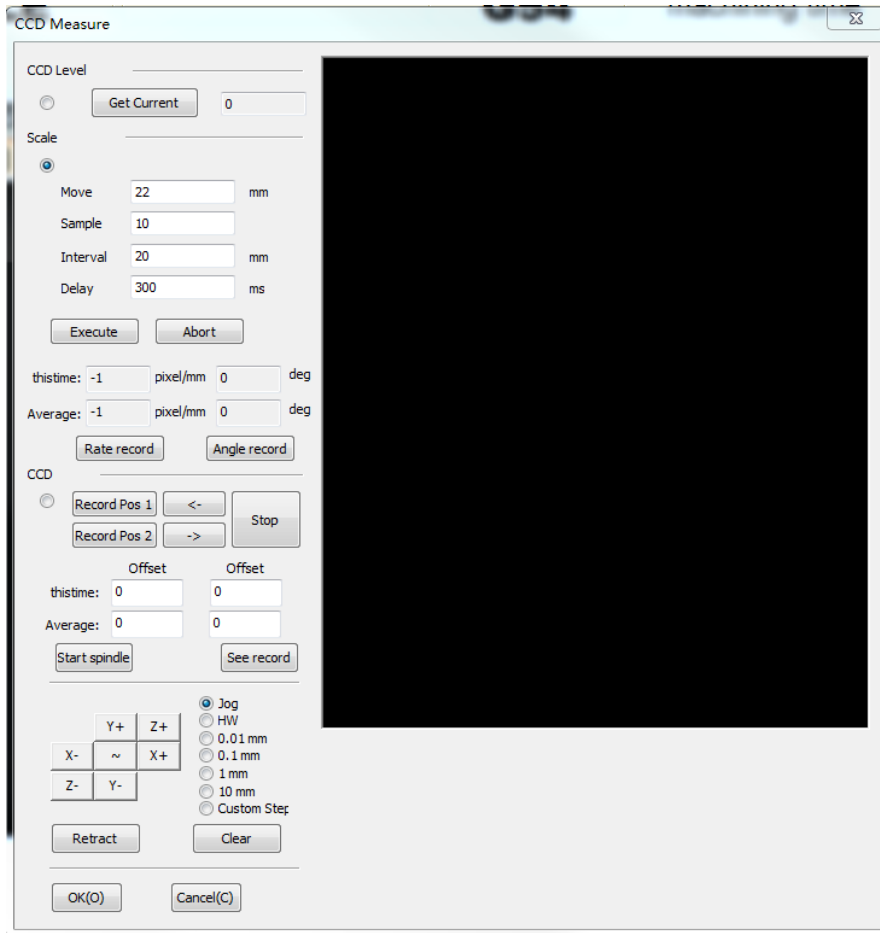
Image takes pixel as unit, but machine moves in millimeter. Therefore, the relationship between the pixel and millimeter is the magnification factor.

Characteristic point on the workpiece is used to decide the magnification factor.

Steps

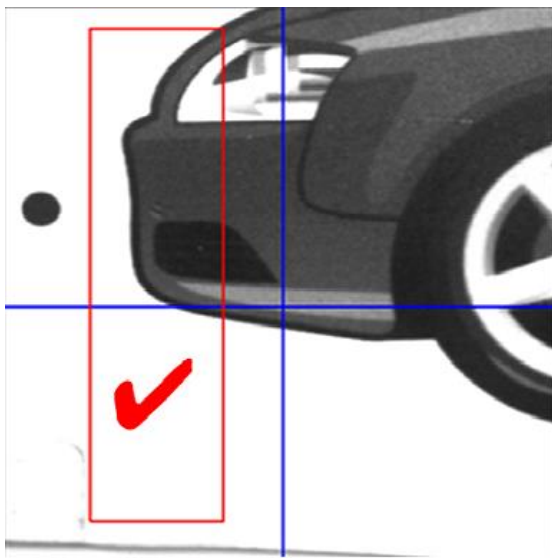
To set parameter **CCD Magnification Factor**:

1. Turn the system to **Manual** mode, Click **Vision** → **CCD** → **Parameters** → **Manufacturer Param** → **Measure** to switch to **CCD Measure** interface.

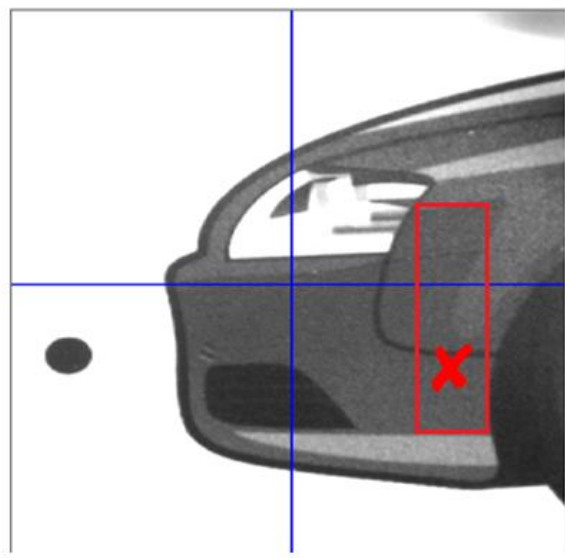


- Adjust the machine axes to appropriate position until a clear characteristic point appears in the right window.

Following are good and bad sampling areas.



Good sampling area



Bad sampling area

3. Set parameters.

Move

It sets the moving distance of the machine.

Sample

It sets how many times that CCD shoots and acquires sample or characteristic points.

Interval

It sets the sampling interval distance.

Sampling delay

It sets the delay time before each sampling.

4. Click **Execute**.

The machine automatically moves and conducts measurement.

(Optional) Click **Stop** to suspend the sampling process.

5. Click **History Record** after the measurement finishes.

Magnification factor and CCD-Spindle angle of each measurement will be shown in history records.

6. Click **OK**.

Average value of measuring results will be updated as camera parameter.

For repeated measurement, please clear the history record before next measurement, to avoid possible interference.

Example

Following is parameter setting suggestion.

Moving distance: 22mm
 Sampling times: 10
 Sampling distance: 20mm
 Sampling delay: 300

Setting CCD-spindle Offset

CCD-spindle offset refers to the distance between the camera and the spindle. It includes X-axis offset and Y-axis offset.

Steps

1. Drill a hole on the workpiece surface.
2. Click **Record Pos 1**. The system records the current machine coordinates.

- Click left and right arrow buttons to move the camera. Stop moving the camera until the cross in camera center is at the hole center.
- Click **Record Pos 2**. The system will automatically calculate the offsets in both X-axis and Y-axis.

Picking Template

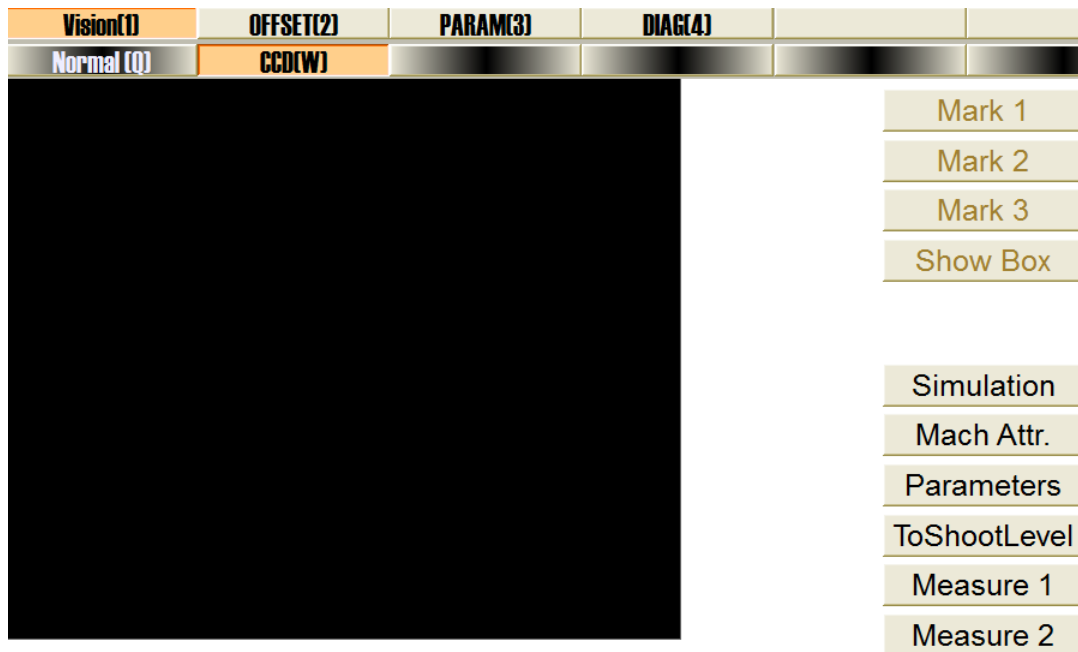
In shoot-cut mode, marks (also called marking point or template) are used to figure out the tool path.

Requirements of the target marking points:

- Clear enough
- Being unique

Steps

- Turn to **Manual** mode, and click **Vision** → **CCD** to switch to **CCD** interface.



- Click **Mark 1**, **Mark 2** and **Mark 3** in order. Three marking points will be recorded.

Tip: For how many marking points you need to take, see Should I use two templates or three templates?

Tip: It is recommended to take marking points at specified shooting positions on workpiece that will be machined next.

- Click **Show Box**, and select templates of different size by dragging the mouse. Make sure characteristic of the template is obvious enough.

All patterns can be used as templates. For different patterns, steps to take the template may differ.

- If the marking point (or called shooting point) is a circle:

Move the CCD center to the circle point, and click **Mark** button.

- If the marking point is a cross or half of a cross:

Move the CCD center to the center point of the cross or half of a cross, and click **Mark** button.



Circle



Cross



Half of a cross

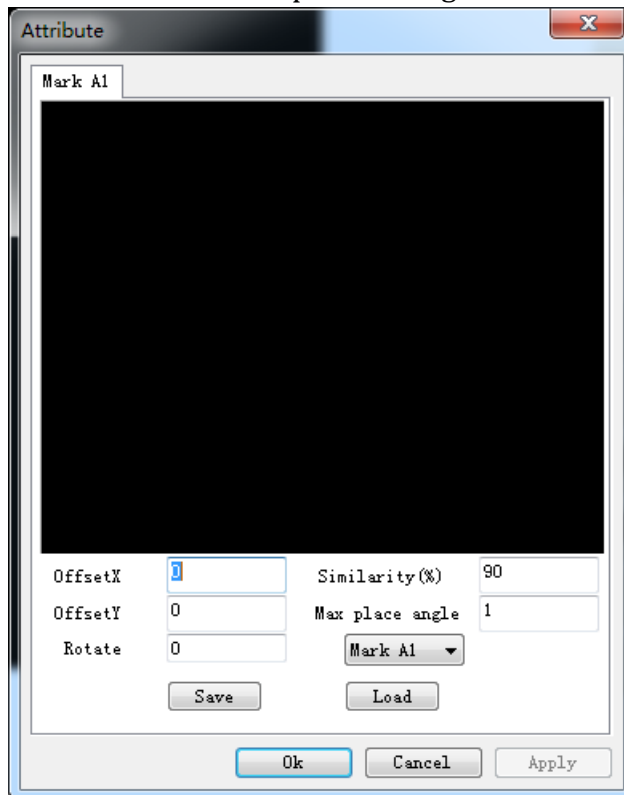
Setting Machining Attributes

Prerequisite

You have successfully picked out marking points.

Steps

1. Click **Mach Attr.** to open a dialog box named "Attribute".



2. Click **Mark A1**. Set parameters.

Offset X/Y

Offsets in X-axis and Y-axis, which decide the position of picking template.

Offset value can be obtained by Measure function or trial cutting.

Rotate

It refers to the plate placing angle of the position of picking template.

Similarity

Default value is 90%.

If the image is relatively clear, set the parameter to a relatively high value.

Max. place angle

Default value is 1 degree.

It refers to the maximum angle deviation between snapping and template. If actual deviation exceeds this value, shooting may fail.

3. Click **Apply** to activate parameter settings and click **OK**.

Measuring Distance and Angles

Use **Measure** function to measure the distance or angle between two specified points.

Steps

1. Move the machine axes to one point, and click **Measure 1**.
2. Move the machine axes to another point, and click **Measure 2**.

The system will calculate the results.

Note that the angle refers to the angle relative to the positive direction of X-axis.

Preparing Toolpath

At present, CCD system supports two kinds of working modes:

- General engraving mode
 - No marking points or shooting points are needed. The system is used as a general engraving control system.
- Machining with marking points
 - Retrieving toolpath from a .jpg file
 - Importing toolpath from a .dxf file

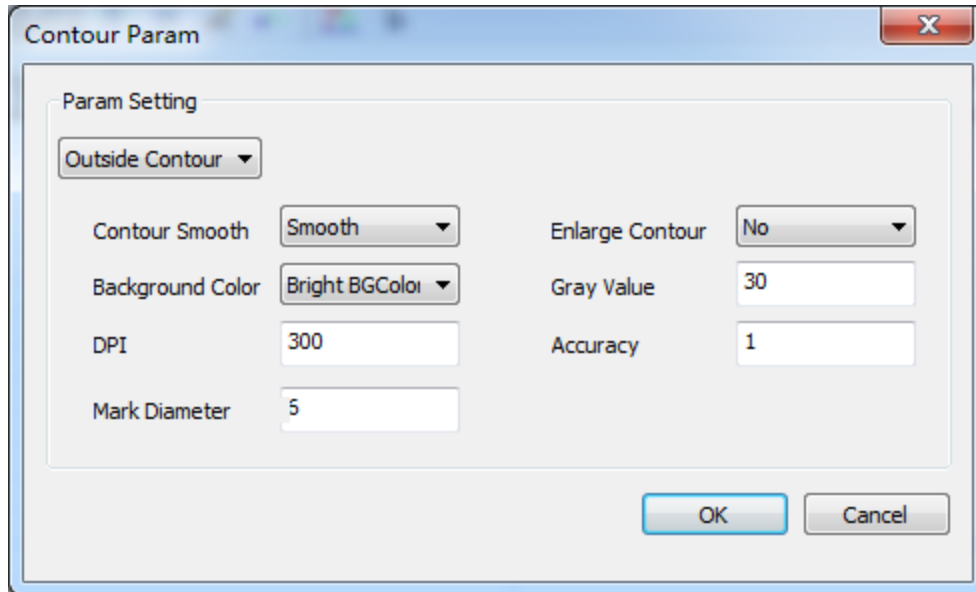
Retrieving Contour from JPG File

By setting related parameters, the control system can automatically retrieve contour from a JPG file.

Do the following to retrieve contour from a JPG file.

Steps

1. Launch **NcStudio**, and switch to **NcEditor** interface.
2. Click **File** → **Import JPG file....** A dialog box named **Open** opens.
3. Select the target .jpg file. A dialog box named **Contour Param** opens.



4. Set related parameters. See Related Parameters for details.
5. Click **OK**.

By default, the system will automatically do followings to deal with the imported .jpg file and retrieve the contour.

1. Converting color to grayscale according to setting value of **Grayscale** parameter.
2. Pixel scaling.
3. Adjusting distance between marking points.
4. Automatically recognize marking points.
5. Finishing contour retrieving.

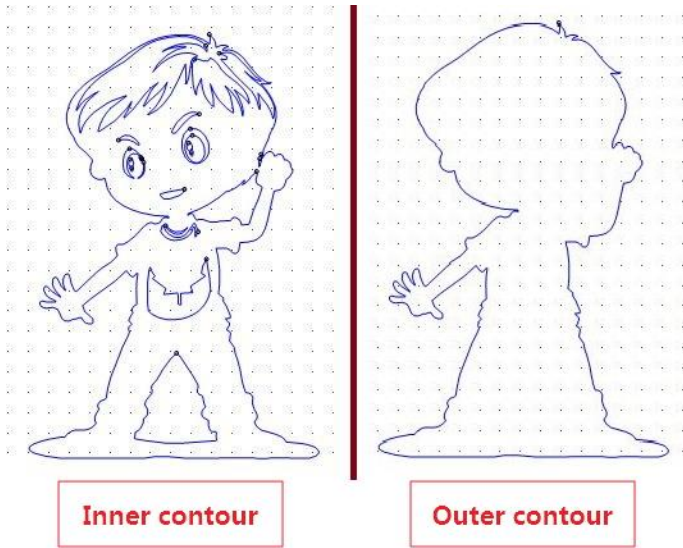
Related Parameters

Followings are related parameters that influence the contour retrieved from JPG image. You can get how each parameter works through comparison and make your own decision.

Inner or Outer Contour

Inner contour means to retrieve the inside part of the imported .jpg file. Outer contour means to retrieve the outside part of the imported .jpg file.

See figure below for comparison.

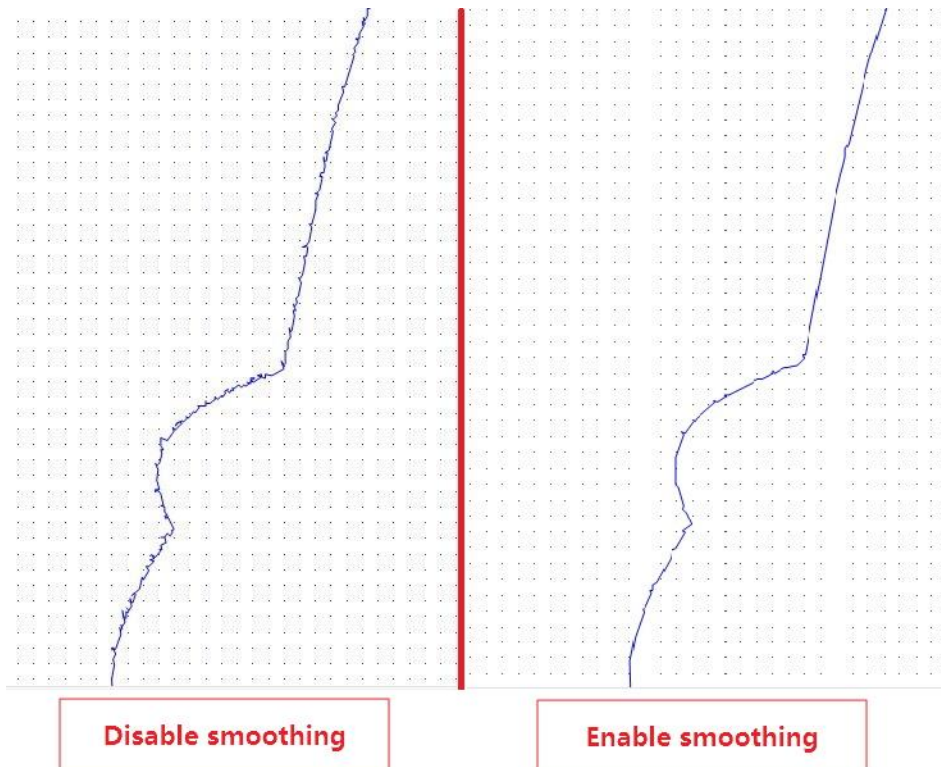


Smoothing Contour

To smooth or not smooth the contour.

If the imported image file has relatively low resolution or the edges of the contour are vague, use the **Smoothing contour** function to remove bad points and smooth the path.

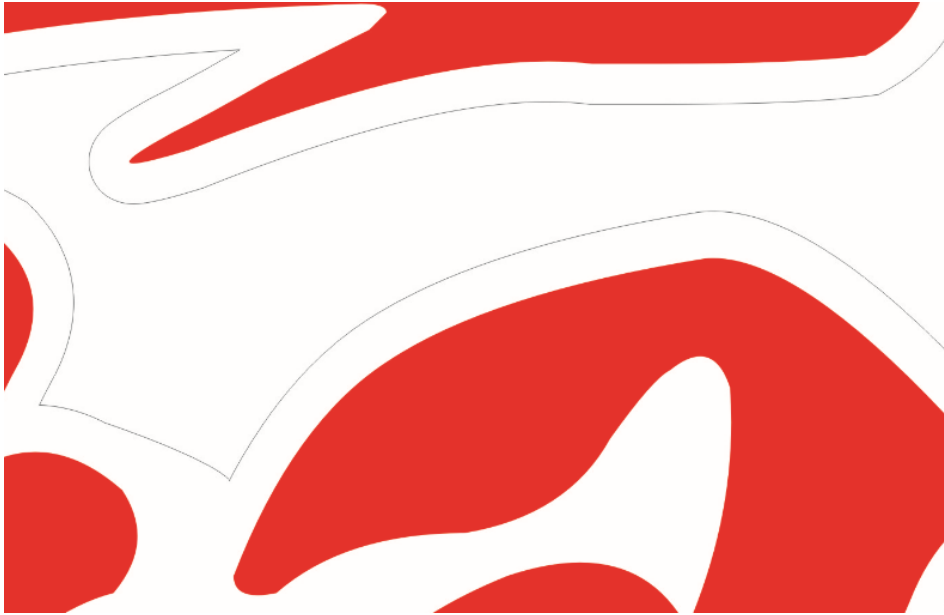
See figure below for comparison.



Enlarge Contour Line

To retrieve relatively thin lines, use **Enlarge contour line** function to magnify the contour.

It does not affect the actual machining size.



Background Color

Choose the background color according to the imported image.

See figure below for images with bright color background and dark color background.

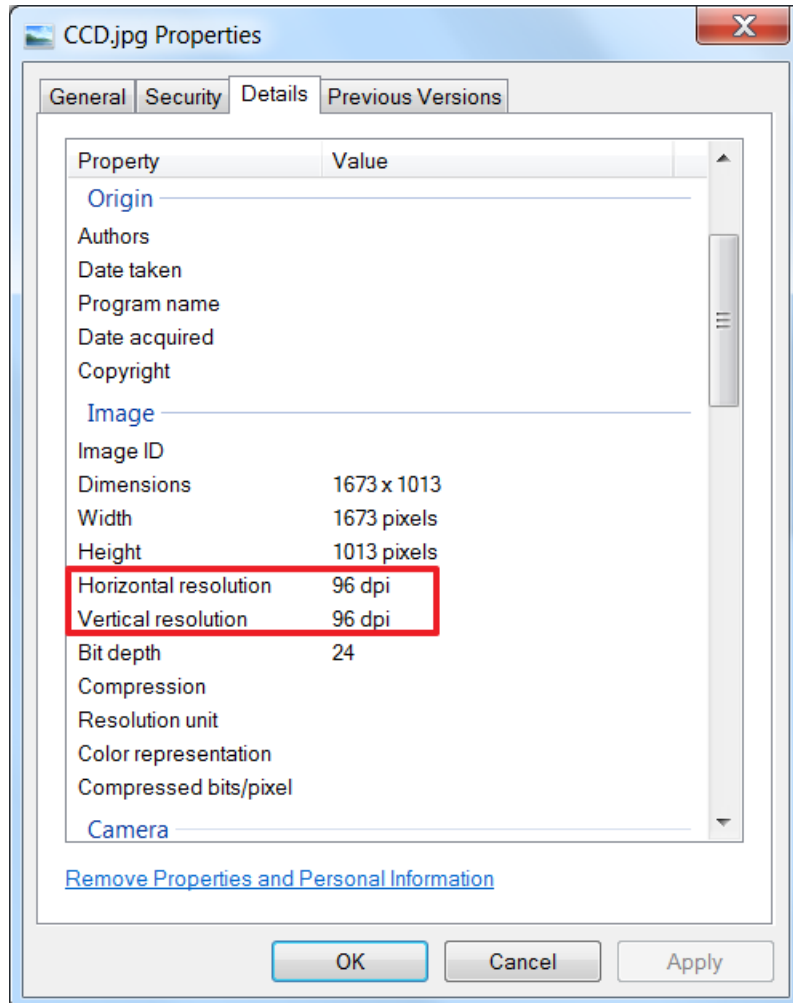


DPI

Dots Per Inch, is a measure of spatial printing or video or image scanner dot density, in particular the number of individual dots that can be placed in a line within the span of 1 inch (2.54cm).

How to check DPI of an image:

1. Right-click on the image file, and select **Property**.
2. Switch to tab **Details**. You can get detailed information about the image.



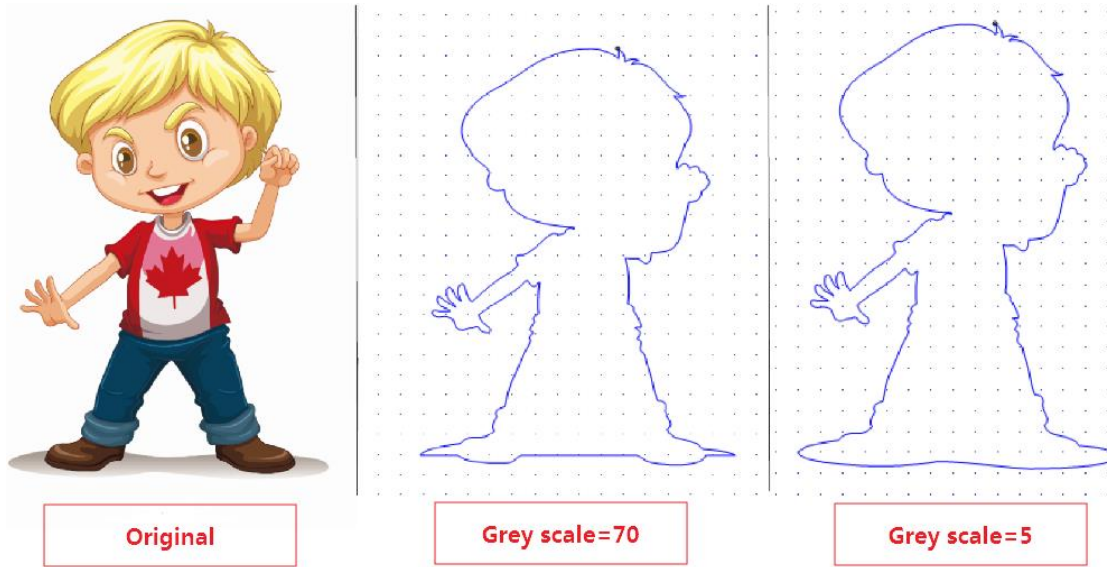
Greyscale

In photograph, computing, and colorimetry, a greyscale or greyscale image is one in which the value of each pixel is a single sample representing only an amount of light, that is, it carries only intensity information. Images of this sort, also known as black-and-white or monochrome, are composed exclusively of shades of gray, varying from black at the weakest intensity (0) to white at the strongest (255).

Best practices for setting greyscale:

- For images with light color background, set low greyscale.
- For images with dark color background set high greyscale.

See figure below for comparison.



Precision

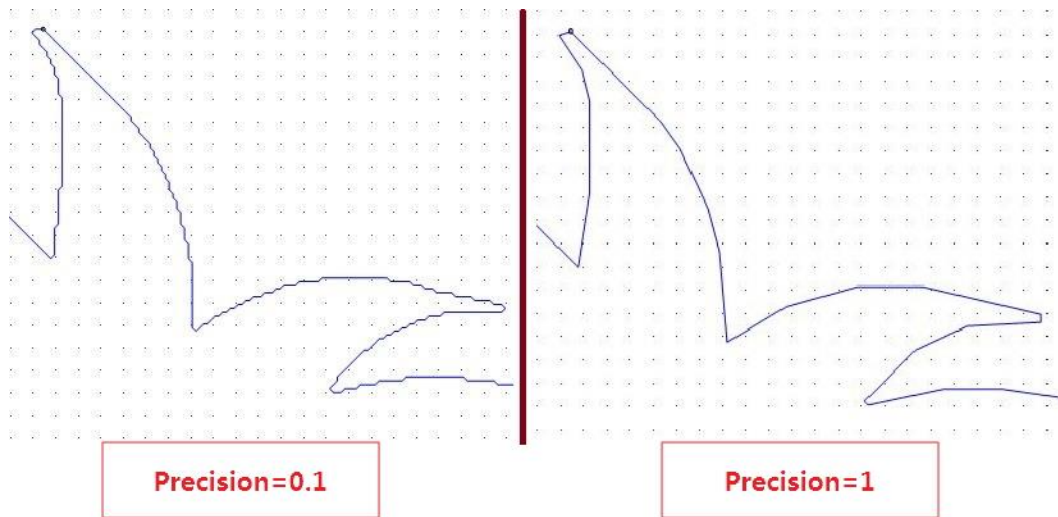
Default value is 1.

Precision will affect the distance between two marking points and how many marking points can be retrieved.

Relationship among precision, distance between marking points and number of marking points are:

- Higher precision, larger marking points distance, less marking points.
- Lower precision, smaller marking points distance, more marking points.

See figure below for comparison.



Marking Point Diameter

At present, the system can automatically recognize marking points of circular type.

For marking points of circular type , the system will do the following:

1. Calculate the contour area of the circle.

Area = πr^2 //r represents circle diameter, namely, setting value of **Mark point diameter** parameter

2. Make a threshold according to the result of circle area.

Threshold: $[-(20\% \cdot \text{Area}), +(20\% \cdot \text{Area})]$

3. According to the threshold, pick out all circles whose diameters are within the range and make them marking points.

For circles whose diameters are smaller than the minimum value of the threshold, they will be recognized as useless points and be ignored in retrieving process.

Editing Toolpath

After retrieving contour from a JPG file, users can edit the contour and convert it to toolpath that is ready for machining.

Users need to do followings when editing toolpath:

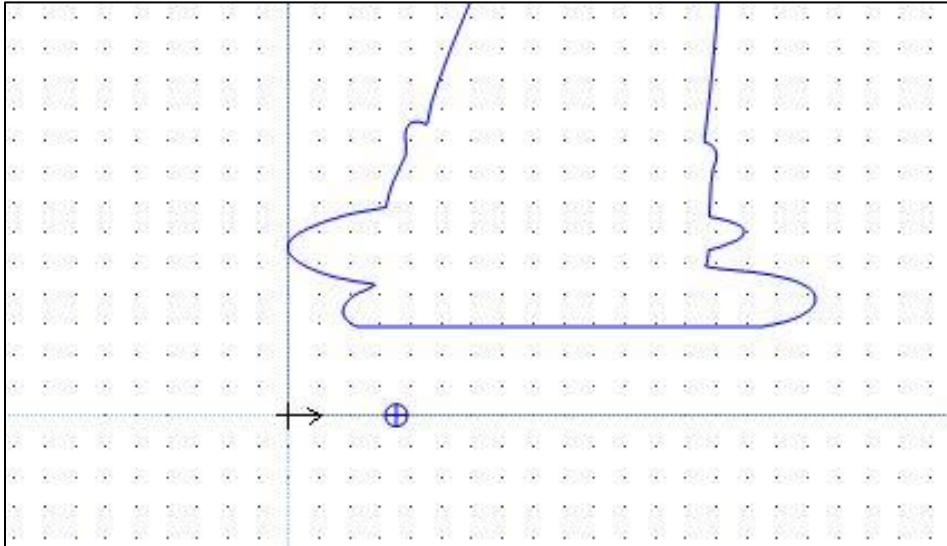
1. Setting workpiece origin.
2. Setting machining direction.
3. Setting tool compensation.

4. Setting lead lines.
5. Deciding active objects.
6. Setting in-process parameters.

Setting Workpiece Origin

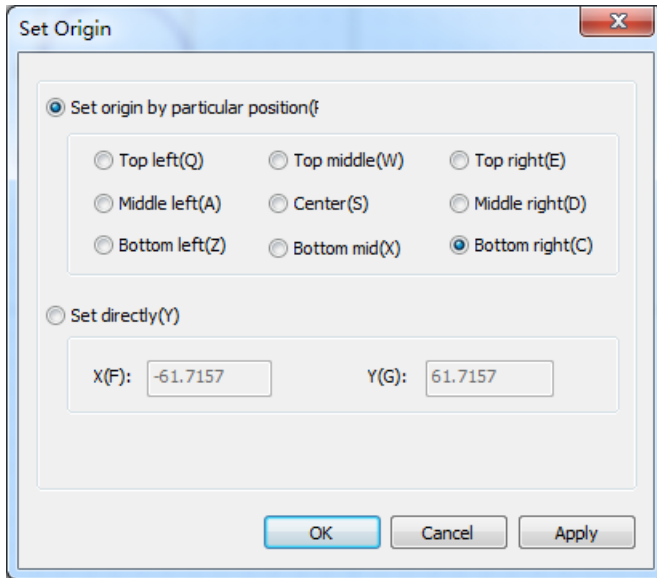
After contour is retrieved and has been imported it into the system, a default workpiece origin will be defined at the lower-left of the contour.

See figure below for default workpiece origin.

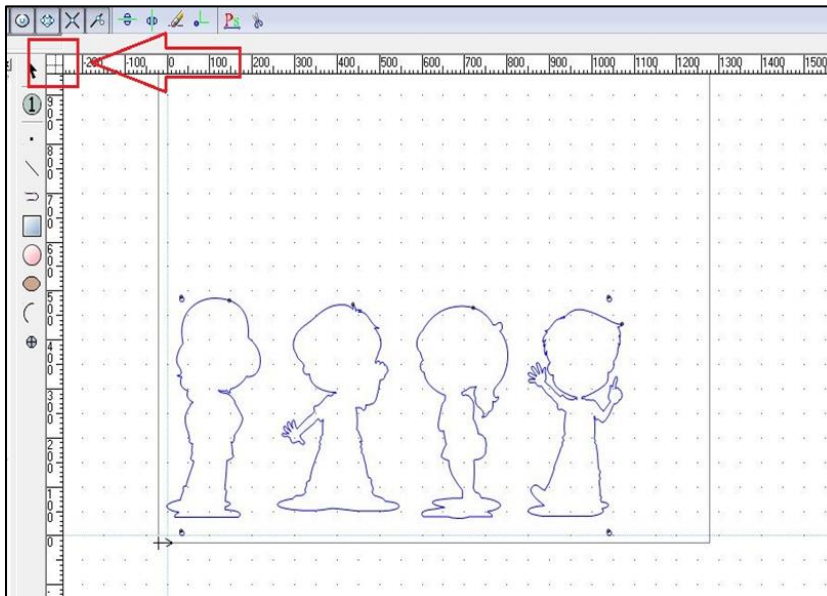


Do one of the followings to modify the workpiece origin.

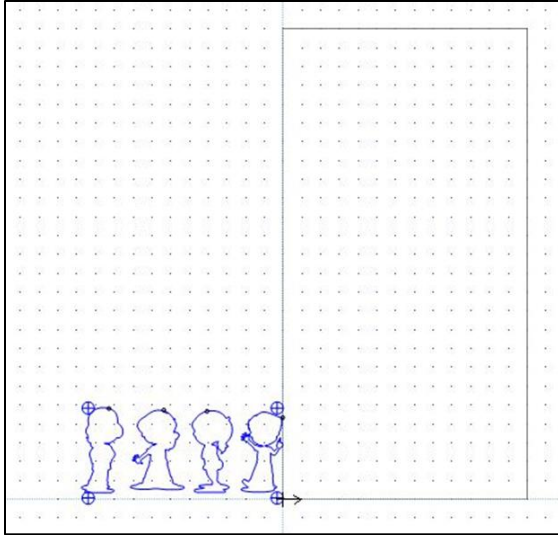
- Click **Draw** → **Set Origin** and set the workpiece origin in the pop-up dialog box.
 - (Recommended) Select the position of the marking point that will be used as the workpiece origin.
 - Directly enter X, Y coordinates of the workpiece origin.



- Turn to **NcEditor** interface and drag icon with left mouse to target workpiece origin position.



See figure below for the toolpath that has defined the workpiece origin.




After the workpiece origin is defined, the system can know workpiece coordinates of each marking point.

Setting Machining Direction

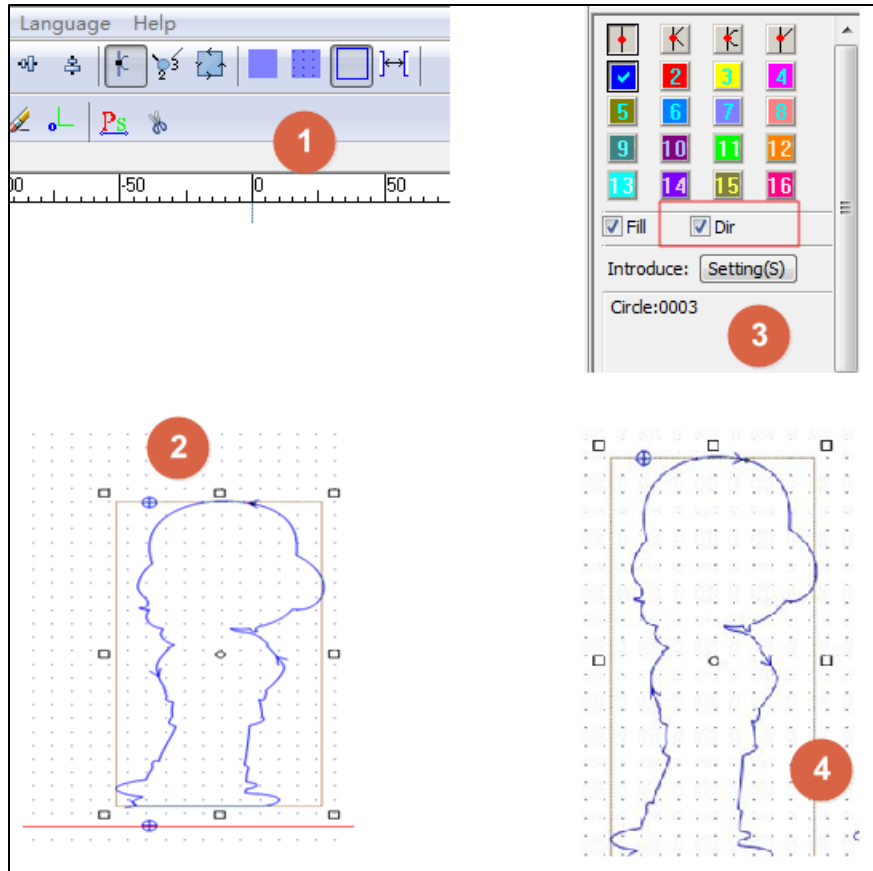
Before you begin, import the contour that has been retrieved into the system.

Do the following to set machining direction.

1. Turn to **NcEditor** interface, and click show/hide machining direction icon  on the tool bar.
2. Select the contour whose machining direction needs to be set in the drawing area.
3. On the **Property** pane, check the setting of **Direction** parameter.
 - If **Direction** parameter has been checked already, uncheck it.
 - If **Direction** parameter has not been checked, check it.
4. Check the machining direction in the drawing area.

Example:

See figure below for how to set machining direction.



Setting Tool Compensation

In real machining scenario, users need to make tool compensation to improve engraving precision.

Steps

Do as following to set tool compensation.

1. Turn to **NcEditor** interface, and select the contour that is ready for machining.
2. Click **Object** → **Toolpath**. It opens a dialog box named **Toolpath**.
3. Set parameters as demand.

Following are related parameters.

Compensation type

It decides what the actual toolpath look like compared with original contour. It includes two types: shrink and extend.

Shrink: The actual toolpath deviates inward by distance that is decided by setting value of **Shrink** parameter, compared with the original contour.

Extend: The actual toolpath deviates outward by distance that is decided by setting value of **Extend** parameter, compared with the original contour.

Shrink

The distance between the shrunked toolpath and original contour. Default unit: mm.

Extend

The distance between the extended toolpath and original contour. Default unit: mm.

Tool diameter

Diameter of the tool. Default unit: mm.

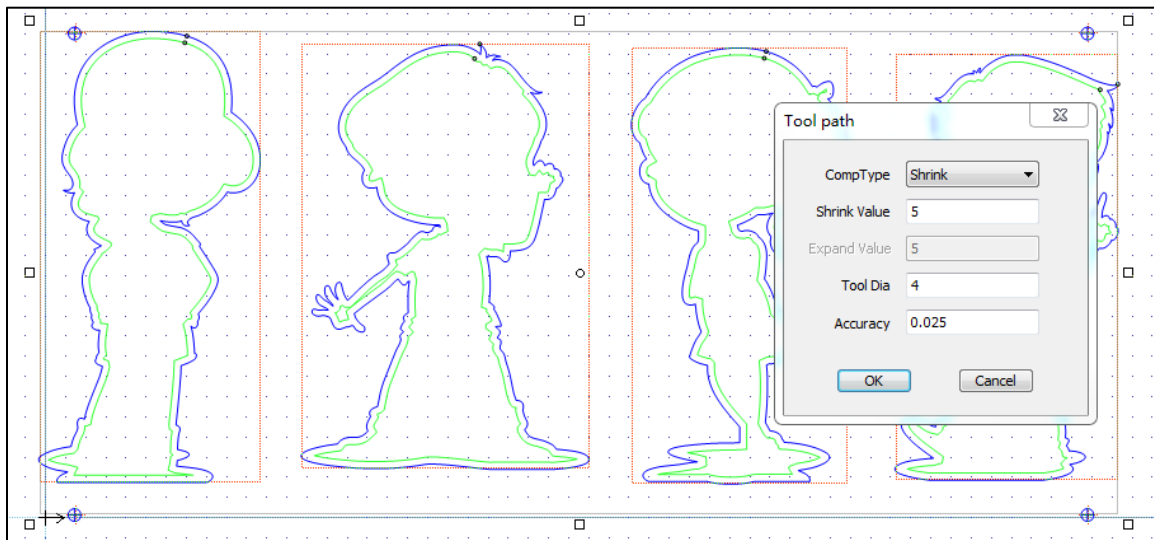
Examples

Following are examples of how to set the tool compensation.

Blue color represents the original contour; and green color represents the actual toolpath with tool compensation.

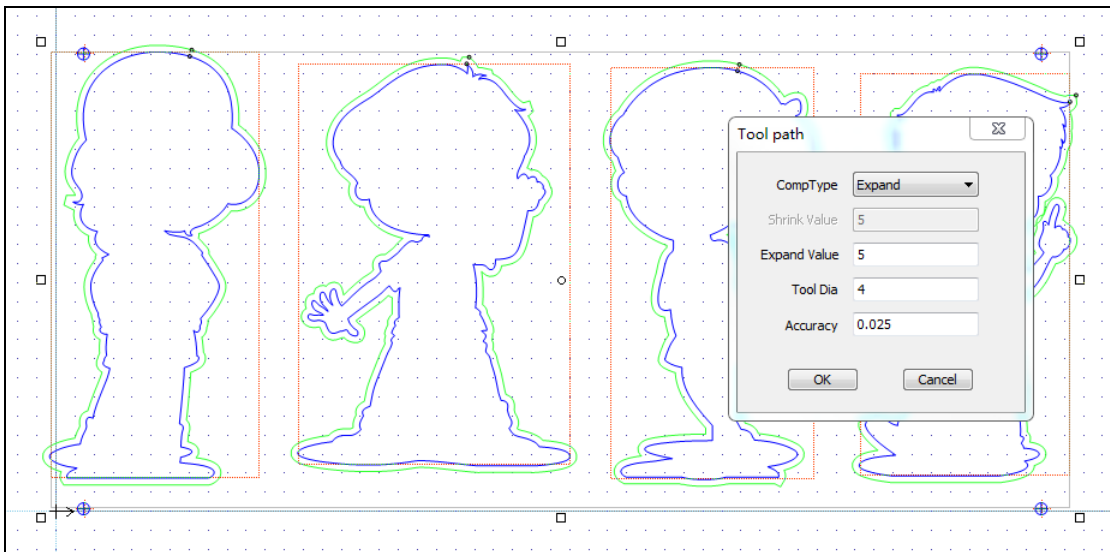
Shrink

See figure below for the preview.



Extend

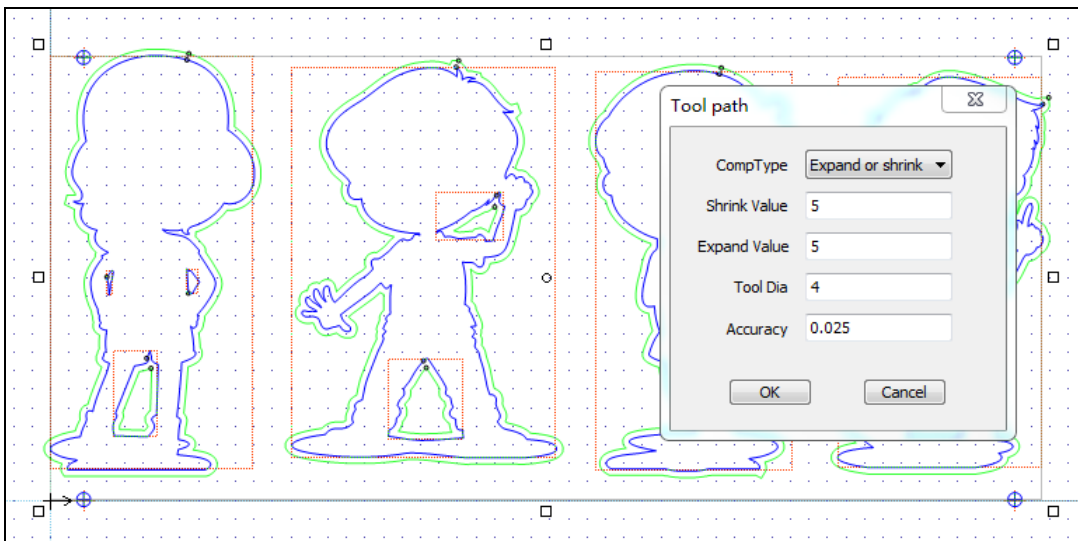
See figure below for the preview.



Shrink the internal contour and extend the external contour

If the original contour includes nested objects, it is recommended to shrink the internal contour and extend the external contour.

See figure below for the preview.



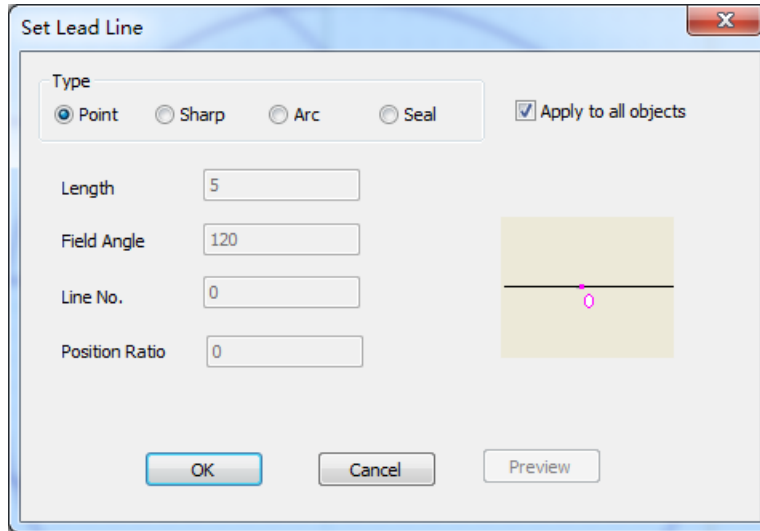
Adding Lead Lines

Setting lead lines decide where and how to start the cutting.

Steps

Do the following to add lead lines for machining.

1. Turn to **NcEditor** interface.
2. Click **Object** → **Set lead line**. It opens the **Set lead line** dialog box.



3. Select the lead line type, and set parameters.
4. (Optional) Check the box **Apply to all objects** if you want to add the lead line to all contours.
5. Click **OK**

Types of Lead Lines

According to the shape, lead lines include four types:

- Dot
- Acute angle
- Arc
- Seal

Except for dot, the other three lead lines are only effective for closed graphic.

According to the position, lead lines include two types:

- Internal lead line
- External lead line

Deciding Active Objects

To decide the contour will be machined or not this time.

Steps

Do the following to decide the contour or object to be machined or not.

1. Turn to **NcEditor** interface and select the contour.
2. Right click on the contour, and select **Not to machine** menu on the pop-up list. When machining starts, this contour will be skipped.
3. (Optional) Right click on the selected contour, and select **Machine** menu on the pop-up list. When machining starts, this contour will be machined as required.

Setting Layer and Parameters

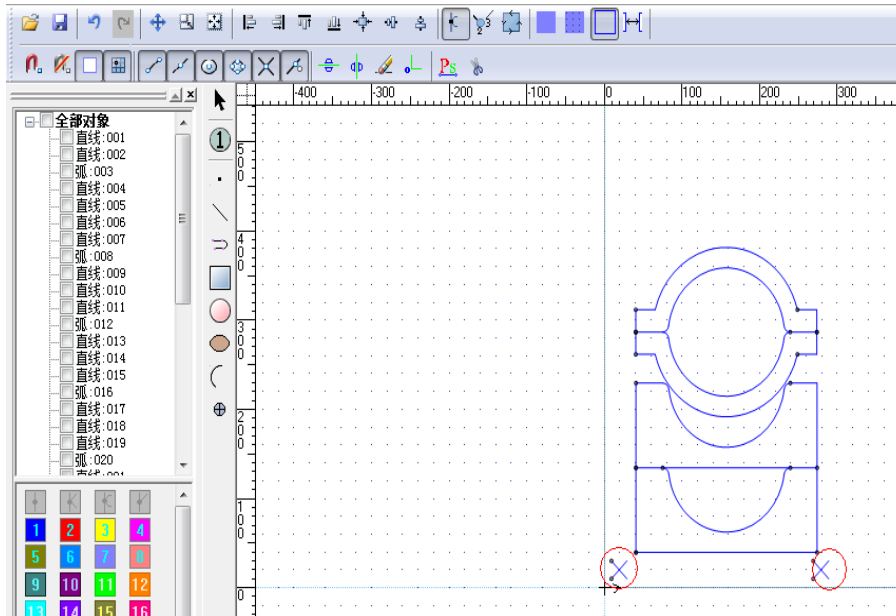
NcEditor takes objects that have the same parameter settings as a layer by default. Each layer is represented in a color. That is, if you modify a parameter of one layer in one color, the parameter setting of all objects in this layer will be updated.

Convert DXF File to Toolpath

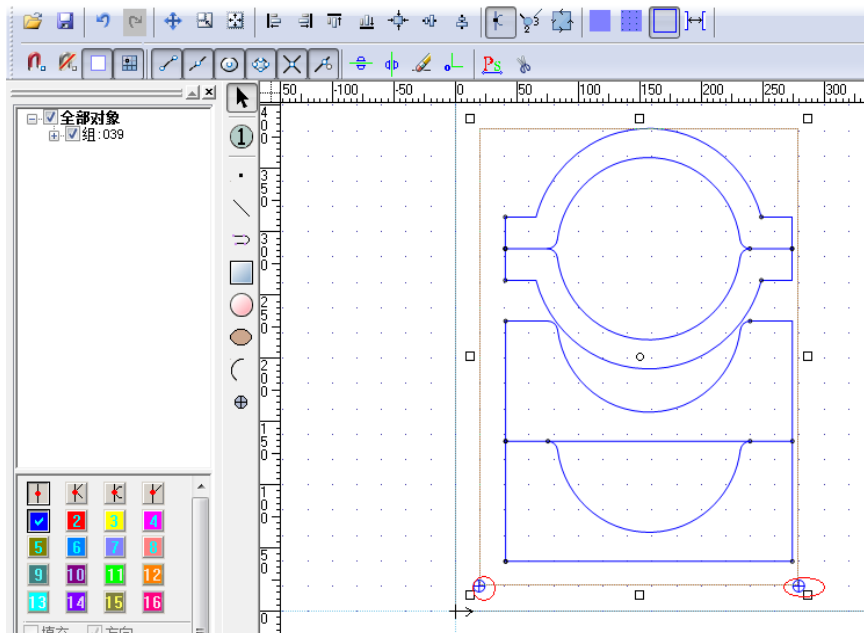
A DXF file can be directly imported to the system and converted to toolpath.

Steps

1. Prepare DXF file.
 1. Draw in AutoCAD or other drawing software.
 2. Add marks to the objects.
 3. Save the drawing as .dxf file format.
2. Launch **NcStudio**, and switch to **NcEditor** interface. Click **File** → **Import DXF file** to import the prepared .dxf file into **NcEditor**.



3. (Optional) According to the desired cutting quantity and position, set arraying related parameters.
4. Adding marking points. Click the cross icon on the tool bar, and replace the marks with cross icon to add marking points.



Shooting points must be nearby the characteristic points or the marks.

5. Click **Object** → **Toolpath** to set tool compensation.
6. Frame check all contour and marking points, and right click the mouse, select **Group**.

All toolpaths or objects that have used marking points must be grouped before being saved as program file.

7. Save the file as .nce program file.

Running the Toolpath

Prerequisite

Before you start automatic running the program, make sure the following:

- All machine axes have returned to the machine origin.
- CCD commissioning has been done.
- Related parameters have been well set.
- Toolpath has been imported into the system.

Steps

Turn to **Auto** mode, and click **Start**.

To sum up, an overall machining process goes like:

1. Launch **NcStudio** system.
2. Return all machine axes to the machine origin.

Is the first-time machining for the graphic?

- Yes: turn to step 3
- No: turn to step 7

3. Turn to **NcEditor** interface, and import .jpg image file into **NcEditor**.
4. Edit the toolpath and save it as .nce program file.
5. Move to the shooting position and get marking points.

Are the marking points correct?

- Yes: turn to **Manual** mode, move the camera center to any shooting center, and click **Mark 1, Mark 2, Mark 3** in order.
- No: turn to **Manual** mode, move the camera center to the actual position corresponding to marking point 1, and click **Mark 1**; move the camera center to the actual position corresponding to marking point 2, and click **Mark 2**; move the camera center to the actual position corresponding to marking point 3, and click **Mark 3**.

6. Click **CCD** → **Property**, and set image similarity.
7. Move the camera center to specified workpiece origin in **NcEditor** and clear coordinates to zero.
8. Turn to **Auto** mode, and click **Start**.

FAQs

Frequently-asked questions.

How to set aperture of the camera lens?

In NcStudio V10 CCD system, the camera lens is used, whose f-number (aperture) ranges from F2.8 to F16.

Following are suggestions to adjust the f-number.

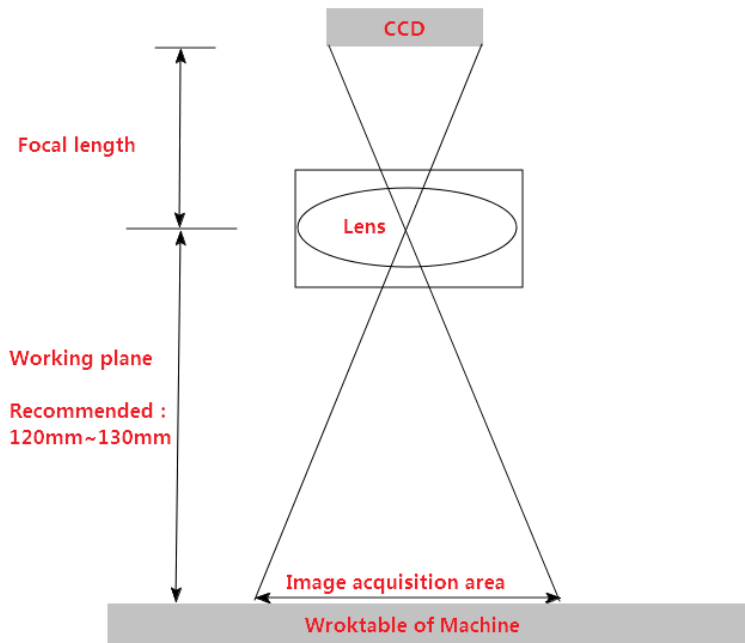
- If there are several light sources on the spot, it is suggested to set f-number to F2.8, in order to ensure enough light passing through the lens.
- If there is individual light source for the camera, it is suggested to set f-number to F4, in order to balance the depth of field and light passing through the lens.

See figure below for where to adjust aperture on the lens.



What's the relationship among the focal length, aperture and working distance?

CCD camera equals to a lens. See figure below for the light traveling road after going through the lens.



Should I use two templates or three templates when getting marking points?

When getting marking points, users need to decide the template number as actual cutting demand.

- Two templates can be used to adjust plate placing angle, and meet the demand of most cutting scenarios.
- Three templates are more precise and reliable.

Glossary

This part lists important concepts and terms in CCD software.

Focal length

The focal length of an optical system is a measure of how strongly the system converges or diverges light. A system with a shorter focal length has greater optical power than one with a long focal length.

Gain

Adjusting the gain of the camera can adjust the contrast between black color and white color of image. It is recommended not to set a high value.

Exposure

In photography, exposure is the amount of light per unit area (the image plane luminance times the exposure time) reaching a photographic film or electronic image sensor, as determined by shutter speed, lens aperture and scene luminance.

Spindle-CCD offset

It specifies the distance between the centerline of the spindle and CCD.

Aperture

Adjustment of the lens opening measured as f-number, which controls the amount of light passing through the lens. Aperture also has an effect on depth of field and diffraction. The higher the f-number, the smaller the opening, the less light, the greater the depth of field, and the more the diffraction blur.

Working distance

It refers to the distance between workpiece and the front-end of the camera lens when image is within the focal length.

A shorter working distance gets smaller camera angle and higher magnification factor. On the contrary, a longer working distance gets bigger camera angle and lower magnification factor.

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