HYUNDAI
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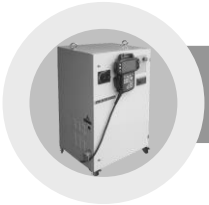
WARNING

INSTALLATION SHOULD ONLY BE PERFORMED BY QUALIFIED INSTALLATION PERSONNEL AND MUST CONFORM TO ALL NATIONAL AND LOCAL CODES

Hyundai Robot

Hi5VM140401FMEN1



Hi5 Controller Function Manual

HRVision 3D-MultiCam

HYUNDAI
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1 Introduction

1.1. About HRVision 3D-MultiCam

“HRVision 3D-MultiCam” is a PC-based vision software to measure 3D location/position of car body for Hyundai robots and Hyundai Hi4a/Hi5 controllers.

“HRVision 3D-MultiCam” provides color graphic control buttons and intuitive user interface for convenient controls and is applied with pattern recognition method using automatic exposure calibration, multipattern registration, and geometric shape information in order for quick and precise pattern recognition in unstable illumination settings.

3D location/position of car body is measured with 3 points or more vision measurement and additional cameras prevent vision measurement errors because of camera trouble and vision misrecognition.

Additionally, Hyundai robot control data communication protocol is embedded so that any user can easily interconnect and use the vision and robot systems.

“HRVision 3D-MultiCam” is an optimal tool for easy and stable 3D location/position recognition of car body using Hyundai robots.

“HRVision 3D-MultiCam” provides the following convenient functions.

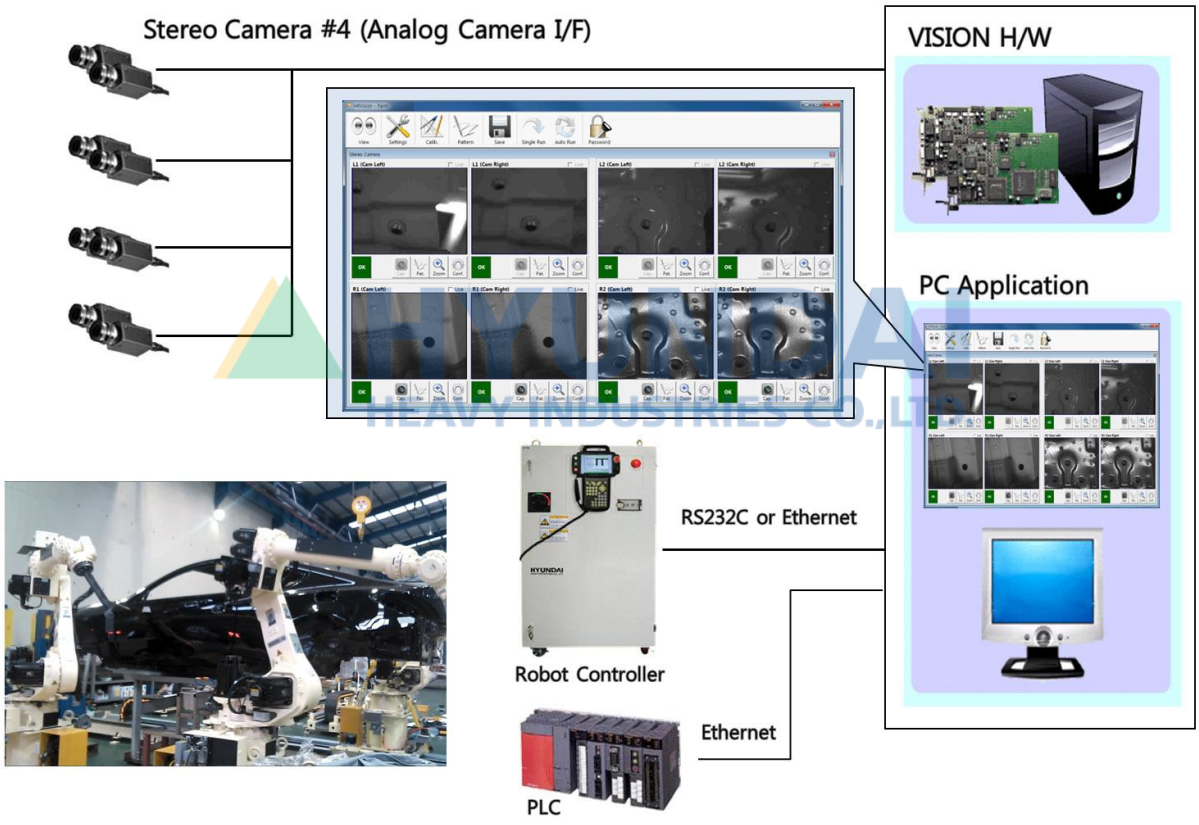
Simple operation	You can set and operate the vision system easily by using the operating button.
3D location/position measurement	With 4-point stereo camera system, 3D location/position of car body is obtained on the basis of common coordinate system.
Multiple pattern support	You can add multiple numbers of patterns for one model and enable various pattern additions depending on the light and surrounding environment.
Exposure calibration	Automatic exposure calibration and user-defined exposure configuration help good pattern recognition regardless of ambient illumination changes.
Geometric pattern score	By executing the pattern score by using the geometric shape of the workpiece, you can execute the pattern recognition work strong to environmental changes.
Tool function	You can easily set and manage various types of data including camera calibration, pattern addition, registration of reference car body, communication setup etc. by using the tool by each function. Additionally, with the data communication protocol installed for Hyundai Robot controller, the interface with the Hyundai Robot is simple.
Monitoring function	You can monitor process sequence, communication sequence with Hyundai Robot, pattern recognition result etc, and manage the error history and data history. Additionally, you can save the image of the time of the error.

1.2. System Configuration

The figure below is a brief diagram of the vision system for applying under-body sealant using “HRVision 3D-MultiCam.” The system consists of robot and vision systems: The vision system consists of hardware, such as PC, frame grabber, camera, lighting, and PLC, and “HRVision 3D-MultiCam” software.

With “HRVision 3D-MultiCam” program, a user can configure and operate the vision system while the data is communicated using the PLC communication and Hyundai controller-dedicated communication protocol. Hyundai robot applies the sealant according to the location recognition of the vision system.

If a digital camera is used, the frame grabber is unnecessary.



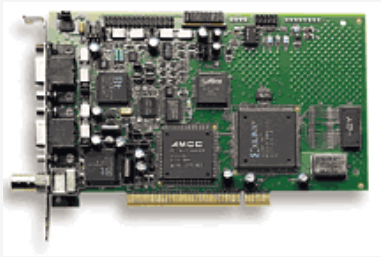
1.2.1. Hardware Configuration

The recommended H/W of “HRVision 3D-MultiCam” is as follows.

H/W	Item	Recommended specifications
PC	CPU	At least 2GHZ Multi-core Processor 512KB or more L2 cache
	OS	Windows XP, Windows 7
	RAM	2GB or above
	Video	PCIe x16 Video Card
	HDD	80GB or above
	CD-ROM	X48
	PCI Slot	2 EA * For mounting the frame grabber when using an analog camera
Lighting	Light	florescent light
Vision system	Frame Grabber	8511VXs or 8514VXs (COGNEX) : 2EA * Unnecessary when using a digital camera
	Camera	XC-HR70s (SONY) or MV-BX30As (CREVIS) : 8EA
	Lens	H1214-M(PENTAX) Can be changed depending on installation environment and usage.
	Cable	20m

If you would like to use “HRVision 3D-MultiCam” by adding multiple numbers of patterns, use a PC with high performance CPU and sufficient memory.

Here are the specifications of the vision system for using an analog camera:

Model name	Exterior	Specifications
MVS-8111VX **MVS-8514VX**		High speed Frame Grabber Number of camera that can be connected: Maximum of 4 units Connection method: RS170, CCIR 1/2 slot PCI
XC-HR70, **MV-BX30A**		1/3" CCD 1024(H)×768(V) C Mount DC 12V 29(W)×29(H)×30(D) mm
H1214-M		Focal Length : f12mm Format Size: 1/2", 1/3" Mount : C-mount Filter Screw Diameter(mm) : M27 P0.5 Weight : 55g Focus & Iris Lock Screws

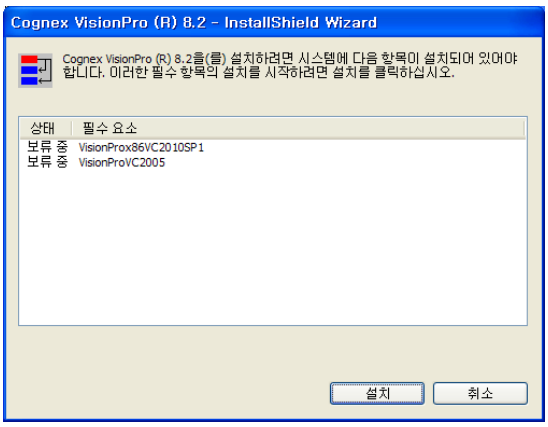
1.2.2. Software Configuration

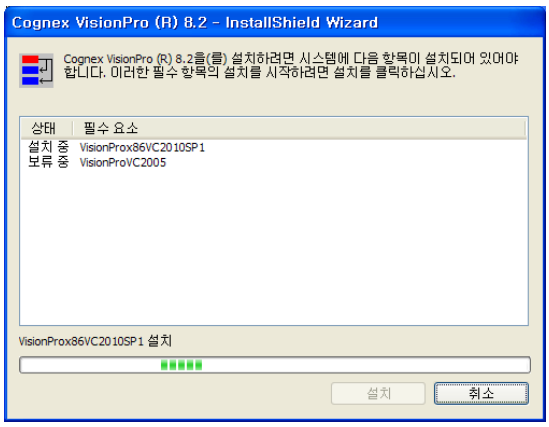
The software consists of “VisionPro 8.2”, “MX Component 4.0”, and “HRVision 3D-MultiCam Setup SW”.
“VisionPro 8.2” is a software that provides the driver for “Cognex Frame Grabber” and different applications.
“MX Component 4.0” is a software that provides different applications for “Mitsubishi PLC.”
It is essential if it is necessary to connect it with “Mitsubishi PLC” in the applied process.
“HRVision 3D-MultiCam Setup SW” is a 3D robot vision software dedicated for Hyundai robots to recognize the location of car body using a PC, and it requires installation and license registration before use.

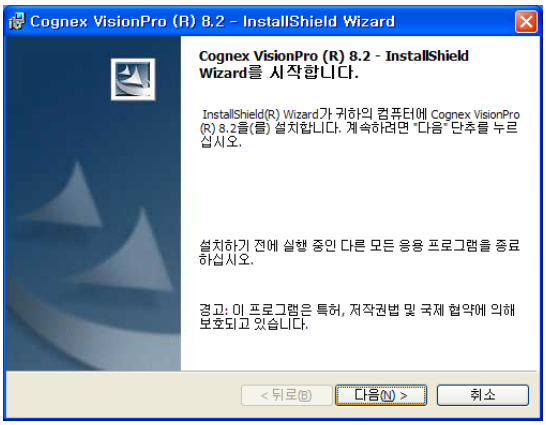
1.2.2.1. VisionPro Installation

End all application softwares on the system.
Insert the installation CD of “VisionPro” into the CD-ROM drive. If it is not automatically executed, execute the setup.exe file among the installation files.

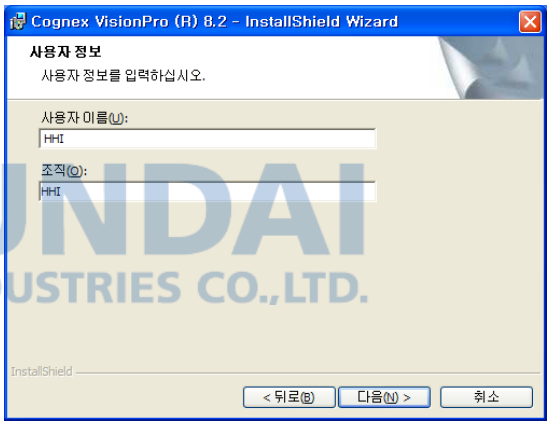
When the following installation appears, follow the installation procedure and direction as the general Windows program.



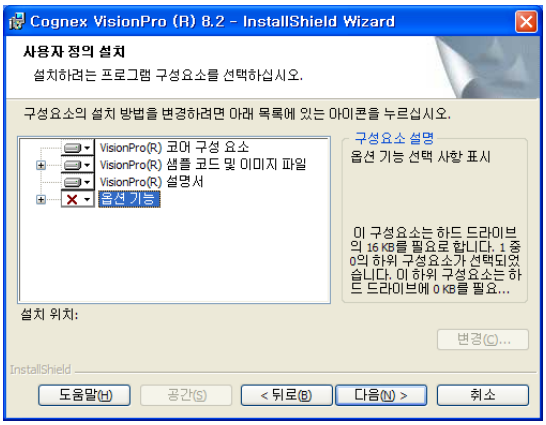


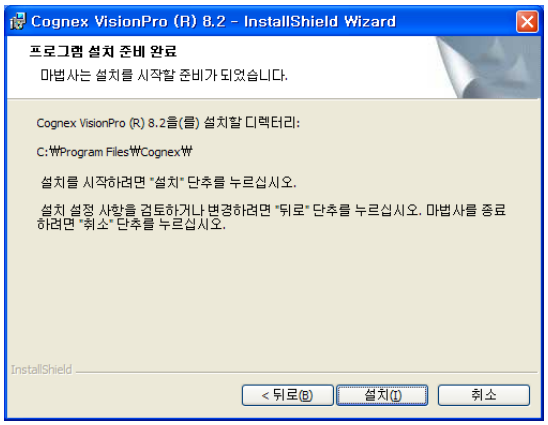


Please agree with the license used below and enter user information.



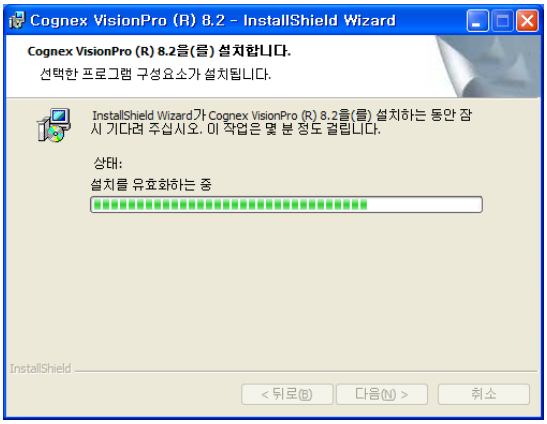
Follow the instructions to install “Cognex VisionPro(R) 8.2” as follows.

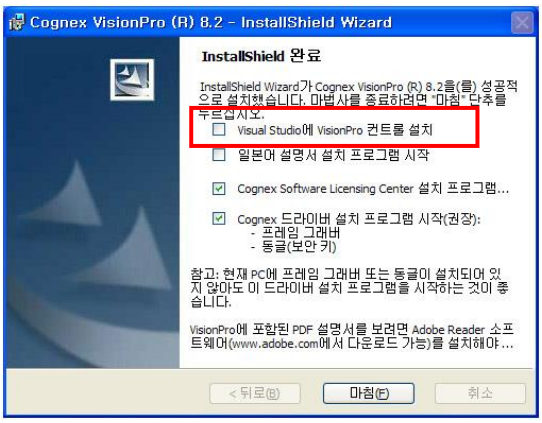




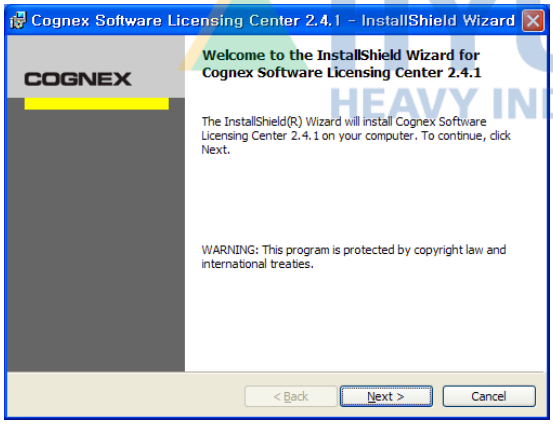
When “Cognex VisionPro(R) 8.2” is installed, “Cognex Software Licensing Center” and “Cognex Frame Grabber” drivers are installed.

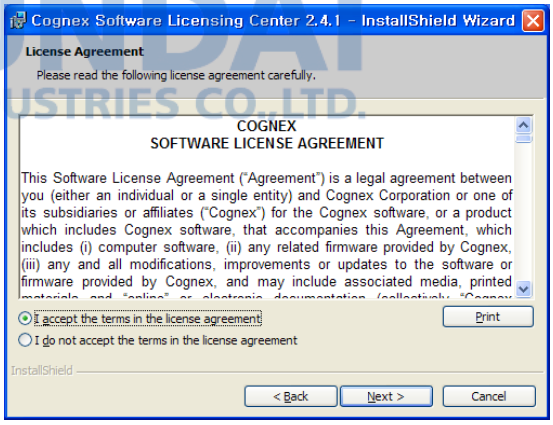
According to the system, “Install VisionPro Control” button can be clicked in “Visual Studio.” Uncheck it and continue the installation.

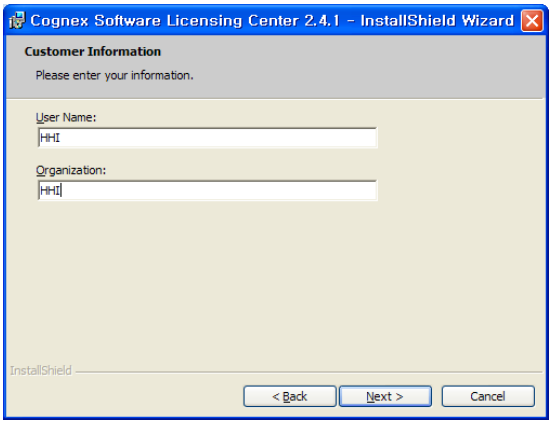


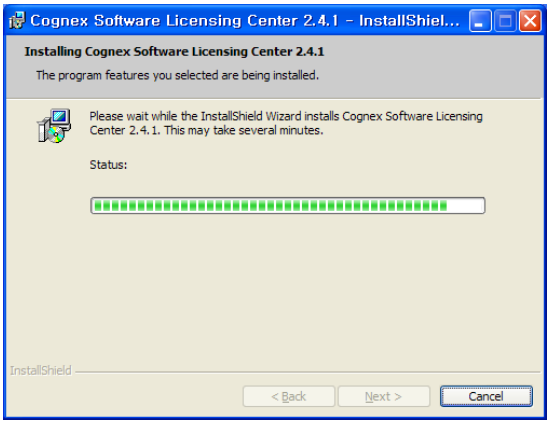


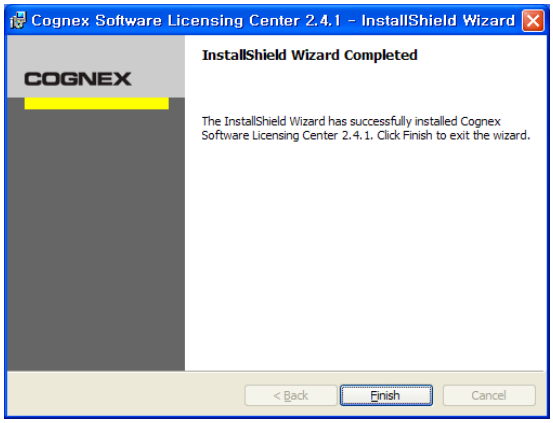
Agree with the license use and enter user information as follows, and then install “Cognex Software Licensing Center.”



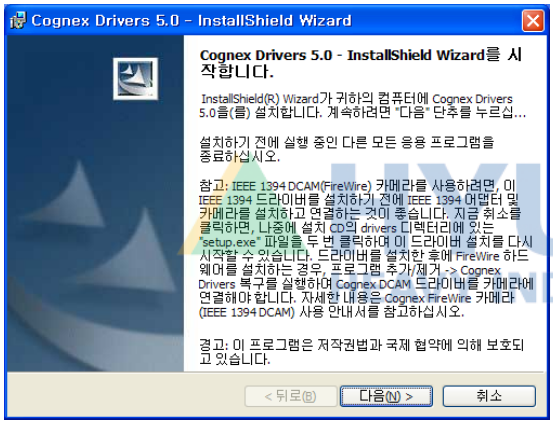


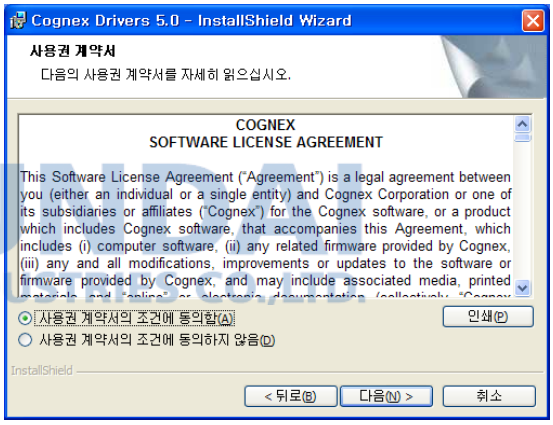


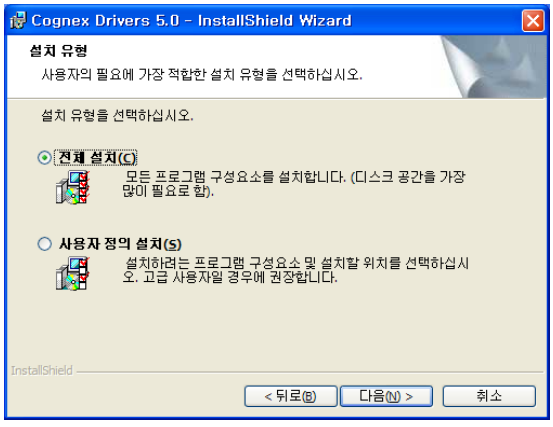


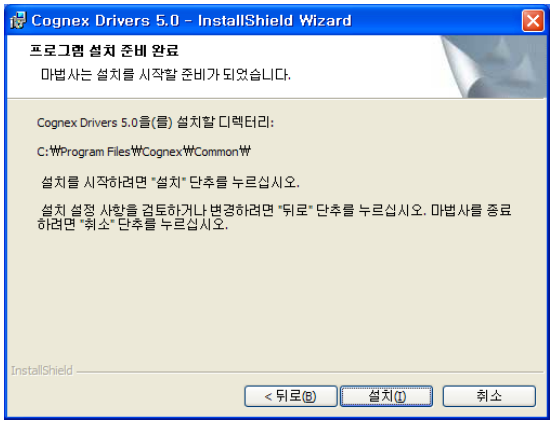


Agree with the user right to install “Cognex Driver” as shown below and select the installation type before proceeding with the installation.



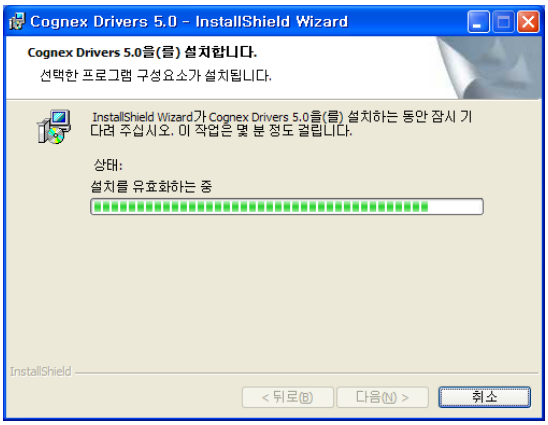


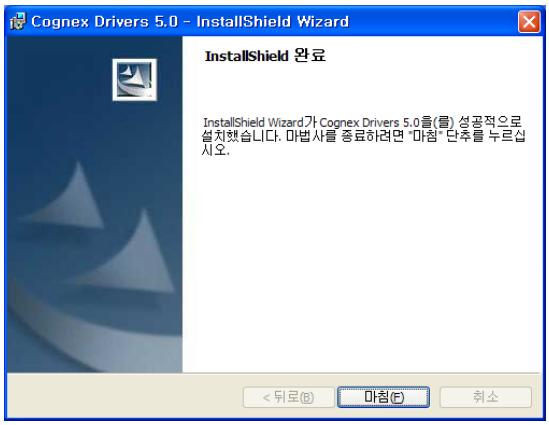


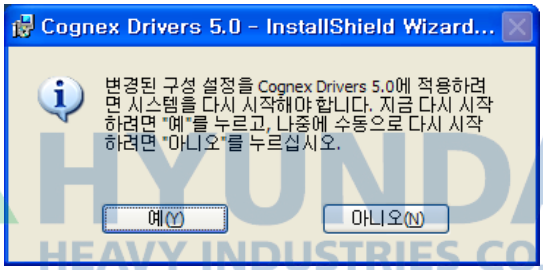


Follow the instructions to install the software for “Cognex Frame Grabber.”

Reboot the system when the driver is installed.

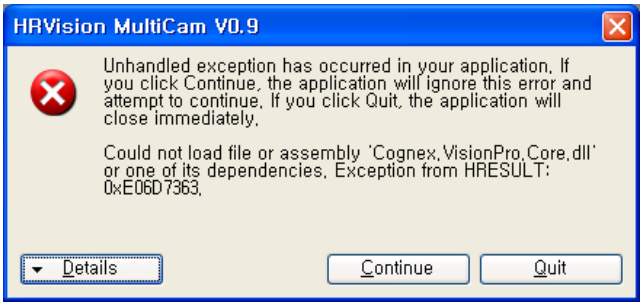






The following warning window pops up if “HRVision 3D-MultiCam” program is installed without “VisionPro 8.2.”

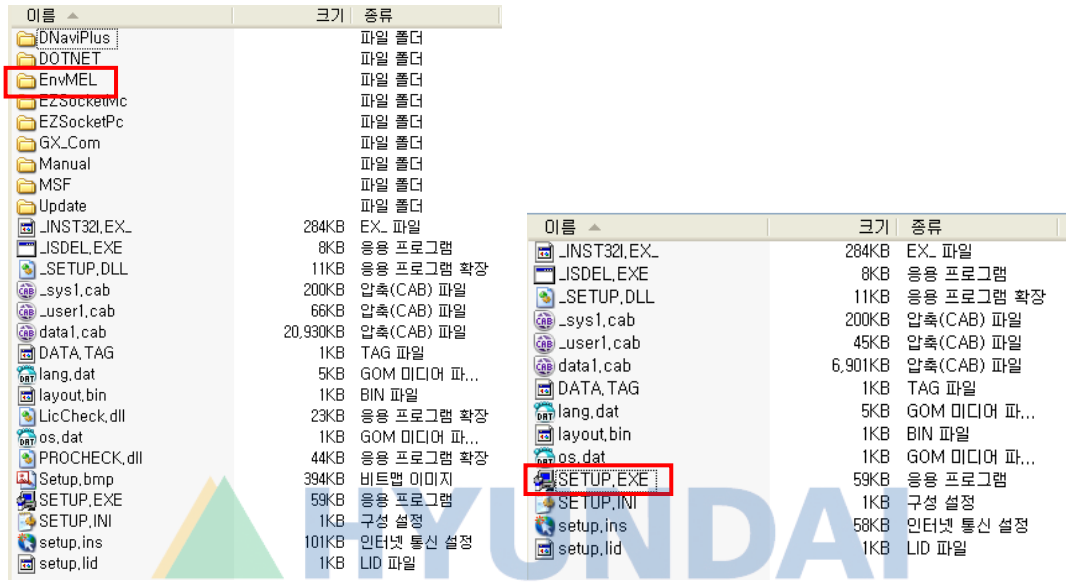
Check if it is installed in “C:\Program Files\Cognex\VisionPro”. Otherwise, install it again.



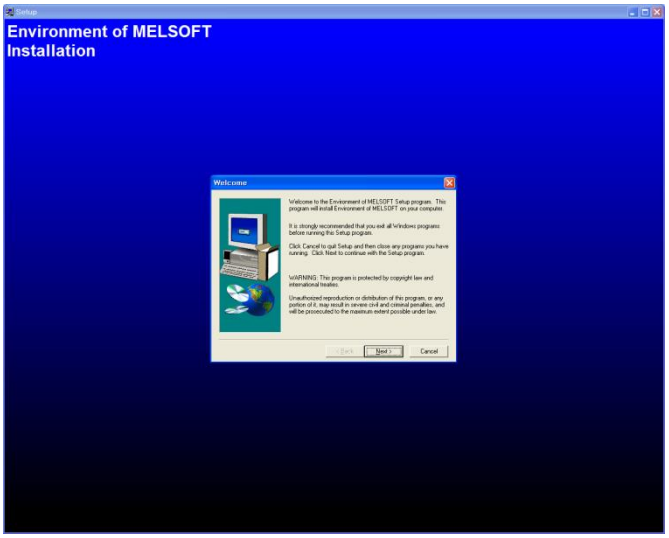
1.2.2.2. MX Component 4.0 Installation

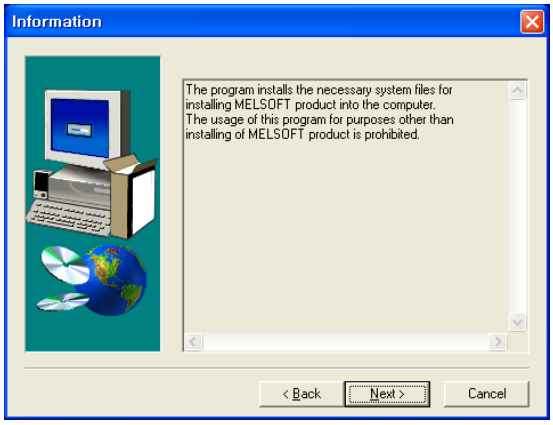
If it is necessary for the vision system to be connected with “Mitsubishi PLC”, it is required to install “MX Component 4.0”. The installation procedure is as follows.

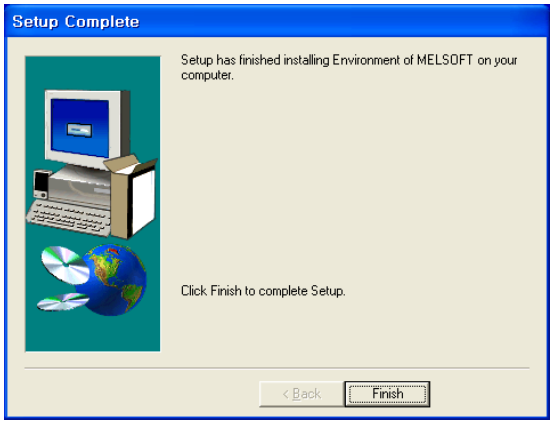
First, run “SETUP.EXE” in “EnvMEL” folder of “MX Component 4.0” installation folder.



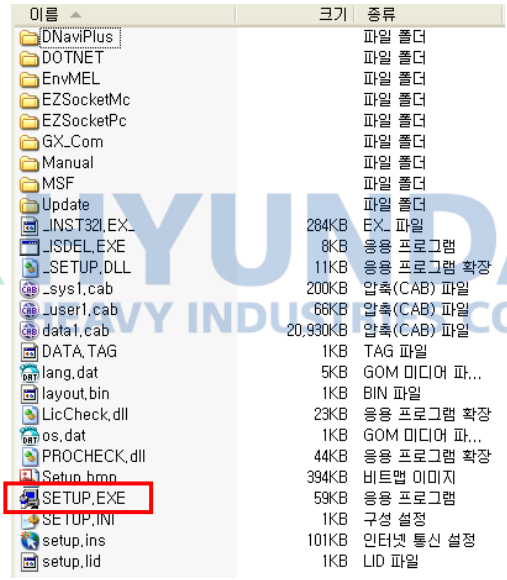
When the following screen appears, follow the directions as the installation procedure of general Windows program.



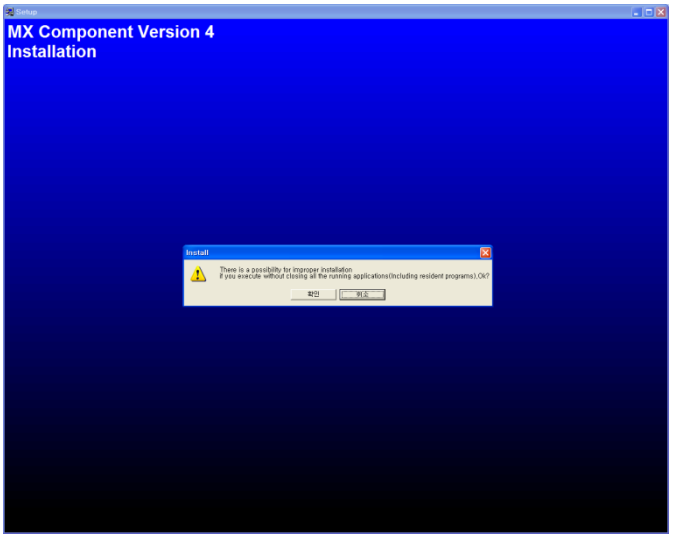


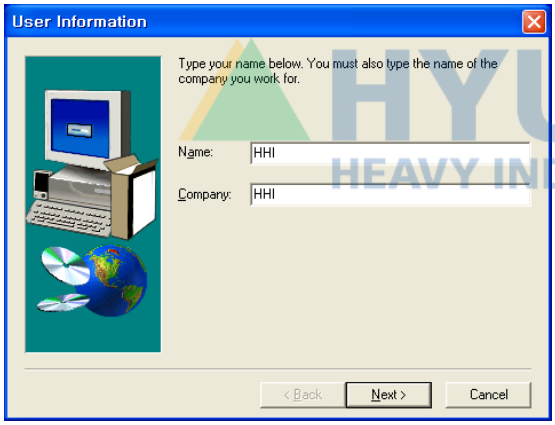


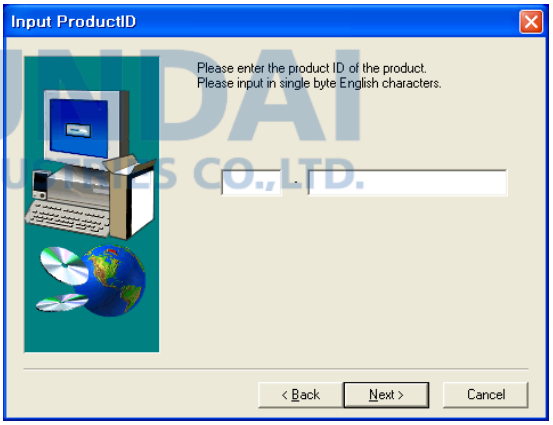
After installing “EnvMEL”, install “MX Component” application. Run “SETUP.EXE”

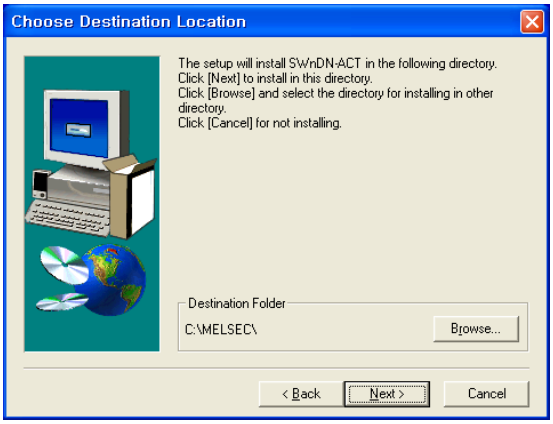


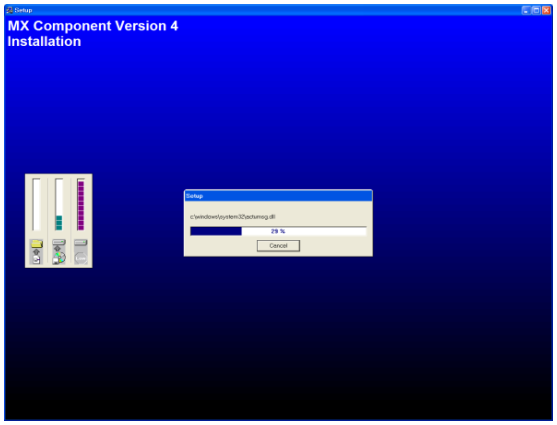
With the installation screen as follows, continue the installation procedure according to the instructions.



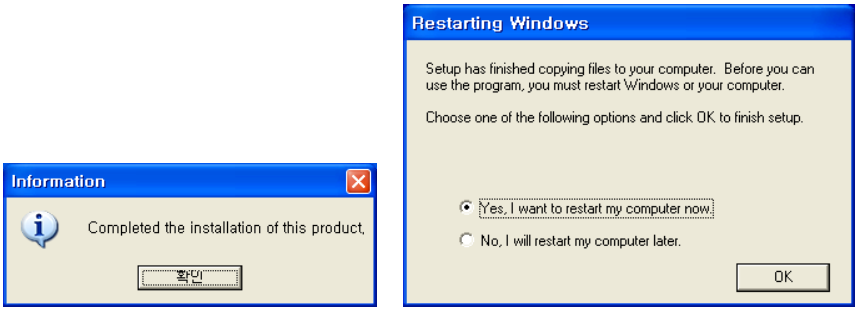








When “MX Component 4.0” is installed, reboot the system.

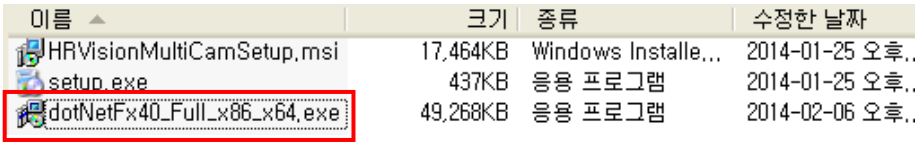


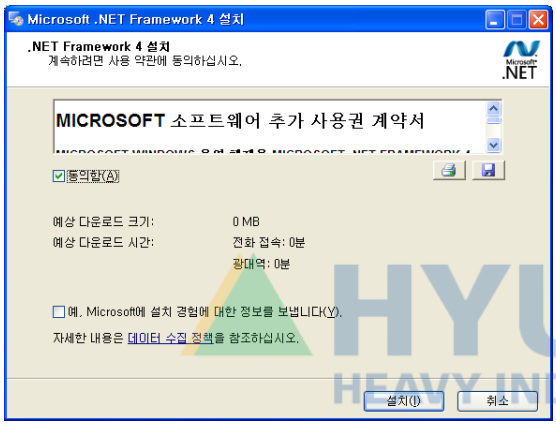
1.2.2.3. HRVision 3D-MultiCam Installation

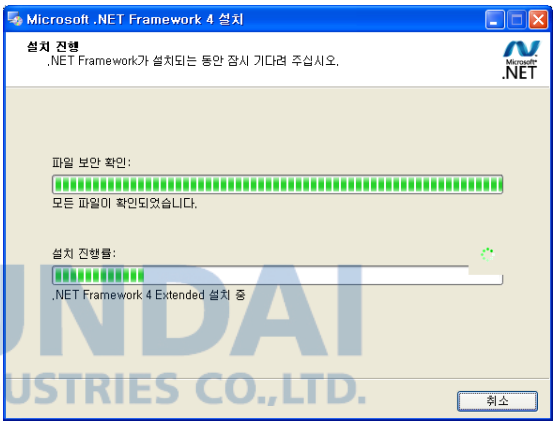
“HRVision 3D-MultiCam” program installation procedure is as follows.

Close all the applications and install “Microsoft .NET Framework 4.”

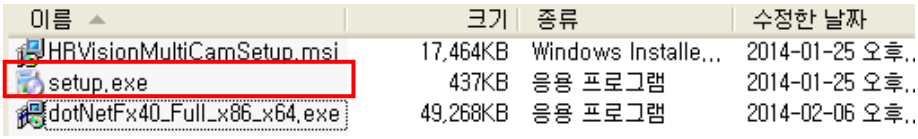
Run “dotNetFx40_Full_x86_64.exe” among “HRVision 3D-MultiCam” installation files and proceed with the instructed installation procedure.



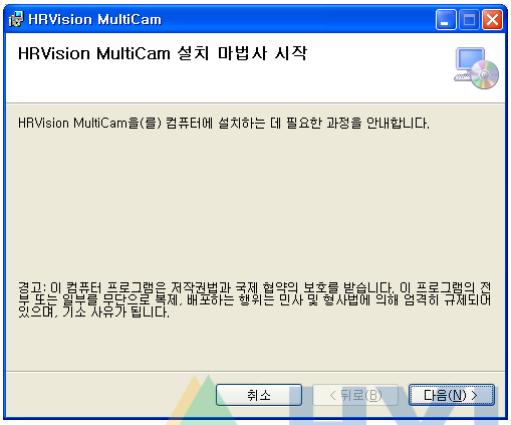


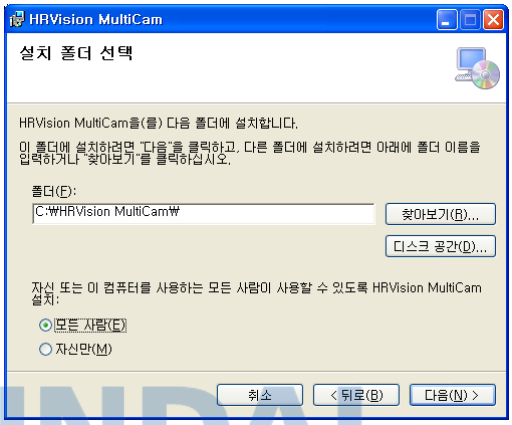


After installing “Microsoft .NET Framework 4”, install “HRVision 3D-MultiCam SW.” Run “setup.exe”



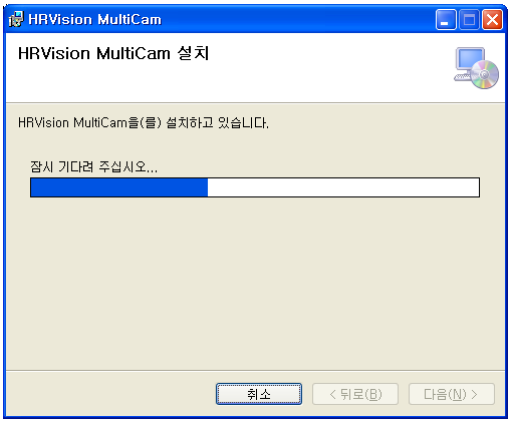
With the installation screen as follows, continue the installation procedure according to the instructions.

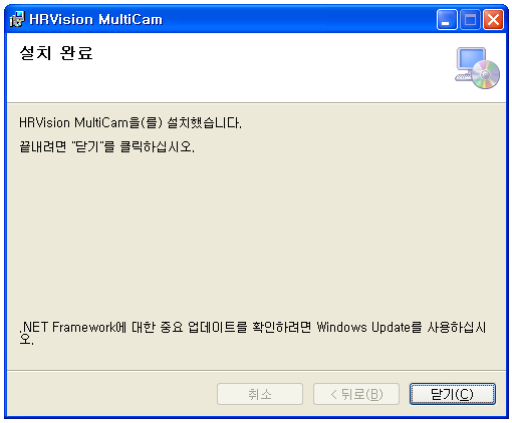




Executable files of “HRVision 3D-MultiCam” are copied into “C:\HRVision MultiCam”, and the user is not allowed to change the folder.

Click “Next” button to install “HRVision 3D-MultiCam” program.





1.3. HRVision 3D-MultiCam Execution

Double-click “HRVision 3D-MultiCam” icon in the desktop to run “HRVision 3D-MultiCam”.

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2 License Entry

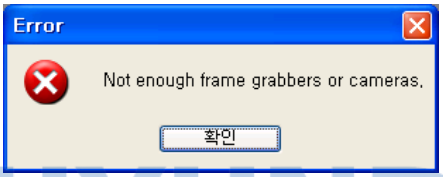
To use “HRVision 3D-MultiCam”, you must enter the license key.
You cannot execute any work in the condition without the license key entered.

2.1. HRVision 3D-MultiCam License

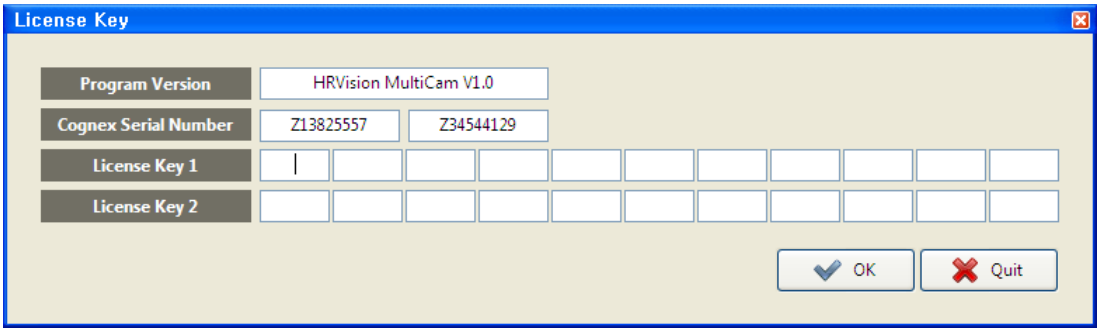
To use “HRVision 3D-MultiCam”, you must enter the license key number that fits the “Cognex Frame Grabber” of the PC with the S/W installed.
To purchase the user license of “HRVision 3D-MultiCam” from the supplier, you must notify the “System Serial No” for the “Frame Grabber” of “Cognex” to use.
The key code that fits the number provided by the customer will be notified to the user.

After the “HRVision 3D-MultiCam” installation, execute the “HRVision 3D-MultiCam” in the method described in 1.3. If “Cognex Frame Grabber” is not installed or is not operating normally, the following warning window will be displayed and the program will be ended.

The user should check whether the “Frame Grabber” is normally installed.



When the “Frame Grabber” is normally installed, the following input window will be displayed.
The user enters the license key received from the supplier and click OK.



When the license code is entered incorrectly or when the “Frame Grabber” installed on the PC is different from the “Frame Grabber” of which the information is provided to the supplier, the following warning window will be displayed.

Once entered license key is saved.
But when you uninstall “HRVision 3D-MultiCam” program from the PC, reinstall the operating system or format the hard drive, the entered key code information will disappear and you need to re-enter during the reinstallation. Therefore keep the key code in a safe location.

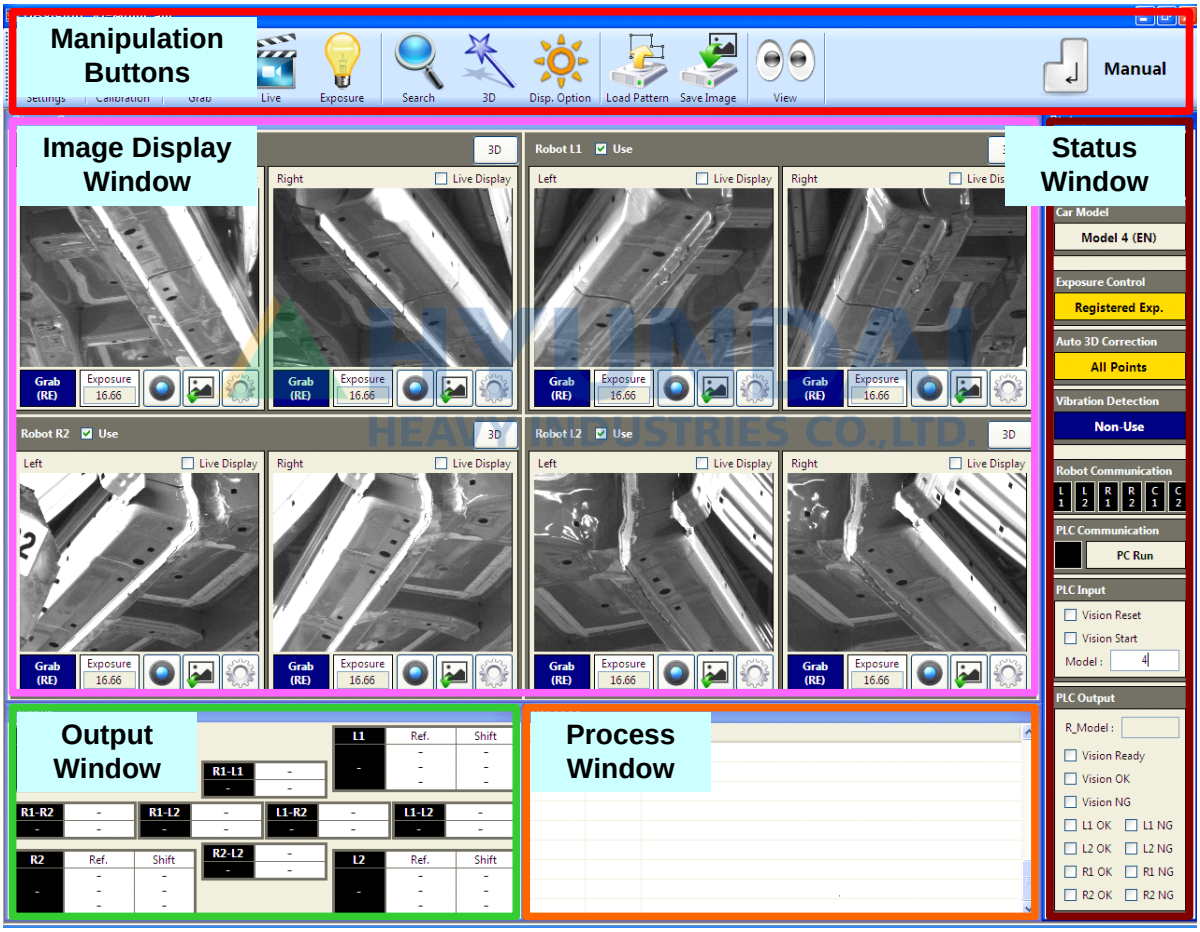
3 Basic Function

3.1. Screen Configuration

"HRVision 3D-MultiCam" supports Korean and English, which can be selected in "Setting" menu. This manual describes English Windows OS only.

3.1.1. Main Screen Configuration

After entering the correct serial key after running the program, the following screen is displayed. "HRVision 3D-MultiCam" screen consists of 5 windows, and each menu of control buttons opens an independent program or setting window.



The key function of each window is as follows.

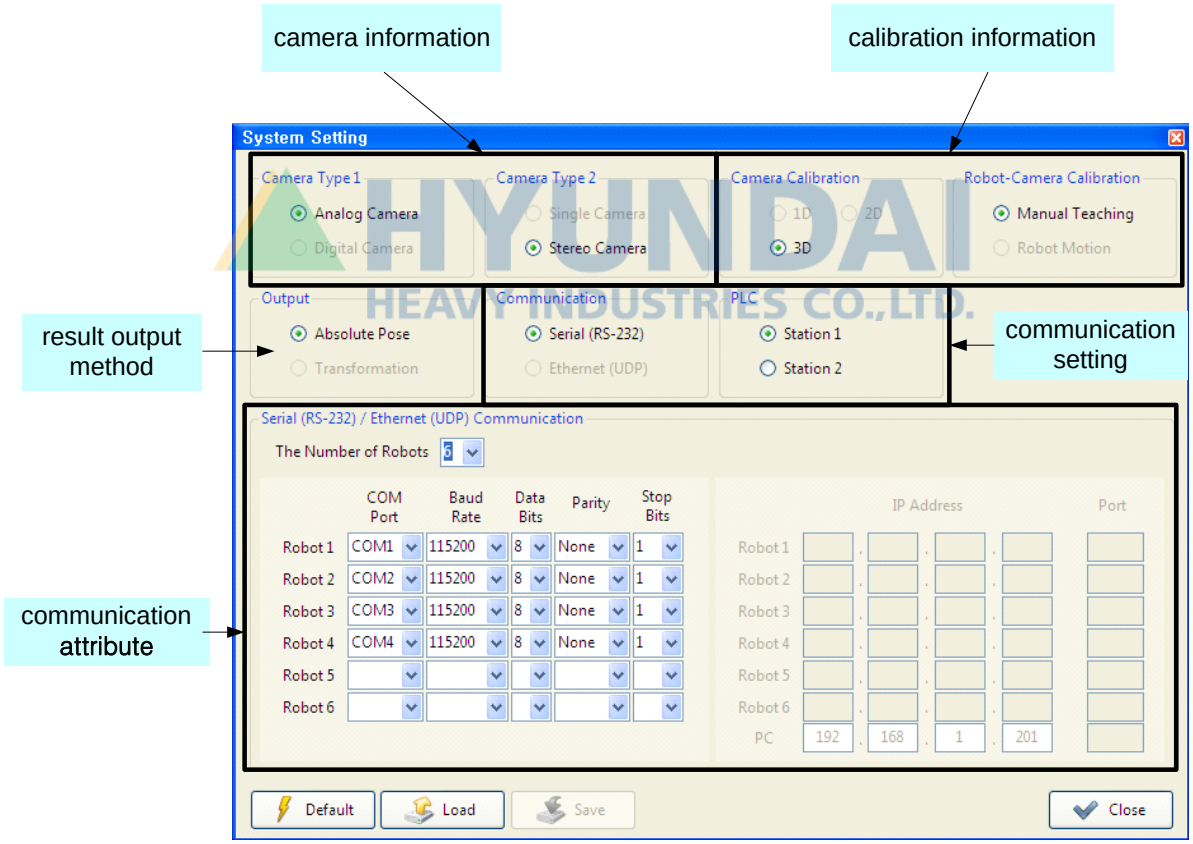
Manipulation Buttons	Settings, image recording, calibration, check, and auto operation menus are provided to control “HRVision 3D-MultiCam.”
Image Display Window	This displays the current live or grabbed image.
Process Window	This displays the communication details with the Hyundai Robot, various status display, progress details etc.
Status Window	Recognition result and communication state are displayed.
Output Window	3D location measurement result on 4 points for the reference and current car bodies. The distance between the points are displayed.

3.1.2. Manipulation Buttons

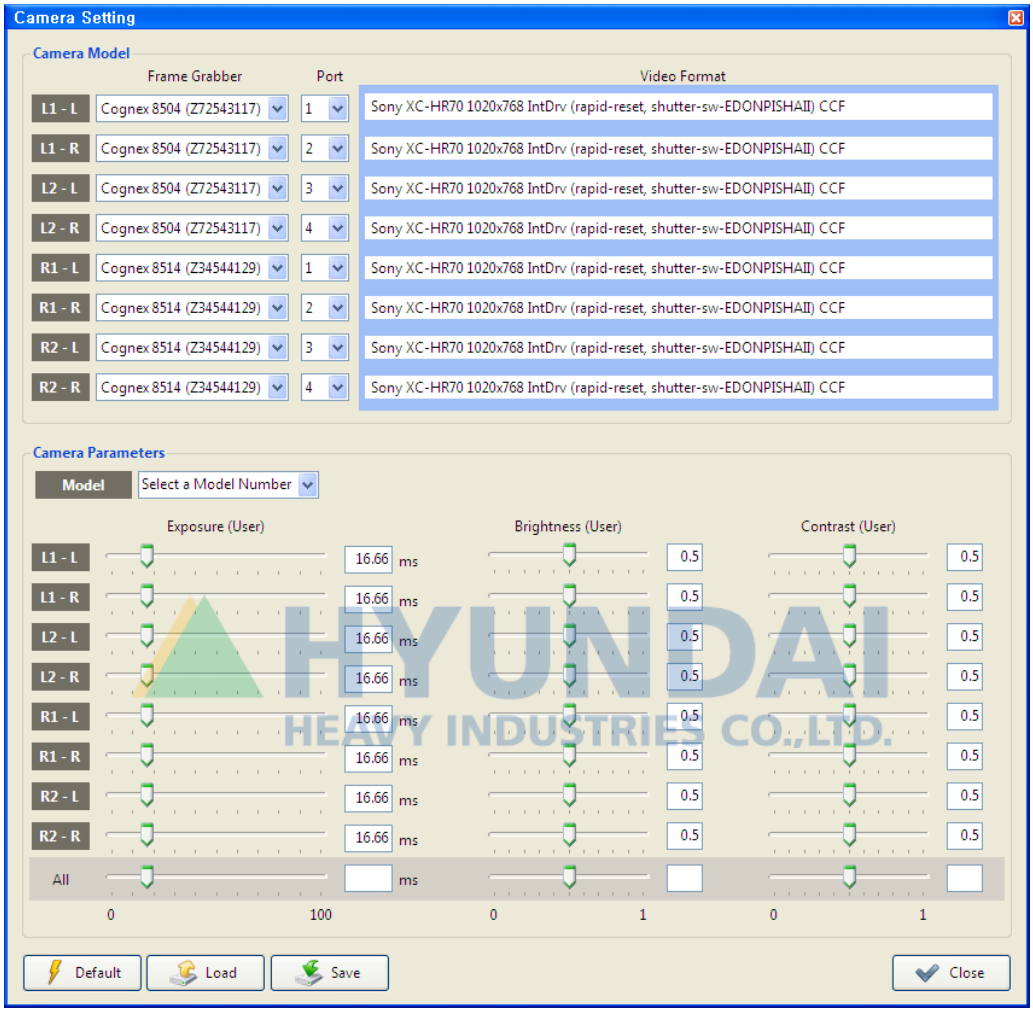
As the button operating the key function of “HRVision 3D-MultiCam”, each function is as follows.

- Settings
  This menu is for configuring/managing different functions and connected HW. There are 12 submenus, which are as follows.

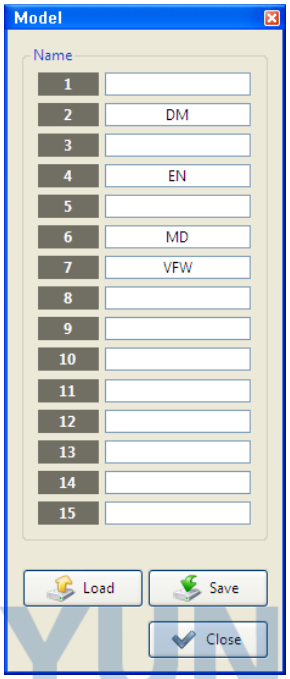
  - System
    Camera type, camera calibration method, result display method, and communication can be configured. Configure them according to the surrounding equipment and installation condition.



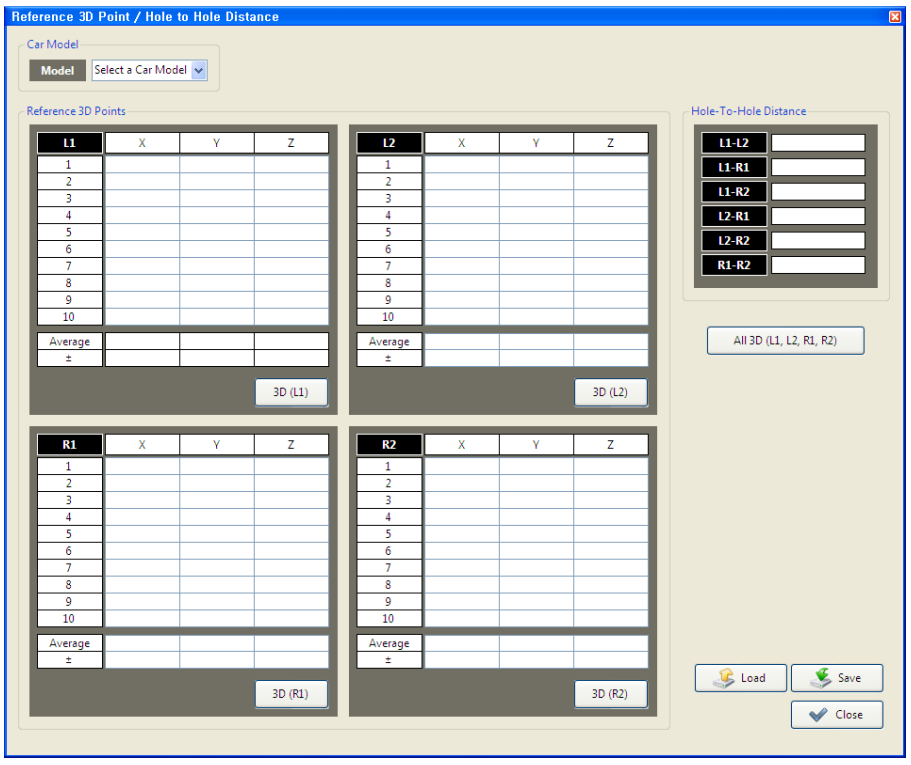
- Camera Setting
  Camera model, connection port, and exposure can be configured.



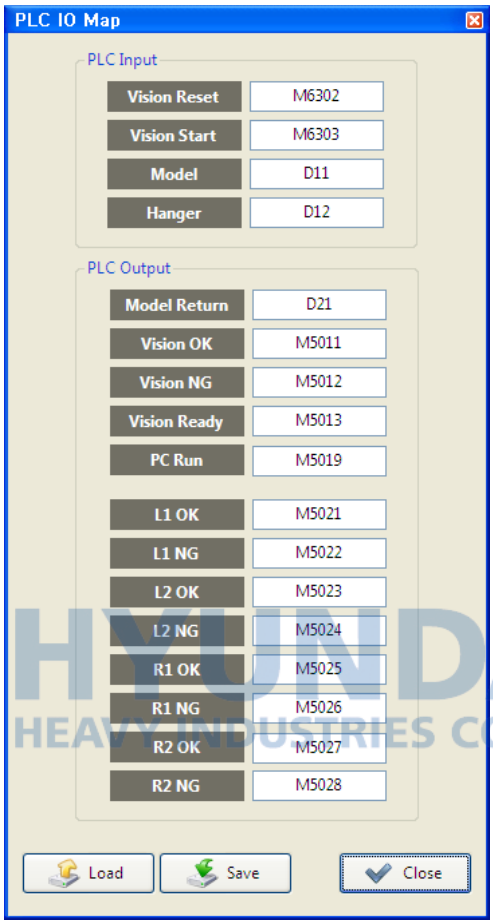
- Model
  Enter car model information and press “Save” button for saving.



- Reference Points
  Location of a car body is registered as the reference location considering the 4 measuring points.

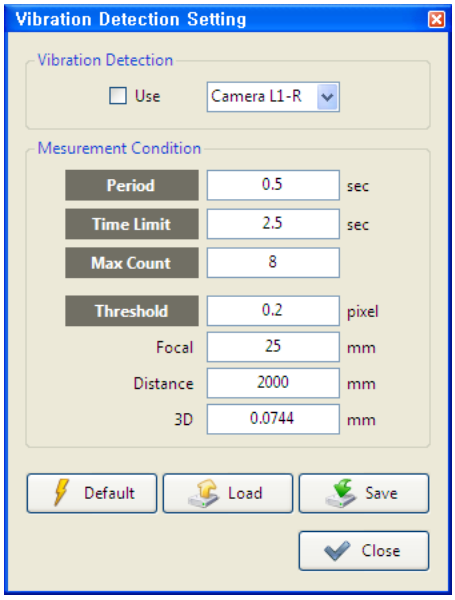


- PLC IO Map
  PLC Input/Output Map can be configured.

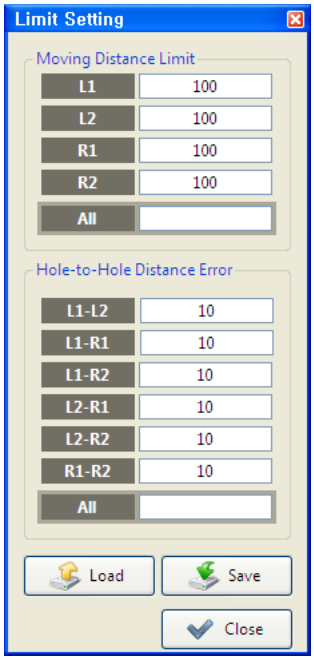


- Auto 3D Correction
  Select “All Points” to compensate and display the measured 3D data or select “Non-Use” to display noncompensated data. “All Points” is recommended.

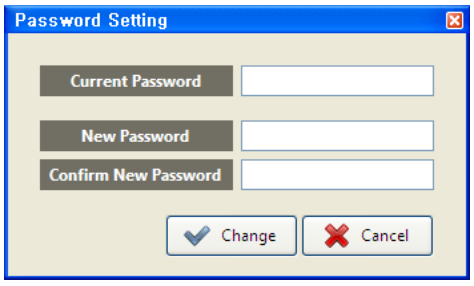
- Vibration
  Vibration-detecting camera and vibration detection variable can be configured.



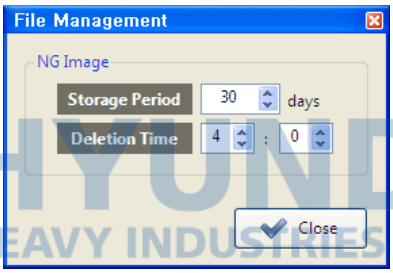
- Limit
  "Moving Distance Limit" is the distance limit for a measured hole to move in a space while "Hole-to-Hole Distance Error" is the tolerance threshold value for the distance between the holes. If the 3D location of a car body moves over "Moving Distance Limit" compared to the reference card body or the distance between the holes is bigger than the threshold value, NG is displayed.



- Password
  Password can be changed.



- File Management
  Saving and deleting cycle can be configured for error images. Deleting data may overload for the system so it is recommended to set the deleting time in early morning when the robots don't work.



- Screen Layout
  According to the robot and camera layout, “Image Display Window” and “Output Window” layout is changed for “HRVision 3D MultiCam” program. There are 4 options, which are as follows:

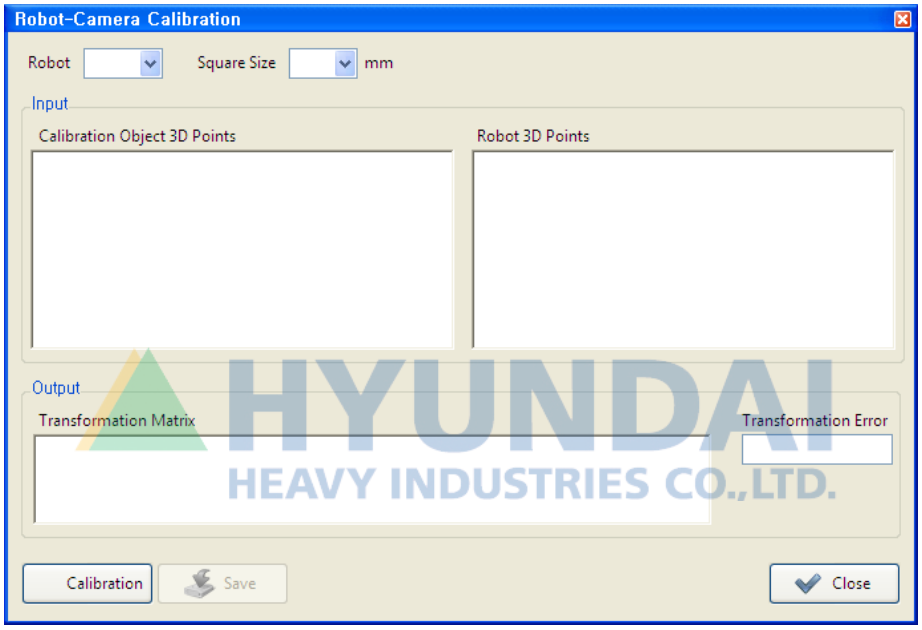
  ·L1-L2-R1-R2
  ·L2-R2-L1-L1
  ·R1-L1-R2-L2
  ·R2-R1-L2-L1

- Language
  Language (English/Korean) can be selected for “HRVision 3D MultiCam” program.

- Calibration
  Camera calibration program can be loaded and the relation between the robot and camera can be calculated.

  - Camera Calibration
    3.2.1 camera calibration program is loaded and the projection matrix is calculated.

  - Robot-Camera Calibration
    Calibration board used for the camera calibration and the relation with the robot can be calculated.



- Grab
  The currently displayed image can be recorded by clicking.

- Live Display
  "Continuous Image" is transferred from an installed camera.

- Exposure
  There are 3 types of automatic exposure modes.

  - Registered Exposure
    An image is recorded with the exposure used for the pattern registration.

  - Auto Exposure
    The exposure level is automatically changed so that the brightness of the image for pattern registration and of the current one is similar. In this mode, image recording becomes slower.

  - User Exposure
    An image is recorded according to user configuration.

- Search
  If there is a pattern registered, pattern recognition is performed once after an image is recorded.

- 3D
  If there is a pattern registered, pattern recognition is performed once after an image is recorded, and then the 3D coordinate value is calculated.

- Disp. Option
  It can be decided if to display result output date displayed in the screen after pattern recognition.

  - Score
    Matching rate is displayed for the result of pattern recognition.

  - Pattern Region
    Pattern recognition area is displayed.

  - Coordinate Axes
    Pattern recognition coordinate axis is displayed.

  - Origin
    Starting point of pattern recognition is displayed.

  - Center and Scale
    Exposure level configured in Camera Setting window is maintained.

  - Center Guide Line
    Cross mark is displayed in the center of image.

- Load Pattern
  Registered pattern is loaded.

- Save Image
  Current image is saved to “C:\HRVision MultiCam\Image” folder.

■ View
Window display settings can be configured.

- Default
  Default layout can be configured for each window.

- Single Camera
  It can be changed to single camera-based screen layout.

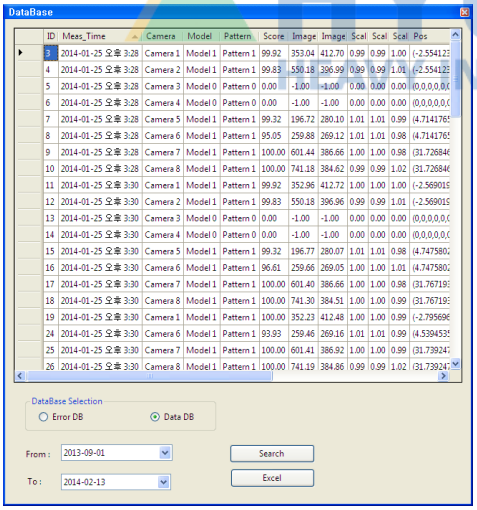
- Stereo Camera
  It can be changed to stereo camera-based screen layout.

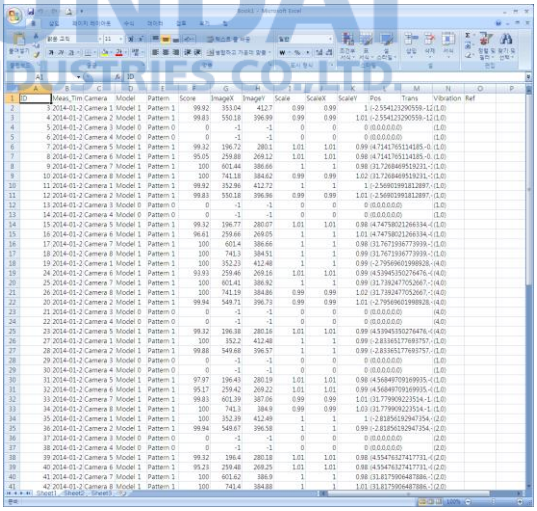
- Output
  Output window is displayed.

- Process Status
  Process Status window is displayed.

- Reset Position

- DataBase
  A search window is displayed for error and measured database.
  Searched data can be displayed in conjunction with “Microsoft Excel” program.

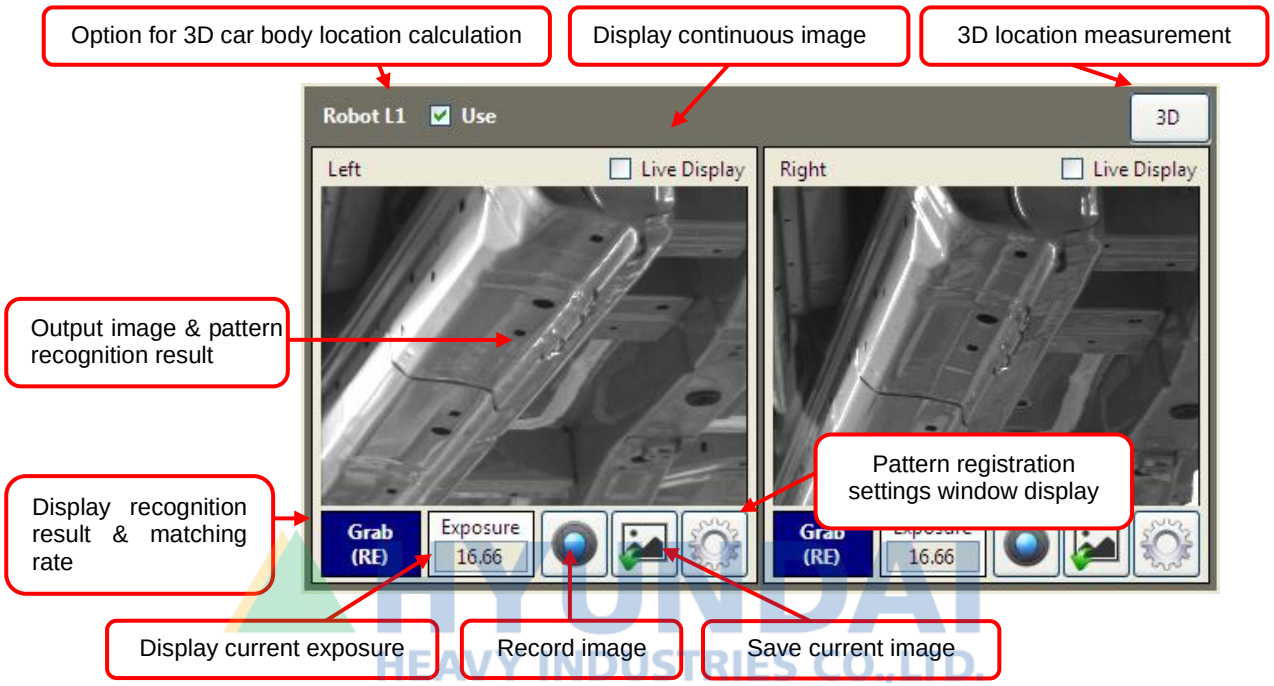




■ Manual
“Manual/Auto” mode can be switched. In “Auto” mode, all the buttons are not available, but it can be controlled only with PLC-robot communication.

3.1.3. Image Display Window

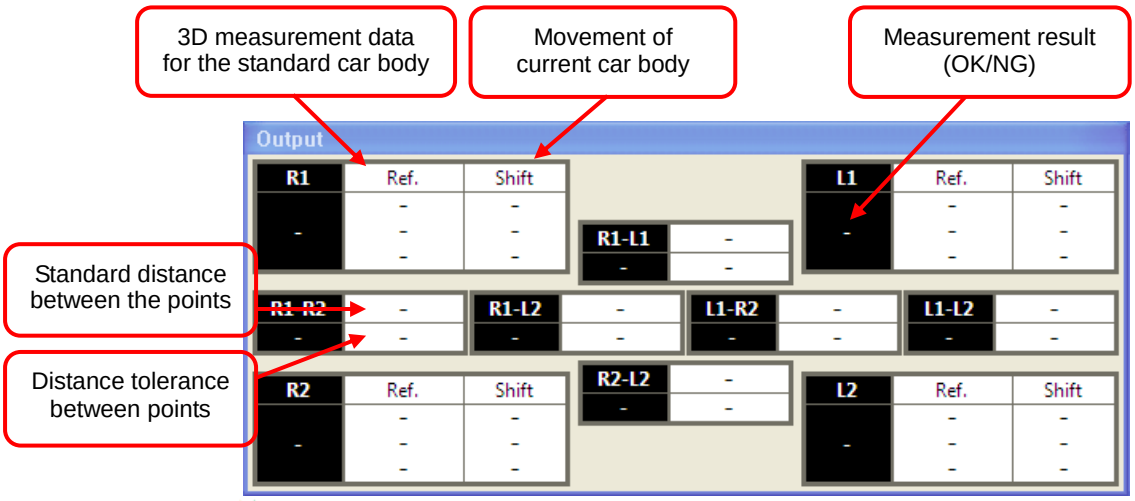
Image window shows continuous image or currently-recorded image as well as the pattern recognition result.



In the image window, you can do “Zoom In/Zoom Out”, “Fit Image”, and “Image Exploration” with the mouse control.

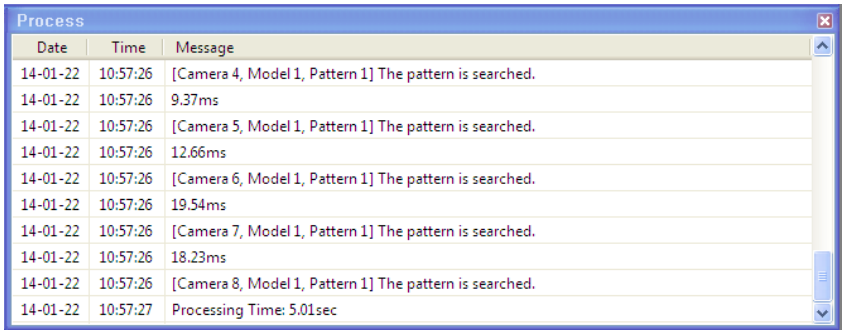
3.1.4. Output

Output window shows 3D locations of 4 points of reference car body and current one as well as the distance between the 4 points, moved distance, and location tolerance for the distance between the points.



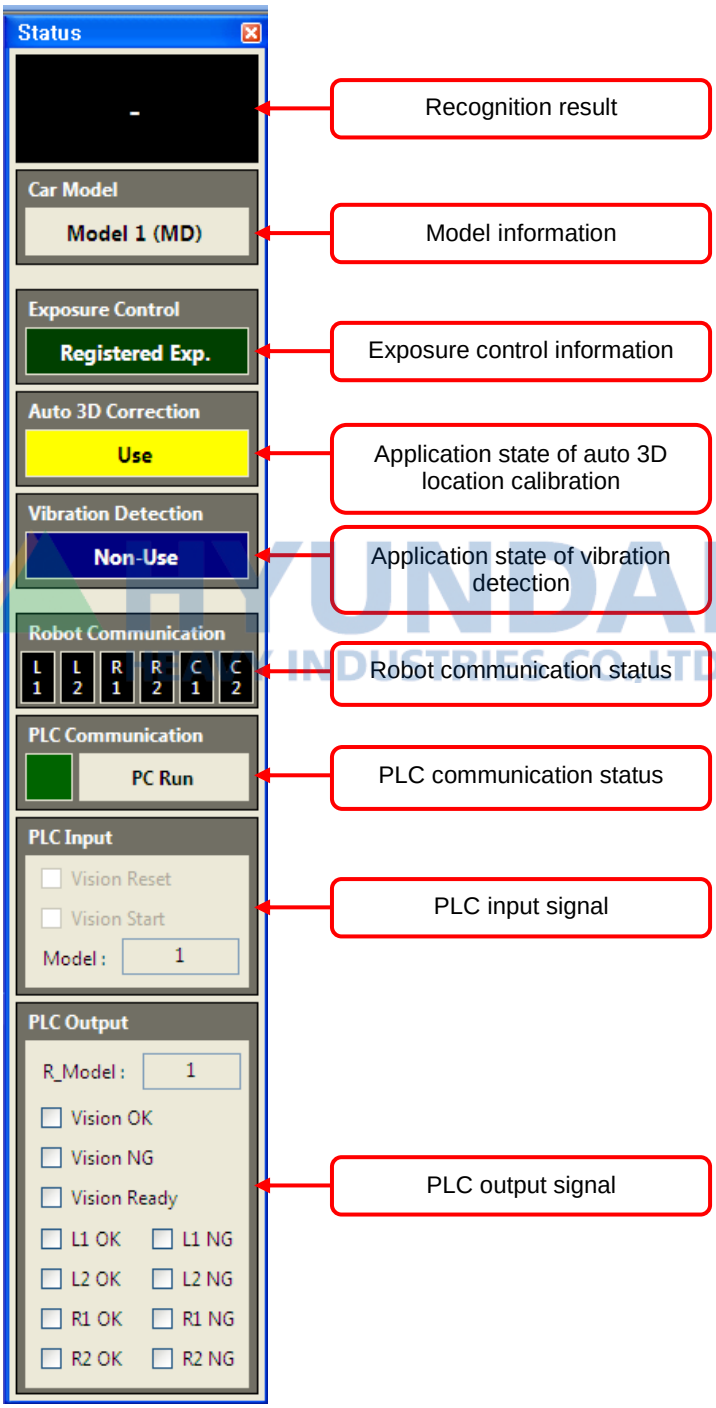
3.1.5. Process Window

"HRVision 3D-MultiCam" operation state is displayed.



3.1.6. Status Window

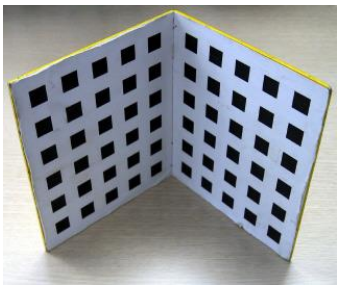
Recognition result, model information, enabled/disabled different functions, and PLC communication state are displayed.



3.2. Key Functions

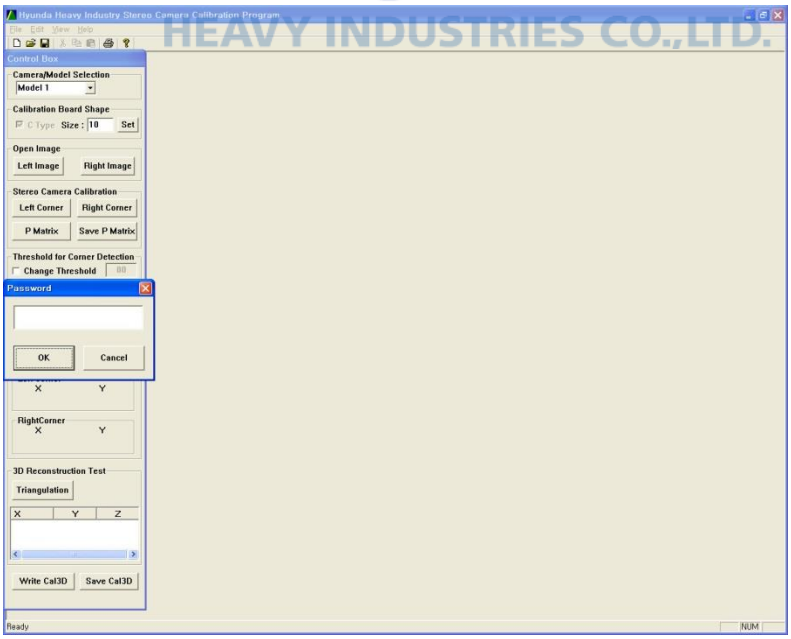
3.2.1. Stereo Camera Calibration

This is a camera calibration process to match camera coordinate system and common one of the process.
“HRVision 3D-MultiCam” performs the calibration using the following calibration board.



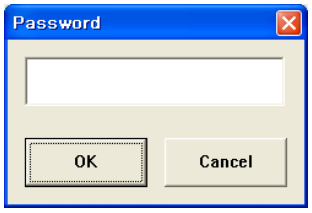
While the calibration board above is placed in the visual area of stereo camera, stereo image is recorded. Recorded stereo image is saved to “C:\HRVision MultiCam\Image” folder.

In “Calibration” menu of “HRVision 3D-MultiCam” menu, click “Camera Calibration” menu to perform the following “Hyundai Heavy Industry Stereo Camera Calibration Program” (Calibration Program).

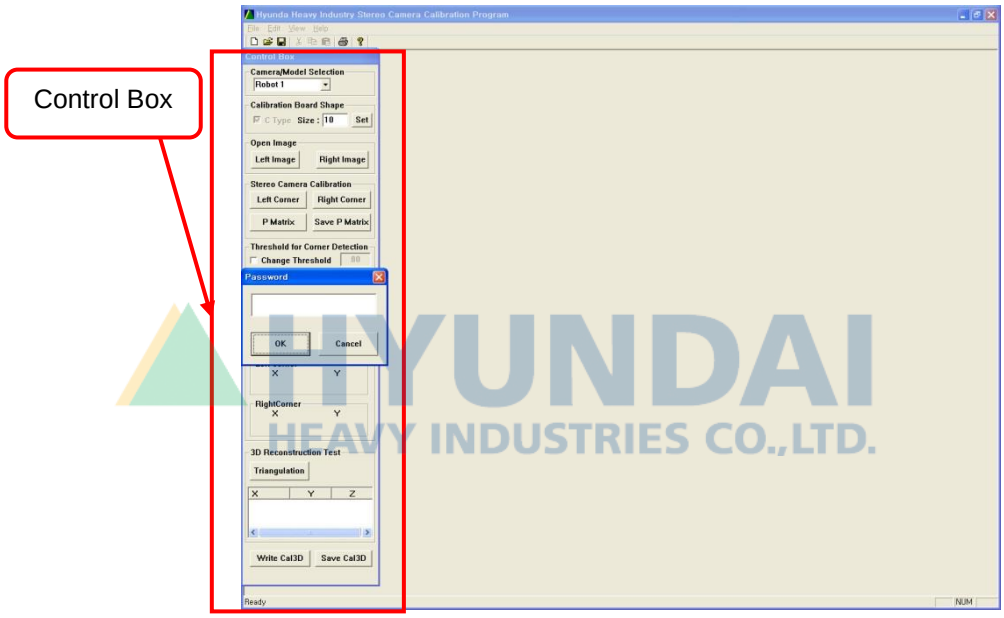


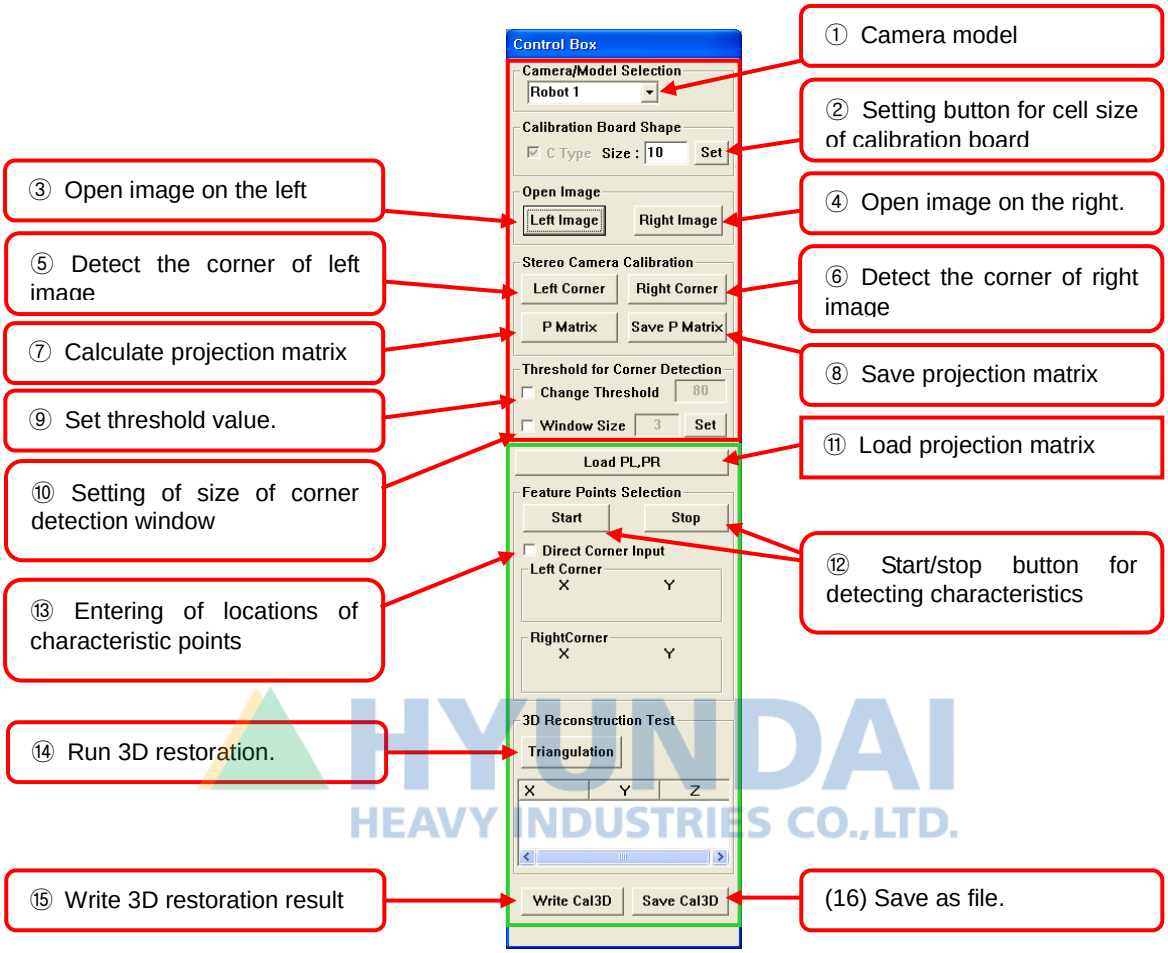
“Calibration Program” can be used only by entering correct password. The password will be provided by the seller of “HRVision 3D-MultiCam SW.” If wrong password is entered, the program is closed.

The figure below shows password prompt.



With correct password, all the functions of “Calibration Program” can be used as shown below. The functions of “Calibration Program” can be executed by controlling the “Control Box.”

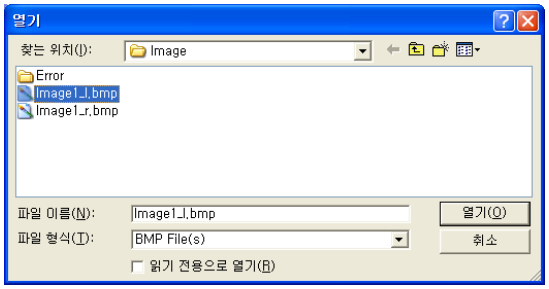


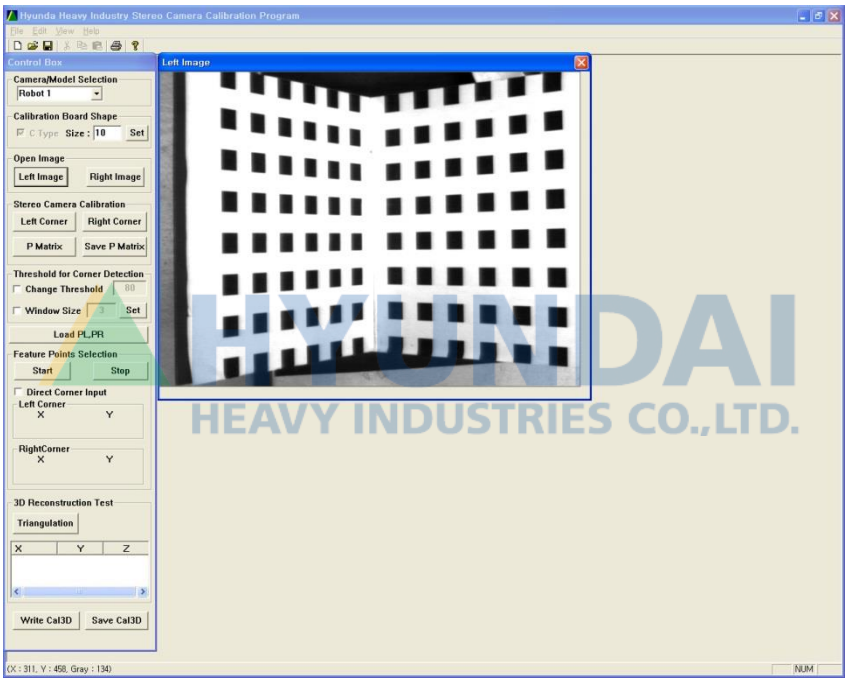


The camera calibration procedure is as follows.
First, select the number of stereo camera with "① Camera model" combo box of Control Box according to the location of robot.

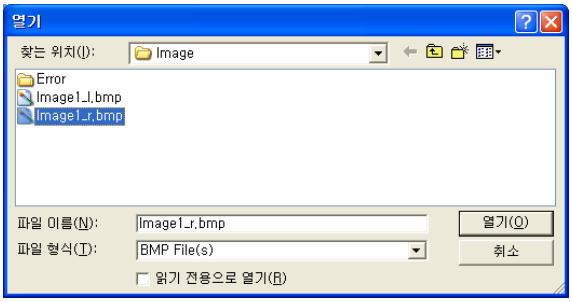
With "② Setting button for cell size of calibration board", enter the cell size of used calibration board. According to the lens specifications and installation environment, the size of calibration board can be 10mm, 15mm, and 20mm while the 10mm one is generally used.

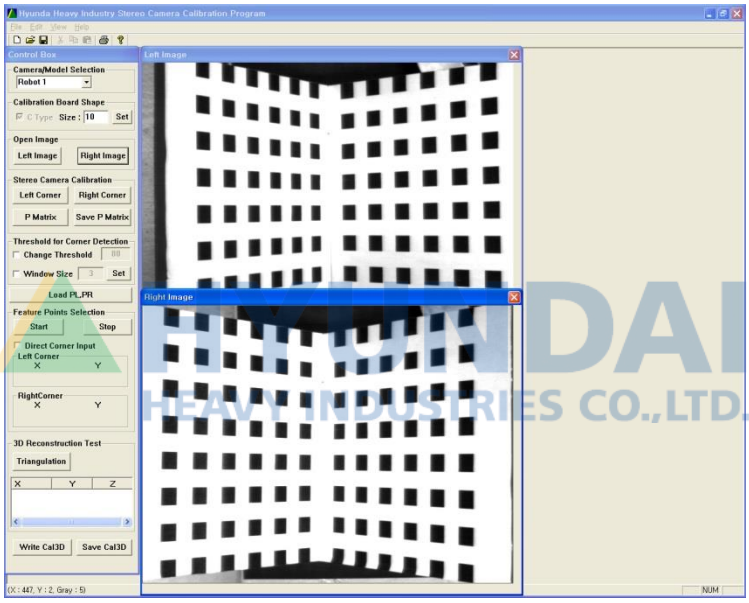
With “③ Left Image” button, open the left stereo image of the calibration board. The image is saved to “C:\HRVision MultiCam\Image” folder. The selected image is loaded to the calibration program.



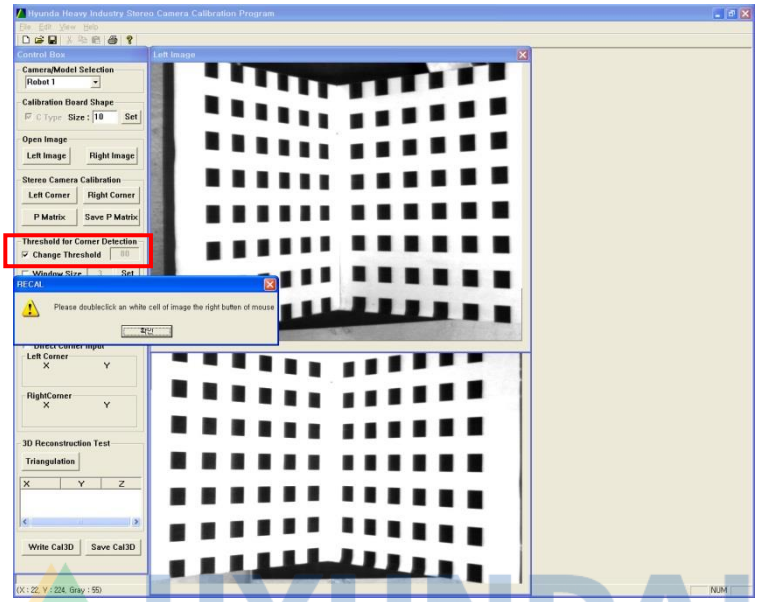


With “④ Right Image” button, open the right stereo image of the calibration board. The image is saved to “C:\HRVision MultiCam\Image” folder. The selected image is loaded to the calibration program.

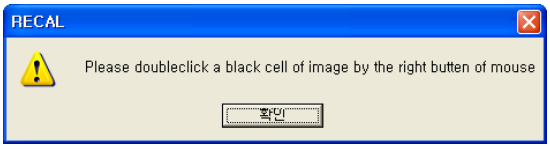


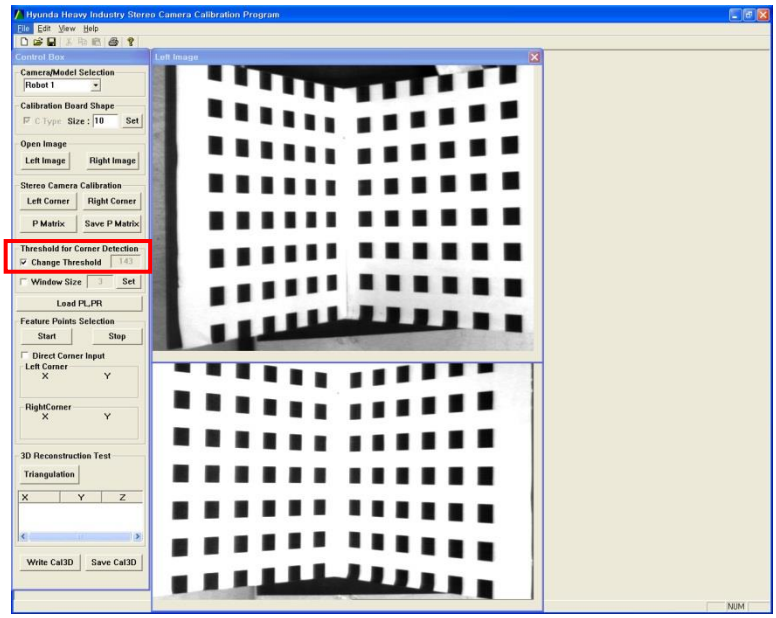


To calculate the corner points existing in the calibration board of the image, set corner detection threshold value. Click "⑨ Change Threshold" check box. Locate the mouse pointer on the white area of left image and double click it.



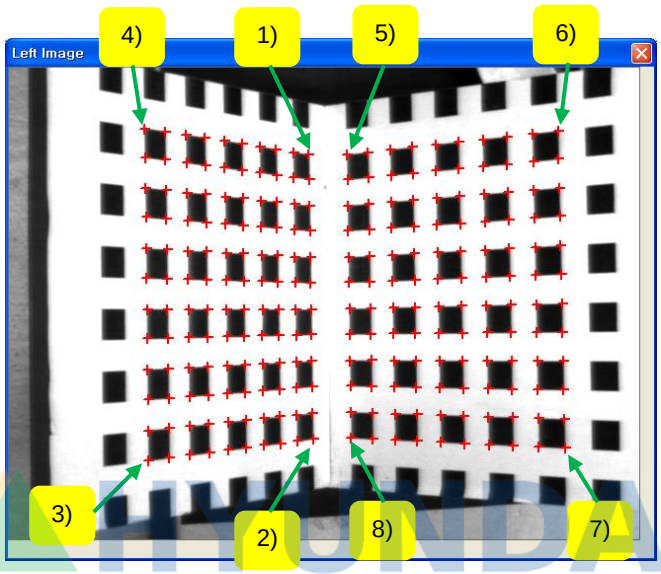
As shown in the figure, locate the pointer on the black area and double click it to automatically configure the threshold value to detect corners.



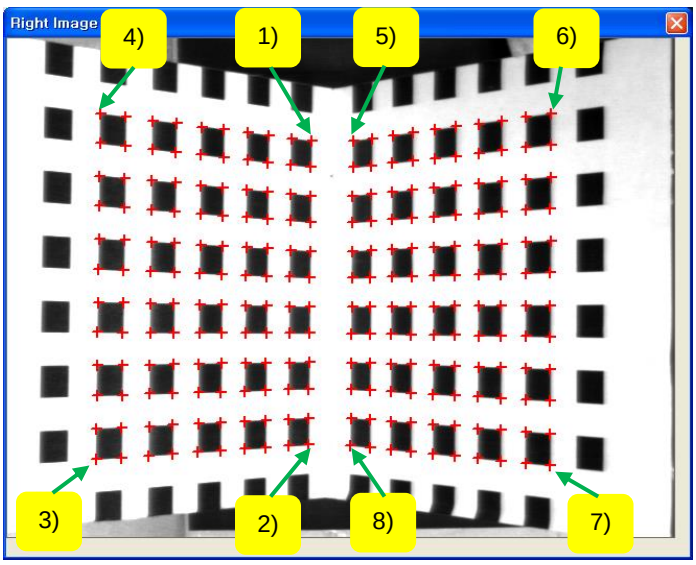


Stereo camera calibration can be performed using the corner points of black rectangles for the same areas between left and right images. The procedure to obtain corner points of each image is as follows.

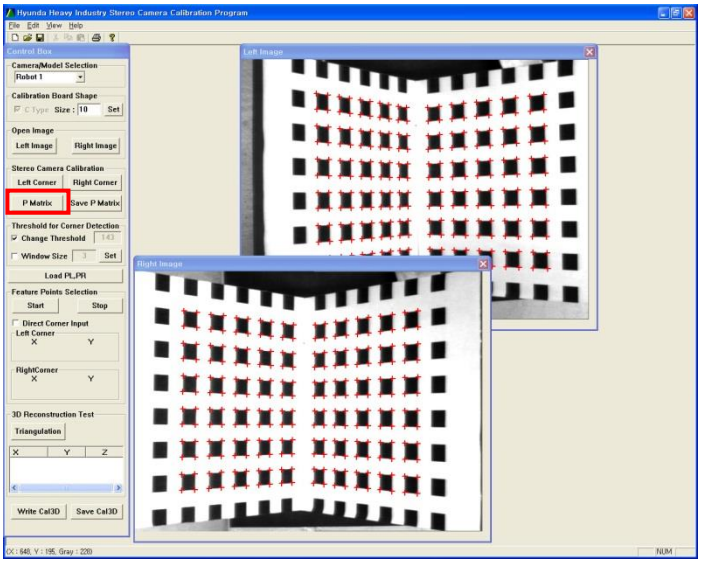
Click "⑤ Left Corner" button and then the contour of the black rectangle of left image in the following order. Click the 8 points in the order to automatically detect the corner of black rectangle in the area.

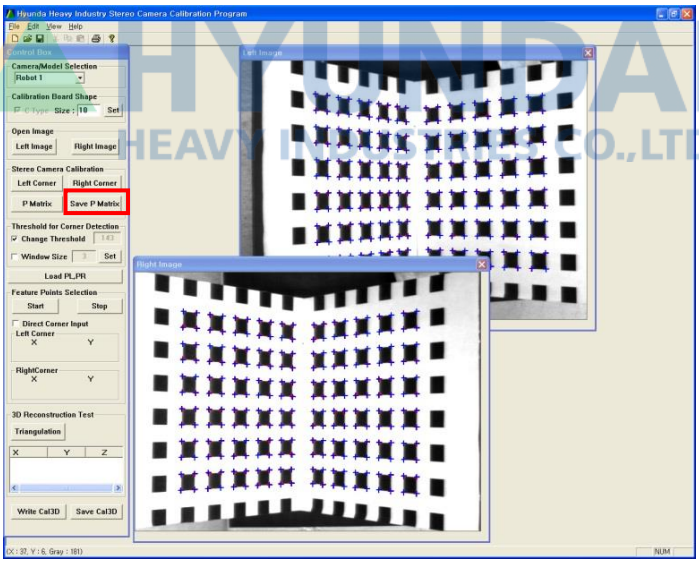


Click "⑥ Right Corner" button and the contour of the black rectangle of left image in the following order. Click the 8 points in order to automatically detect the corner of black rectangle in the area.

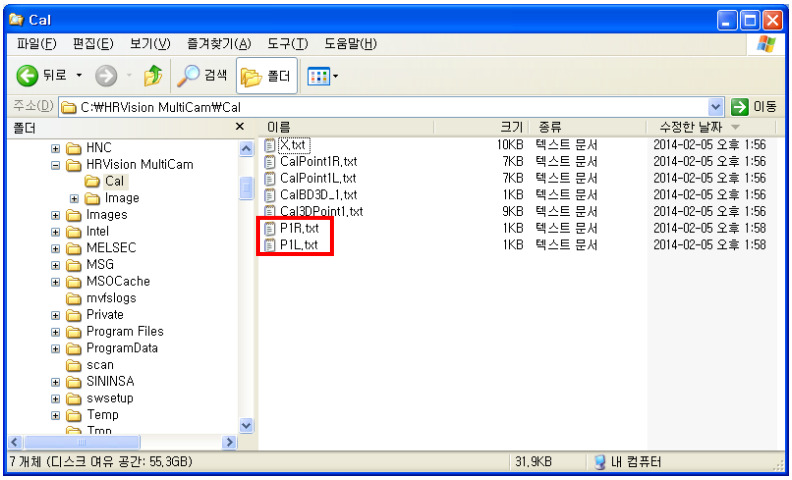


If the detected numbers of corner points are the same for left and right images, click “⑦ P Matrix” button. After the calculation is completed, the corner points become blue.



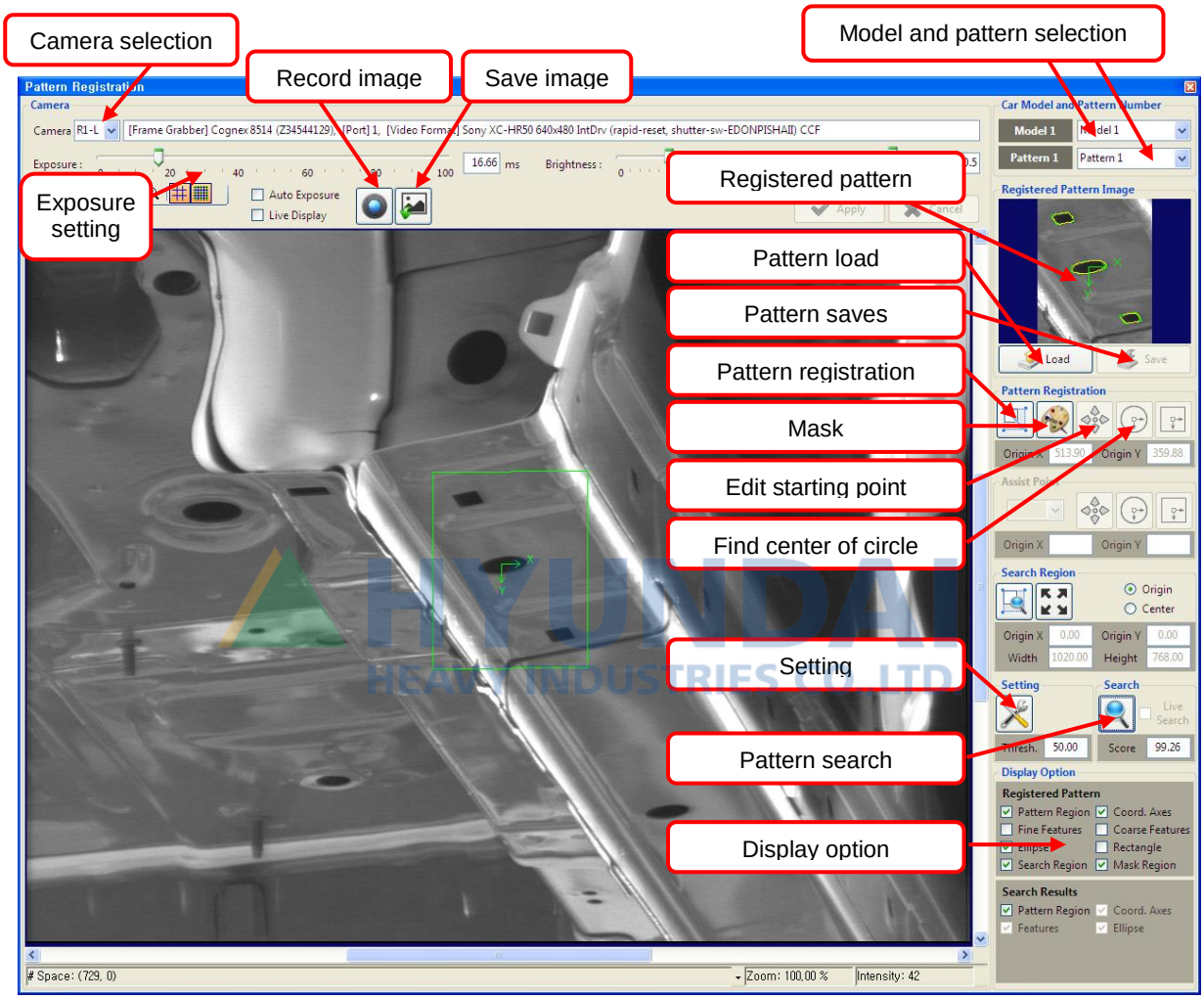


Click “⑧ Save P Matrix” button to save the projection matrix. Saved calibration data is saved to “C:\HRVision MultiCam\Cal” folder. Check if “P(No.)L.txt” and “P(No.)R.txt” files are created for the selected camera model. If the files are created, the camera calibration is completed.



3.2.2. Pattern Registration

This is a function used to manage (register/edit/delete) and teach the patterns for each model.



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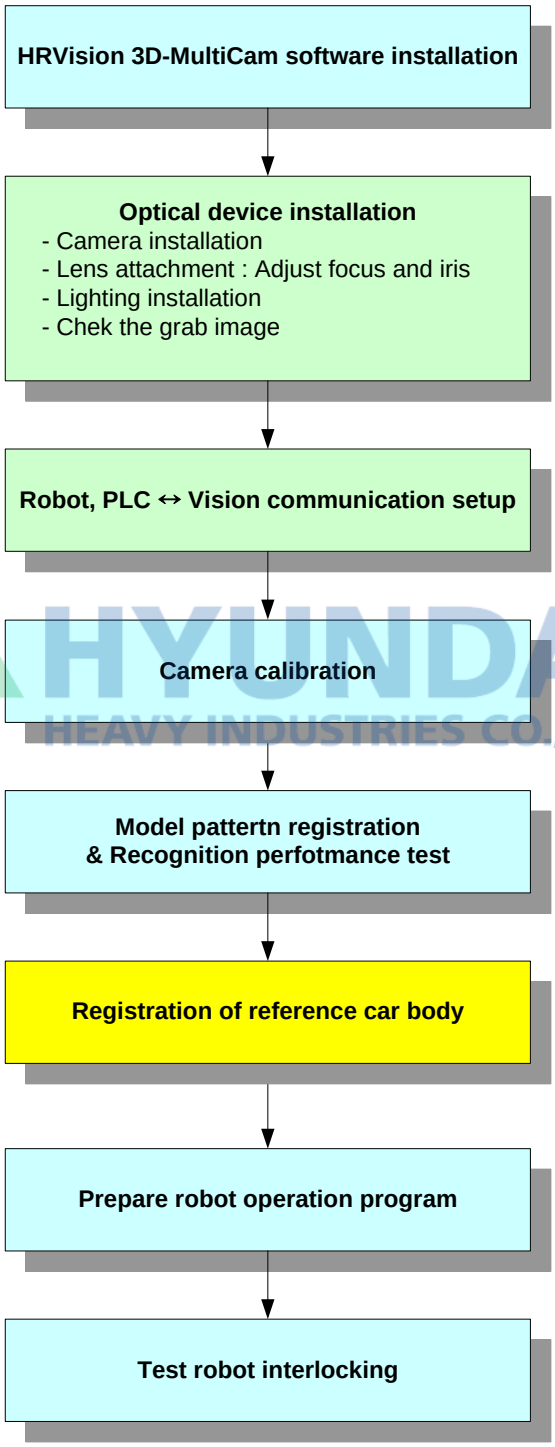
4 Work Procedure

The work procedure of the “HRVision 3D-MultiCam” is as follows.
The detail description of each procedure is provided in the following sections.



4.1. HRVision 3D-MultiCam Software Installation

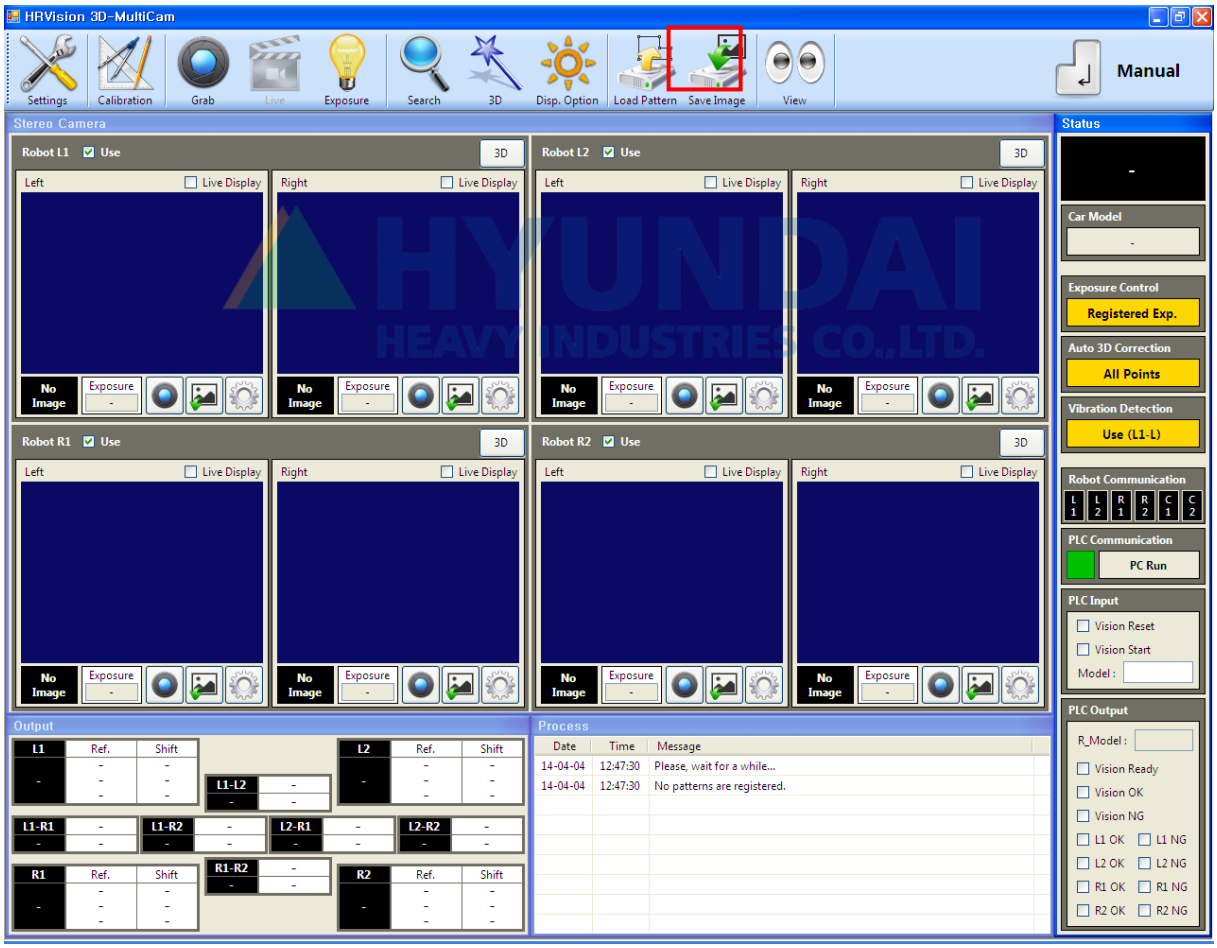
Install “VisionPro 8.2, MX Components SW” and “HRVision 3D-MultiCam” software in accordance with 1.2.2, and register the license key in accordance with 2.1.

This operation procedure describes the installation and operation procedures for HRVision 3D-MultiCam in conjunction with Hi5 controller.

4.2. Optical Device Installation

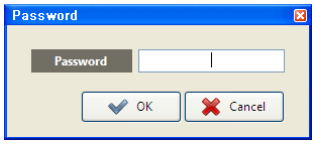
Install the camera and lighting according to the using purpose.

In the following figure, install “HRVision 3D-MultiCam” program and run “HRVision 3D-MultiCam” to create the initial screen of “HRVision 3D-MultiCam.”

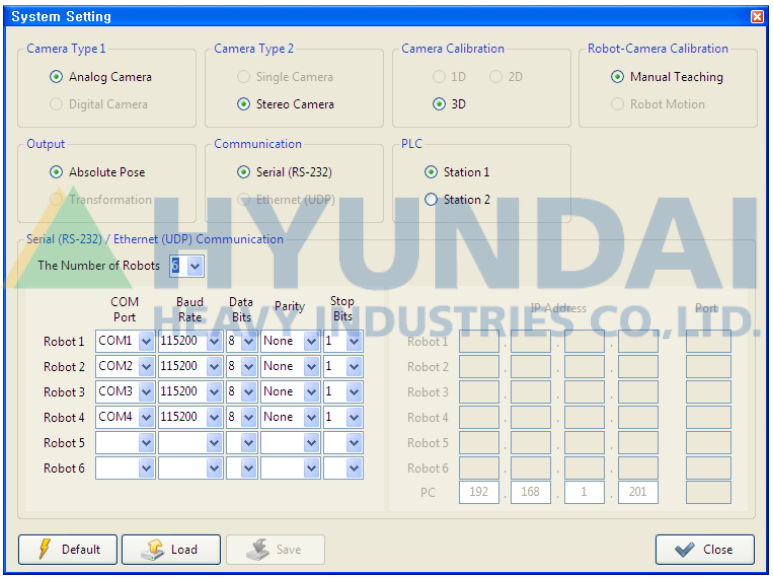


In the initial screen, abnormal image can be recorded because the camera type is not configured. Configure the correct camera type with “Setting” menu.

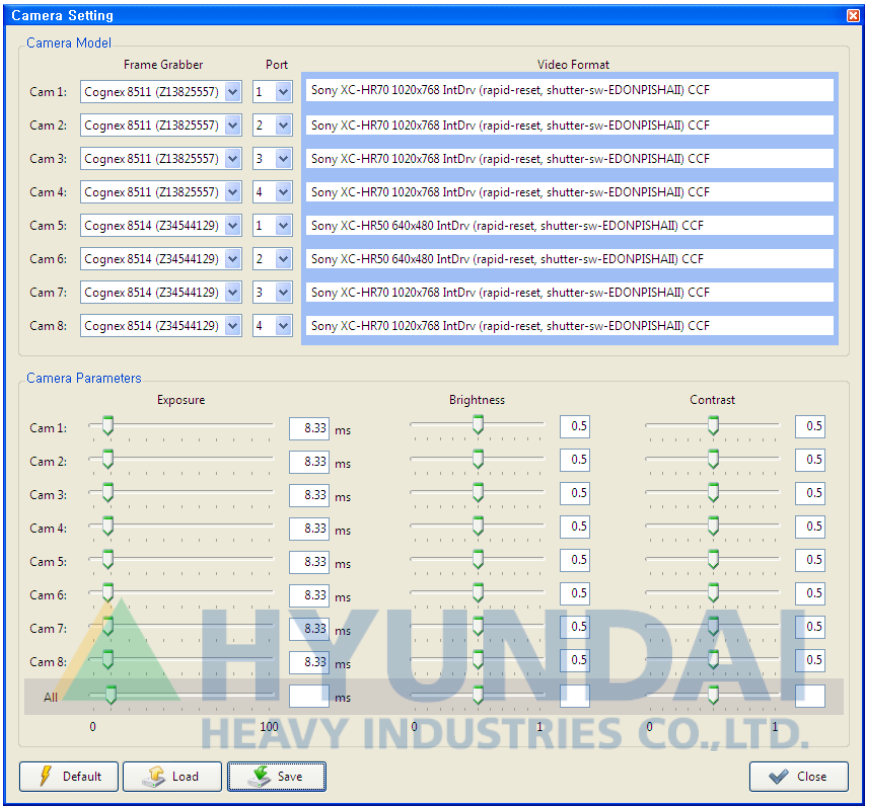
“Settings” and “Calibration” configuration menus require password. Contact the seller for the password.



By clicking “Settings → System Setting”, the dialog below is created. According to the process environment, configure and save the camera type, calibration method, and communication method and properties.

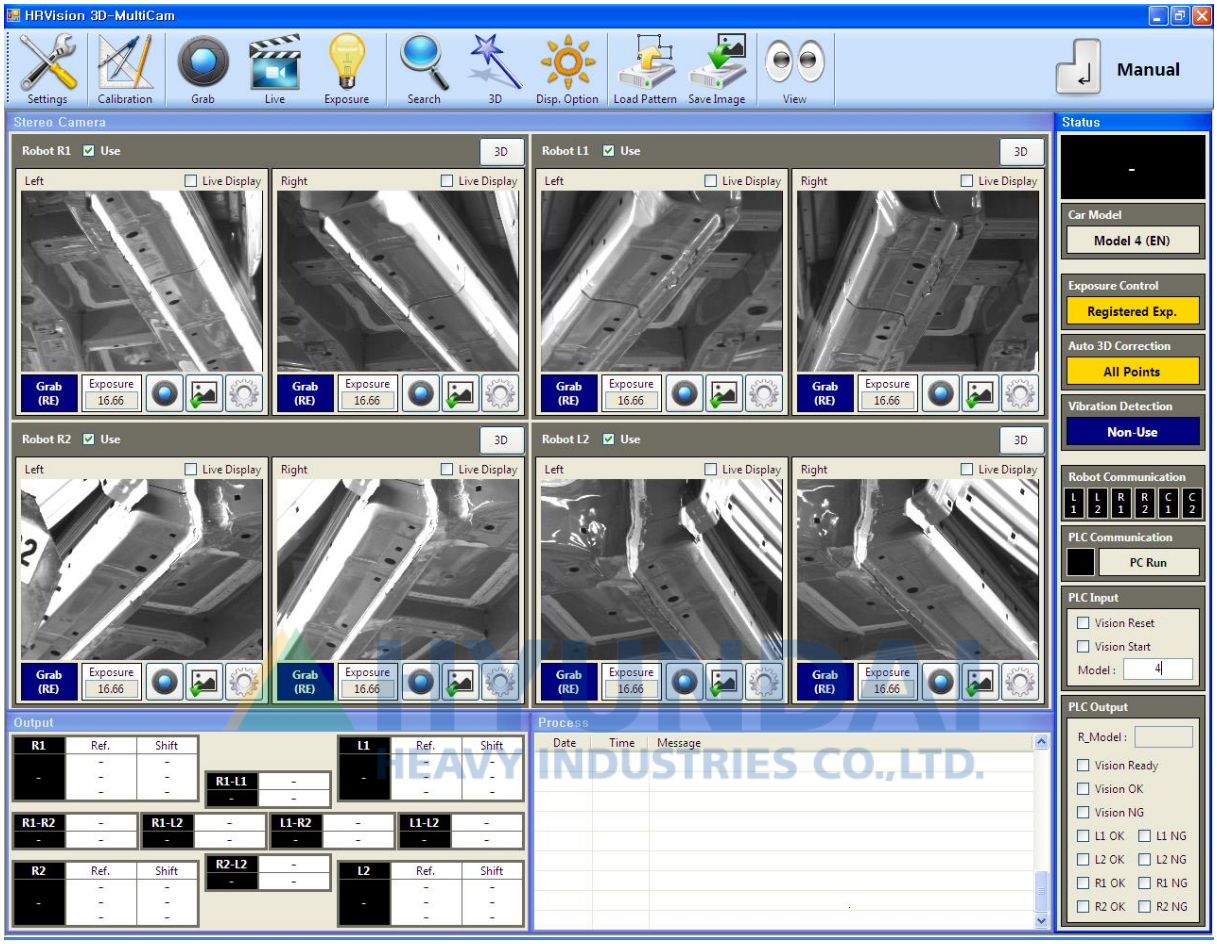


By clicking “Settings → Camera” menus, the type and exposure can be configured for the installed camera.



If you want the camera layout to be same as the process, press “Settings → Screen Layout” to change it.

By clicking “Grab” and “Live” buttons, check if the normal image is recorded.



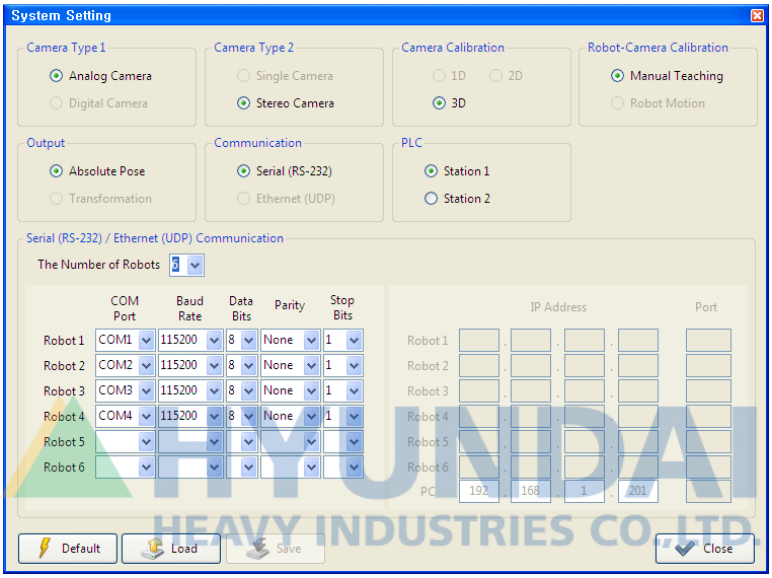
According to the work, distance from camera, and environment, configure the focus and aperture of the camera.
Fix the camera and check the focus and aperture rings to prevent the gap.
After installing the vision, check if normal image is recorded when the peripheral equipment is operated.
If there is noise in an image, check the insulation for the camera and cable.

4.3. Communication Setup of Robot and Vision

4.3.1. HRVision 3D-MultiCam Communication Setup

When image acquisition is completed, configure communication of “HRVision 3D-MultiCam”.

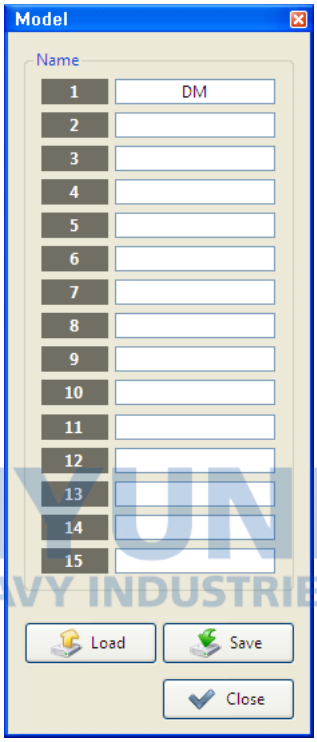
Through “System Setting” dialog, check if the vision system communicates with the robot and PLC according to the configuration.



4.4. Camera Calibration

4.4.1. Model Setup

Pattern recognition result and calibration data is managed by model.
First, click “Setting → Model” menu to select the model.



4.4.2. Camera Calibration Parameter Setup

Camera calibration to align the camera coordinate and robot coordinate is executed. The camera coordinate uses the pixel units and the robot uses the mm units. Therefore, in order to use the measured results from the camera coordinate and execute the work in the robot coordinate, it requires a process to change the results of the camera coordinate into the robot coordinate. This is called camera calibration and “HRVision 3D-MultiCam” uses the calibration board described in 3.7.2 and executes the calibration.

4.4.2.1. Calibration Board Arrangement

Considering first the lens specification, workpiece arrangement, pattern recognition accuracy etc., set the distance between the camera and the workpiece (Grab image location). The distance between the camera and the workpiece is not only used for camera calibration but also for pattern recognition. Therefore you must set it consistently. If the distance between the camera and the workpiece has to be modified start resetting all the setup of “HRVision 3D-MultiCam” including the camera calibration.

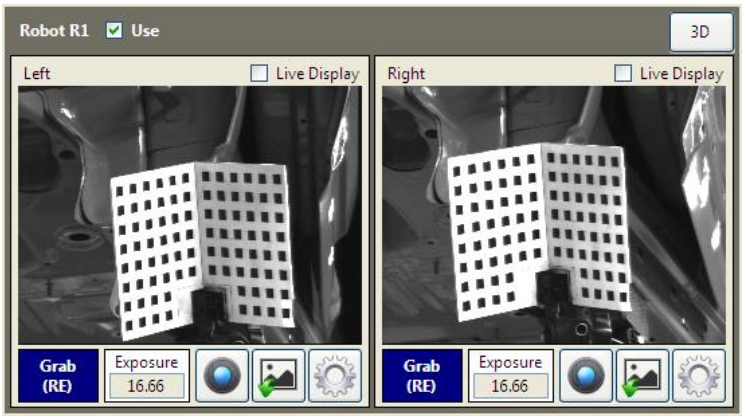
Place the calibration board on the location where the work subject will be located. The calibration board must not move during the camera calibration.

4.4.2.2. Teach Calibration Point

Attach a tip at the tool end of the robot and teach the 3 calibration points of the calibration board.
At this time, enter the tool parameter of the robot and enter the tool parameter of the attached tool.
Each calibration location is logged in the robot operation program on the basis of common coordinate system.

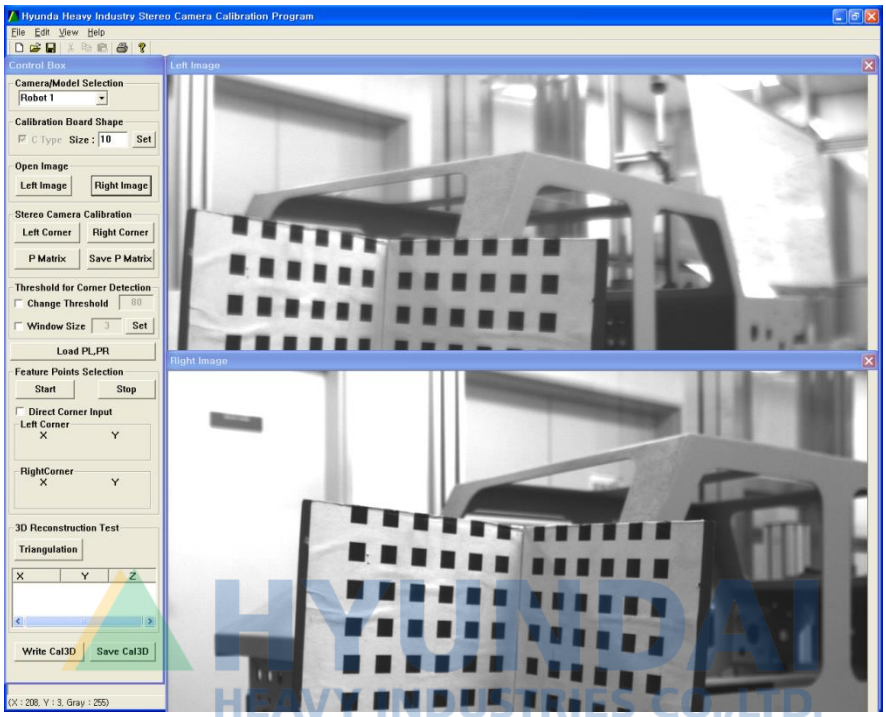
4.4.2.3. Grab Calibration Board Image

Click “Grab” button to record the image, including the calibration board.

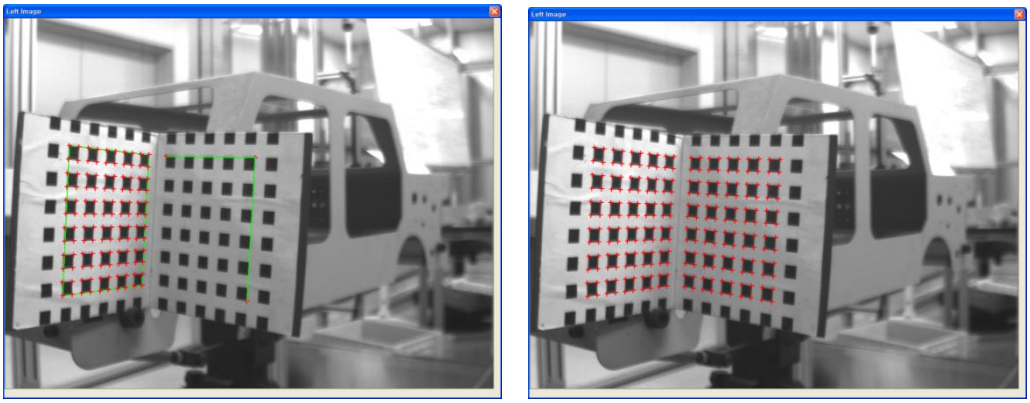


4.4.2.4. Implementation of Stereo Camera Calibration

Click “Calibration → Camera Calibration” menu of controls to run the camera calibration program.



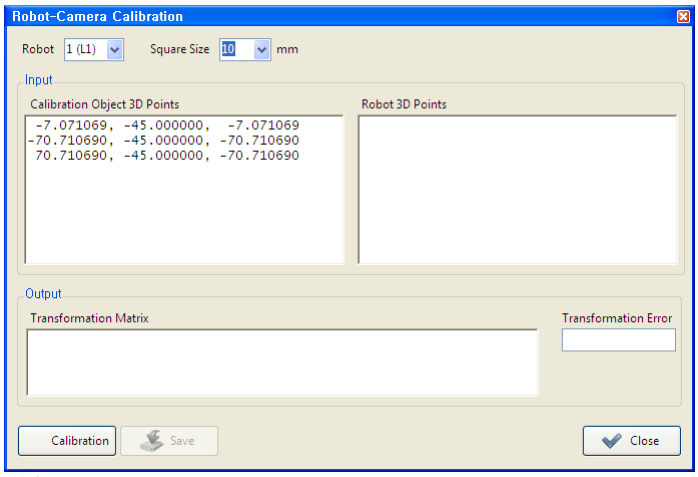
From the left/right image, obtain the corner points according to the stereo camera calibration function described in 3.2.1. For more details, refer to “3.2.1 Stereo Camera Calibration”.



Once all the corner points are extracted from left/right image, click “P Matrix” button to calculate the projection matrix and “Save P Matrix” to save it. The calibration data is saved to “C:\HRVision MultiCam\Cal” folder as “P(No.)L.txt, P(No,)R.txt”

4.4.2.5. Performance of Robot-Camera Calibration

From “HRVision MultiCam” controls, click “Calibration → Robot-Camera Calibration” menu for robot-camera calibration. By selecting robot number and the rectangle size of calibration board, 3 points are displayed on the basis of the calibration board coordinate system and then these points can be taught as the robot.



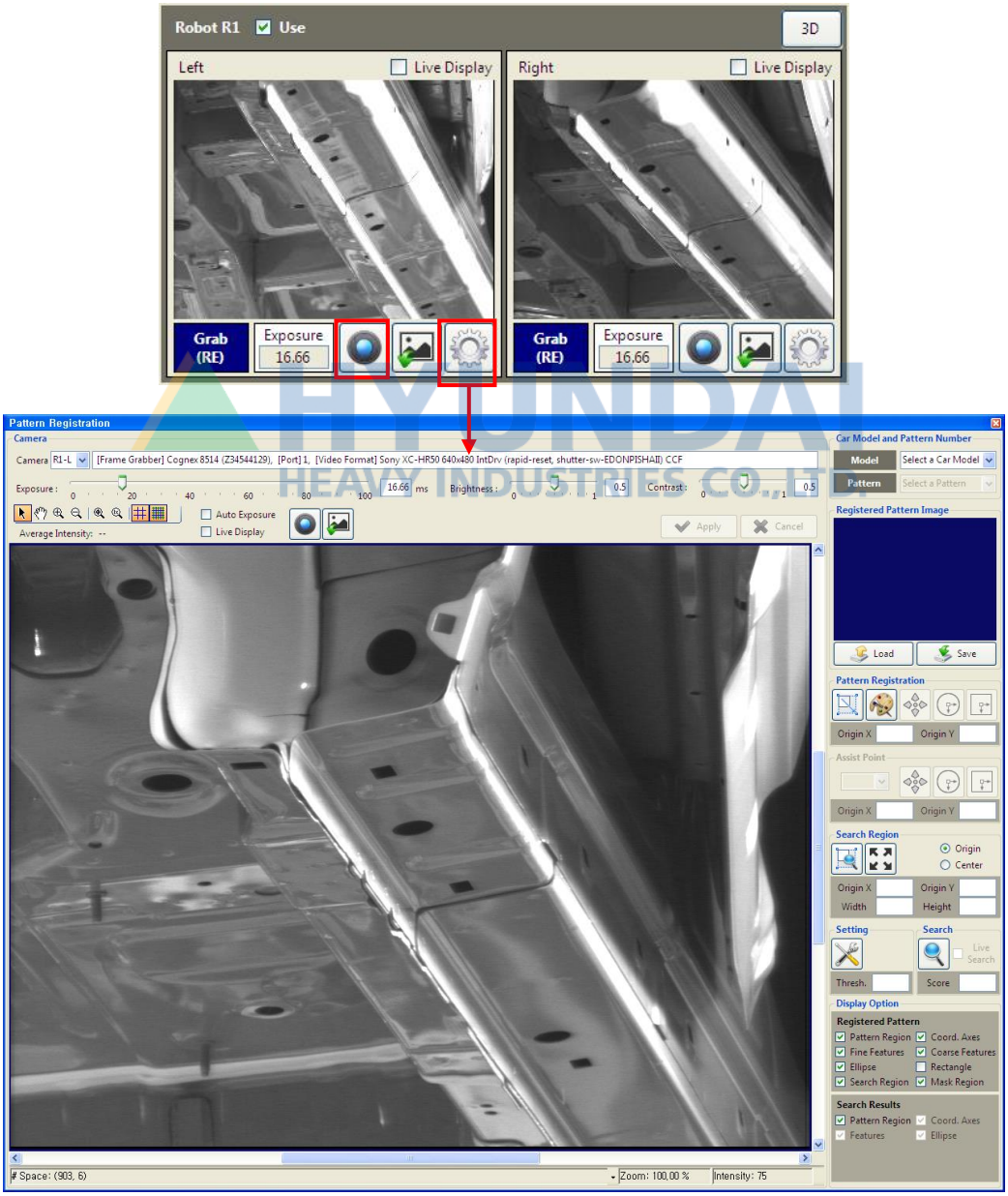
Enter 3 teaching points (X, Y, and Z) in the right space and press “Calibration” to display the transfer matrix and tolerance. If the error is 1mm or more, the calibration has been misconducted so perform the camera calibration again. If the error is 1mm or less, click “Save” button to save the transfer matrix.

4.5. Model Pattern Addition and Pattern Recognition Test

Register all patterns for pattern recognition and execute the pattern recognition test.

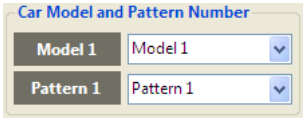
4.5.1. Grab Image

Move the Hyundai robot to a position which cannot be seen in the image. At this time, the workpiece should not be moved.
Click on the “Train” tab from the Setup mode, and click on the “Grab” button of the operation buttons.

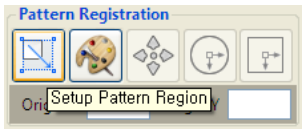


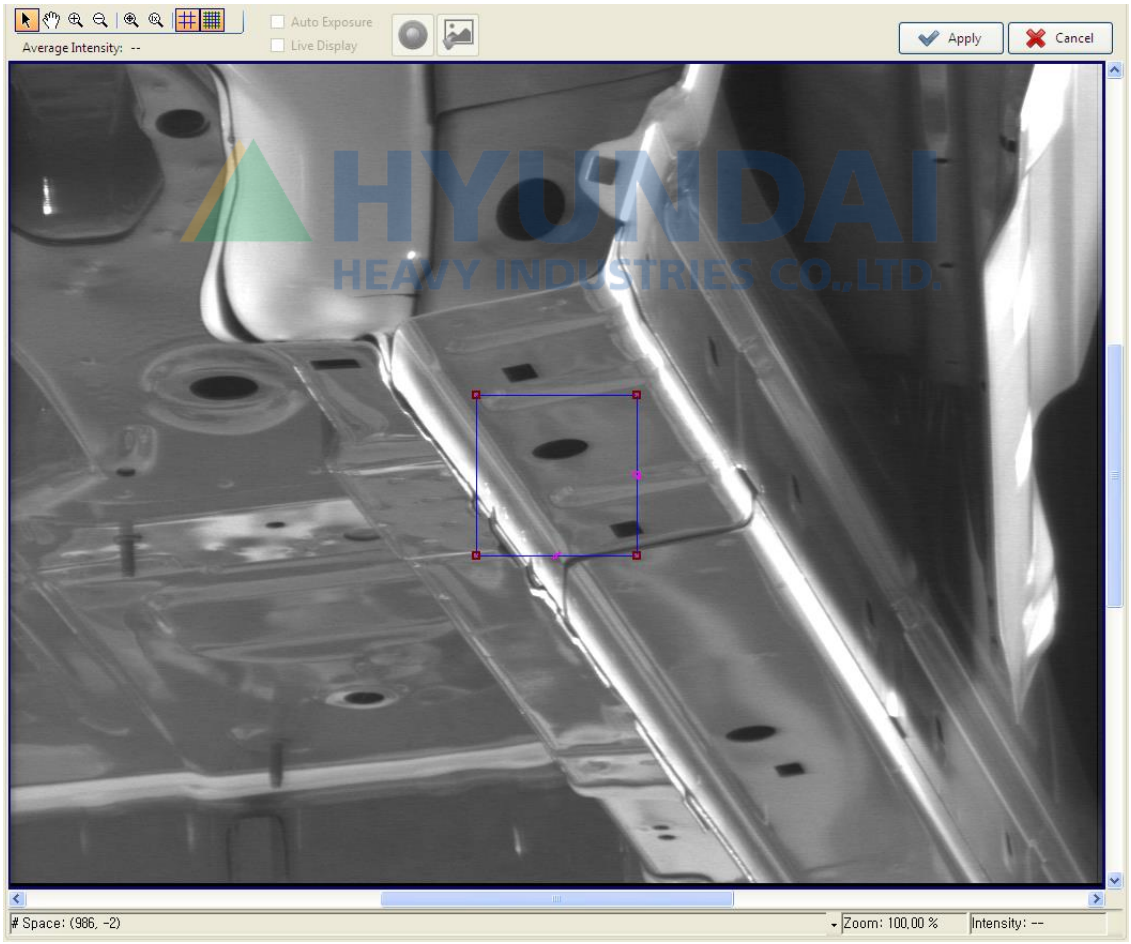
4.5.2. Pattern Addition

Select a car model and pattern number. The pattern number is used to register different patterns for a car model when the starting point of the patterns must be the same. In general, 1 pattern is registered for 1 car model so select “Pattern 1”.

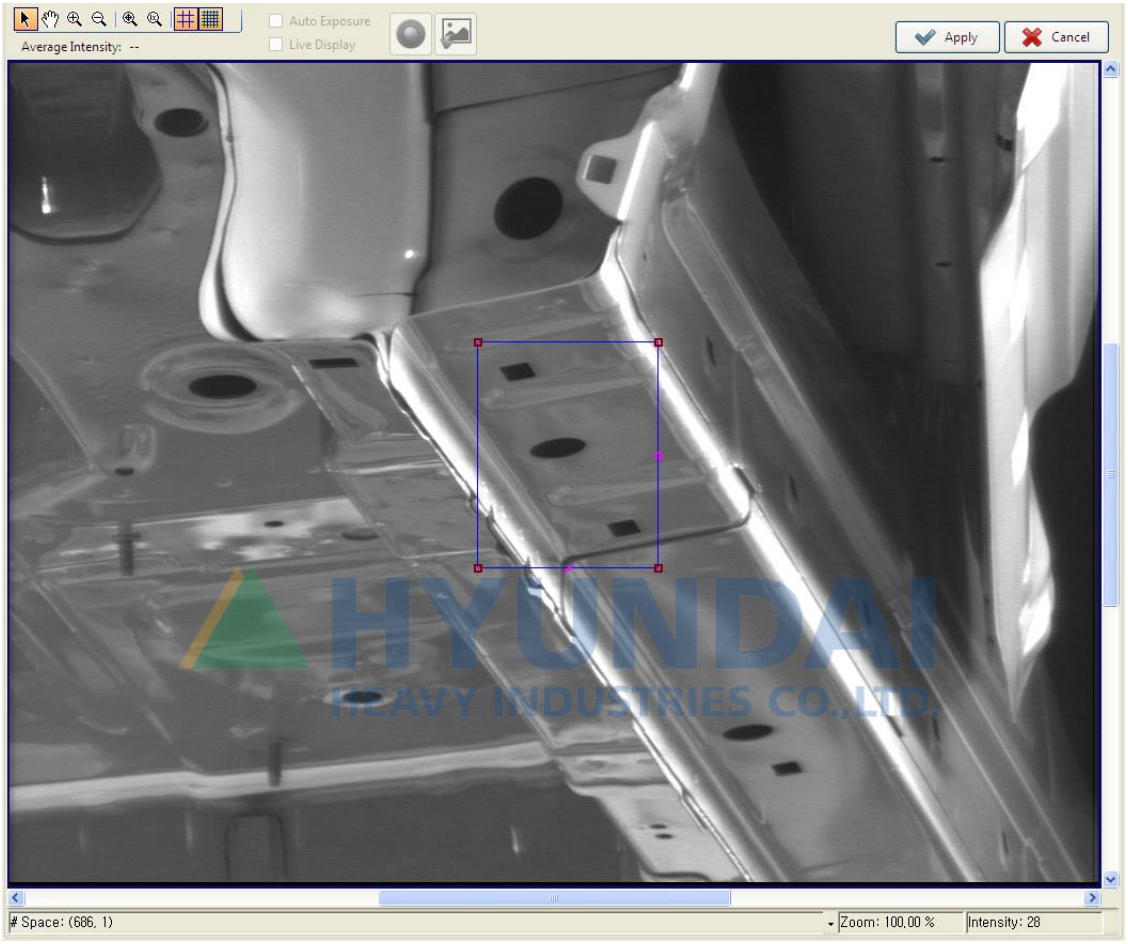


Click “Setup Pattern Region” button to display a rectangle in the screen to configure pattern area.

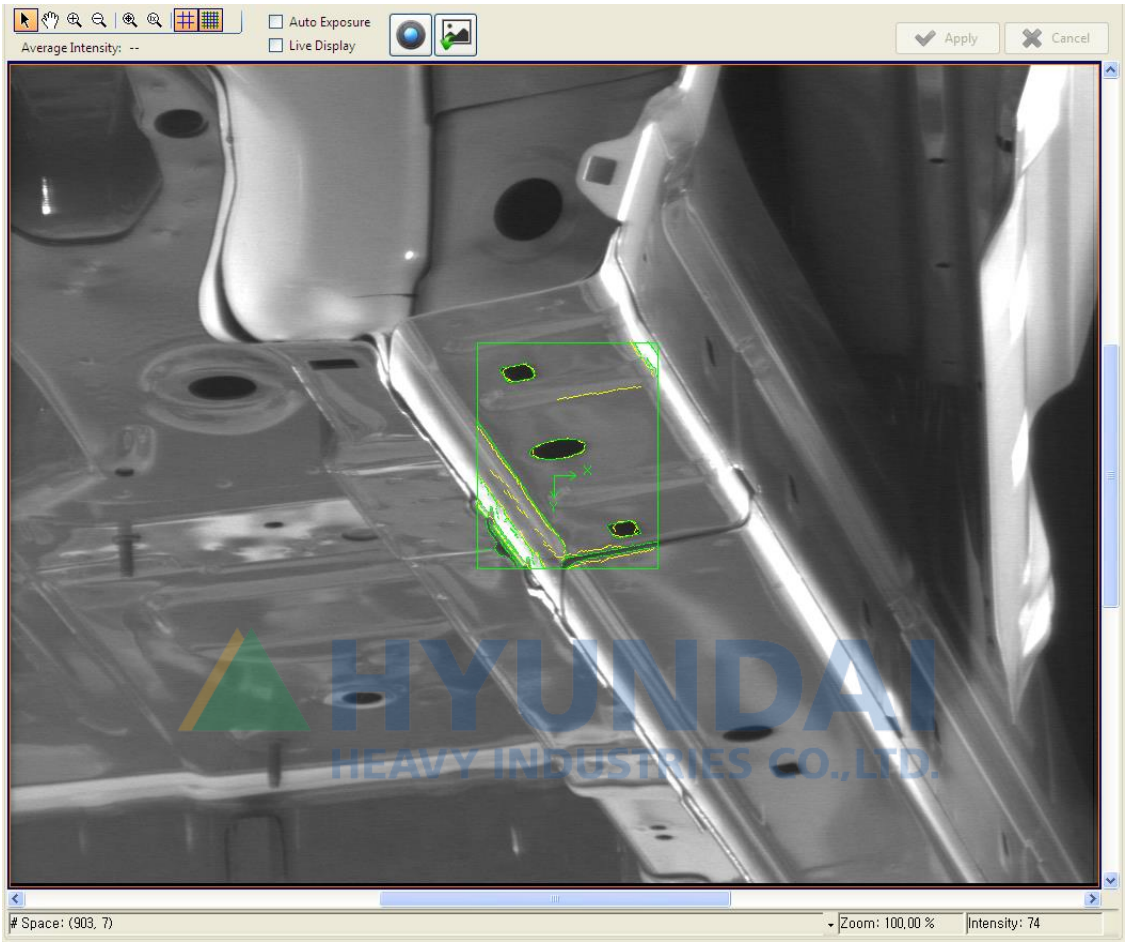




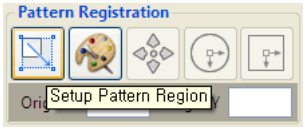
According to the area from which the pattern is extracted, change the size and location of pattern area configuration rectangle. The patterns must be easily distinguishable for each model, and FOV and required accuracy must be considered for the selection.



Press “Apply” button to extract the pattern within the rectangle.

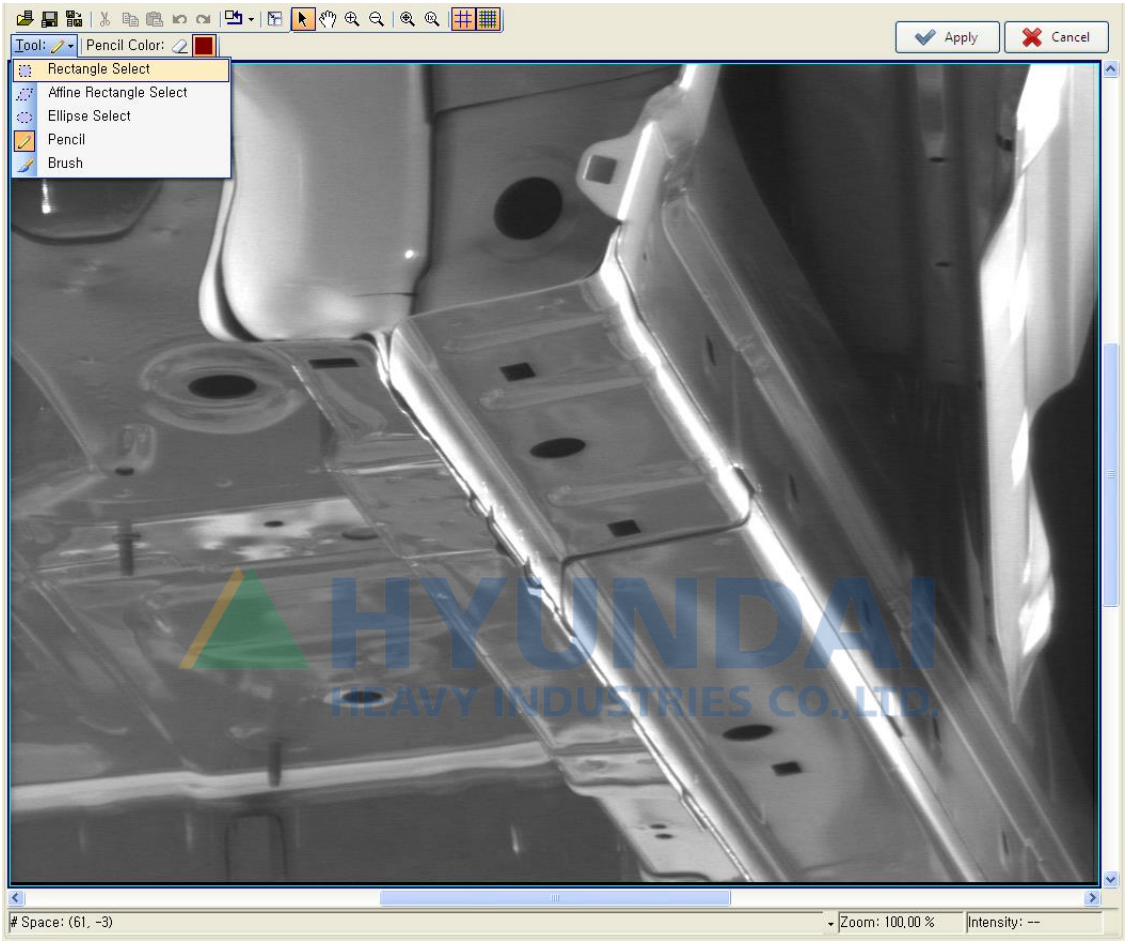


Press “Mask Image” button to remove unnecessary characteristics.

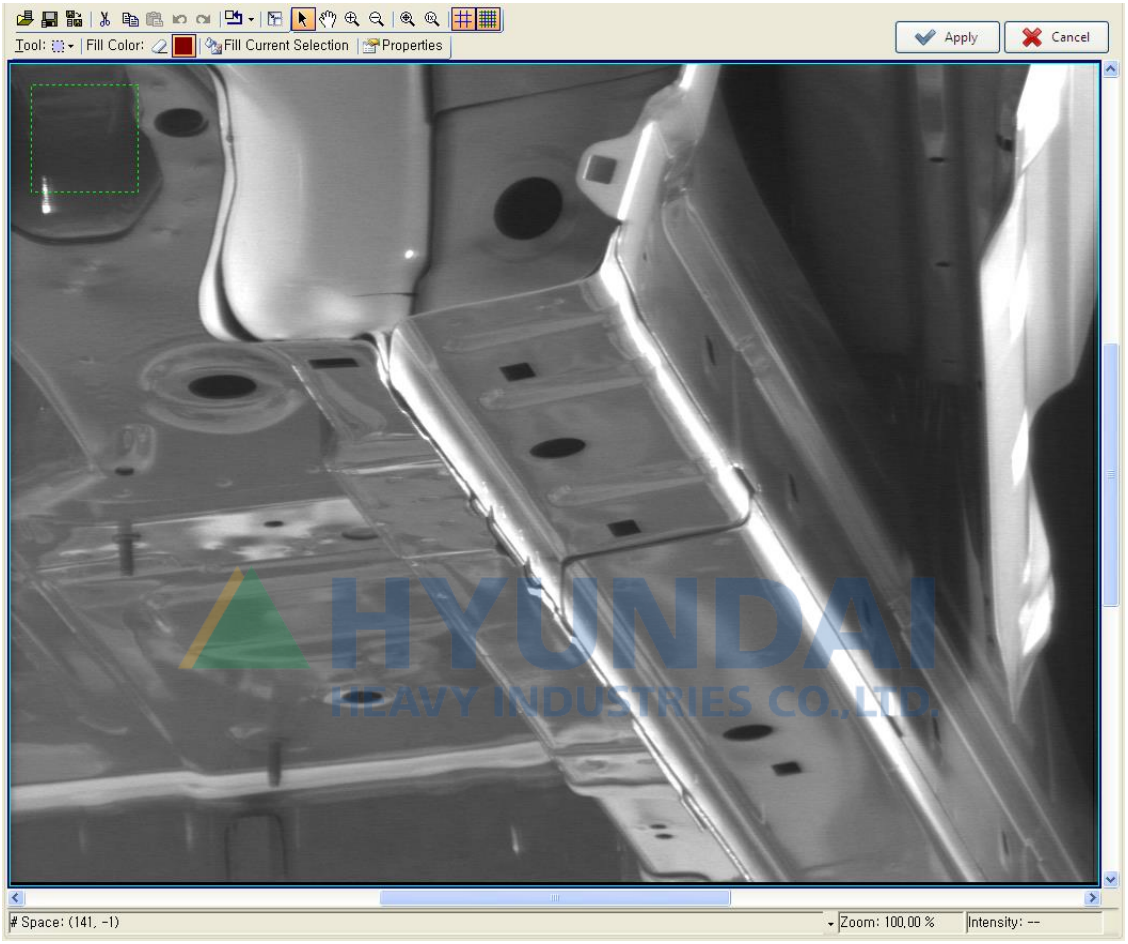


The menus are changed to enable Mask configuration.

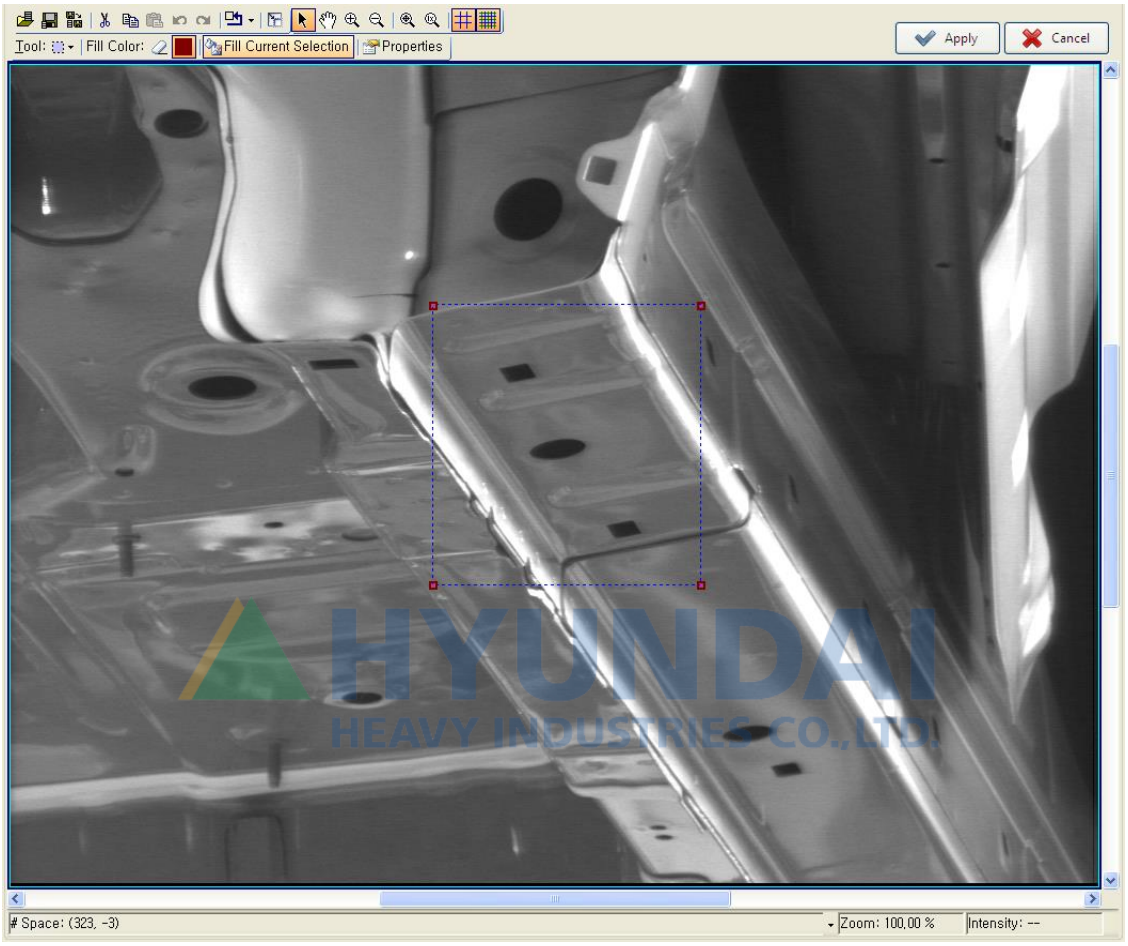
To configure the Mask area, select “Rectangle Select”, “Affine Rectangle Select”, or “Ellipse Select” from “Tool” menu. In general, “Rectangle Select” is good enough but other shapes can be selected if necessary.



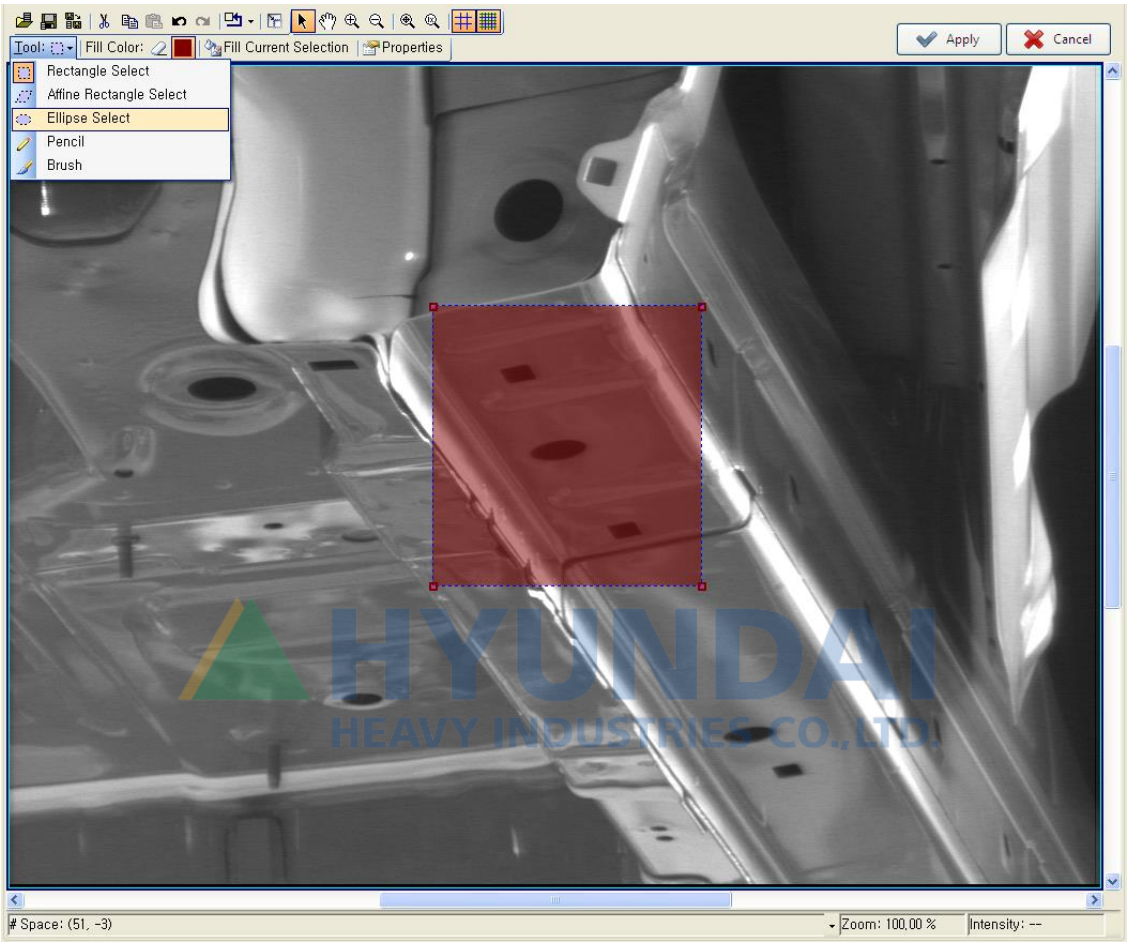
On upper left of the screen, a shape is displayed to configure Mask area. If “Rectangle Select” or “Affine Rectangle Select” is selected, the following rectangle is displayed while if “Ellipse Select” is selected, a circle is displayed.



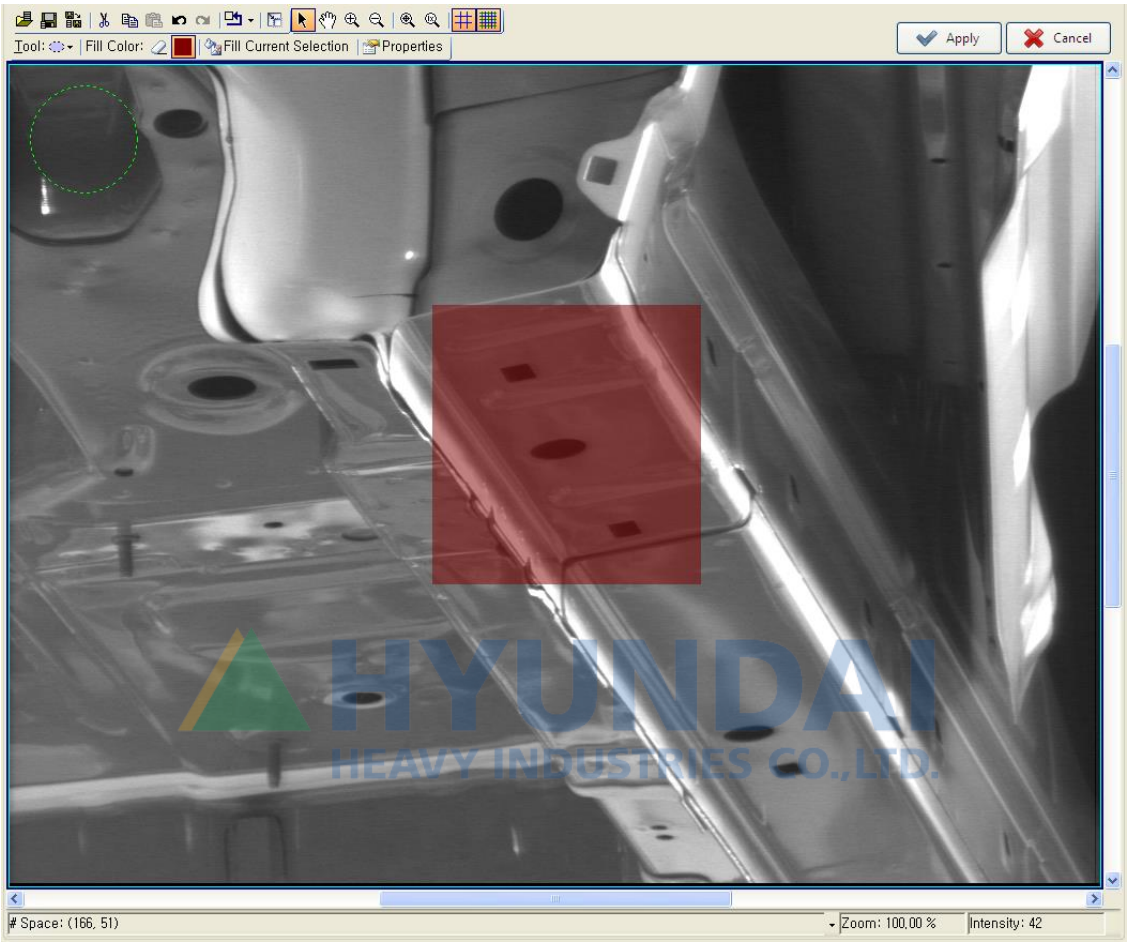
Based on the area to be designated as Mask, change the size and location of Mask configuration rectangle and press “Fill Current Selection” button.



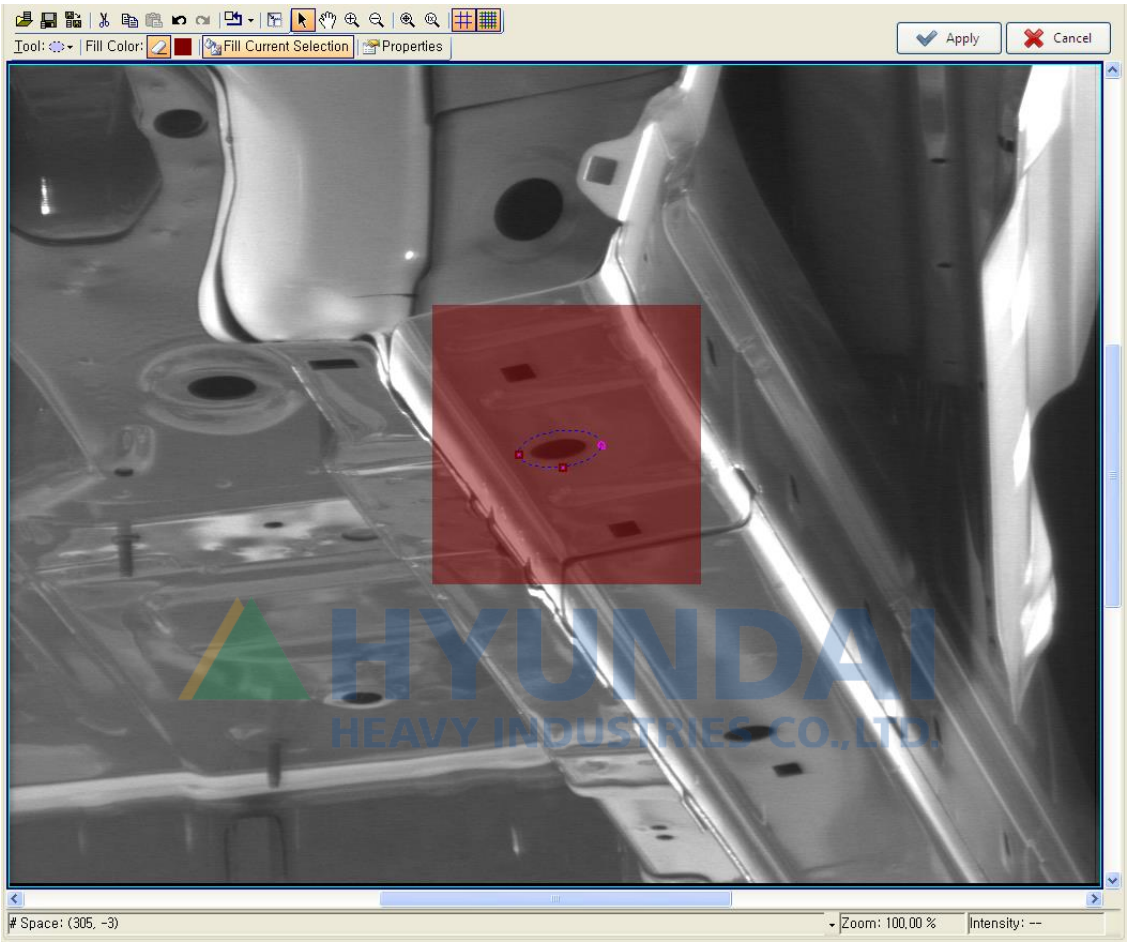
Because it is filled with Mask until the area to be extracted as a pattern, select “Rectangle Select”, “Affine Rectangle Select”, or “Ellipse Select” in “Tool” to exclude the area to be extracted as a pattern.



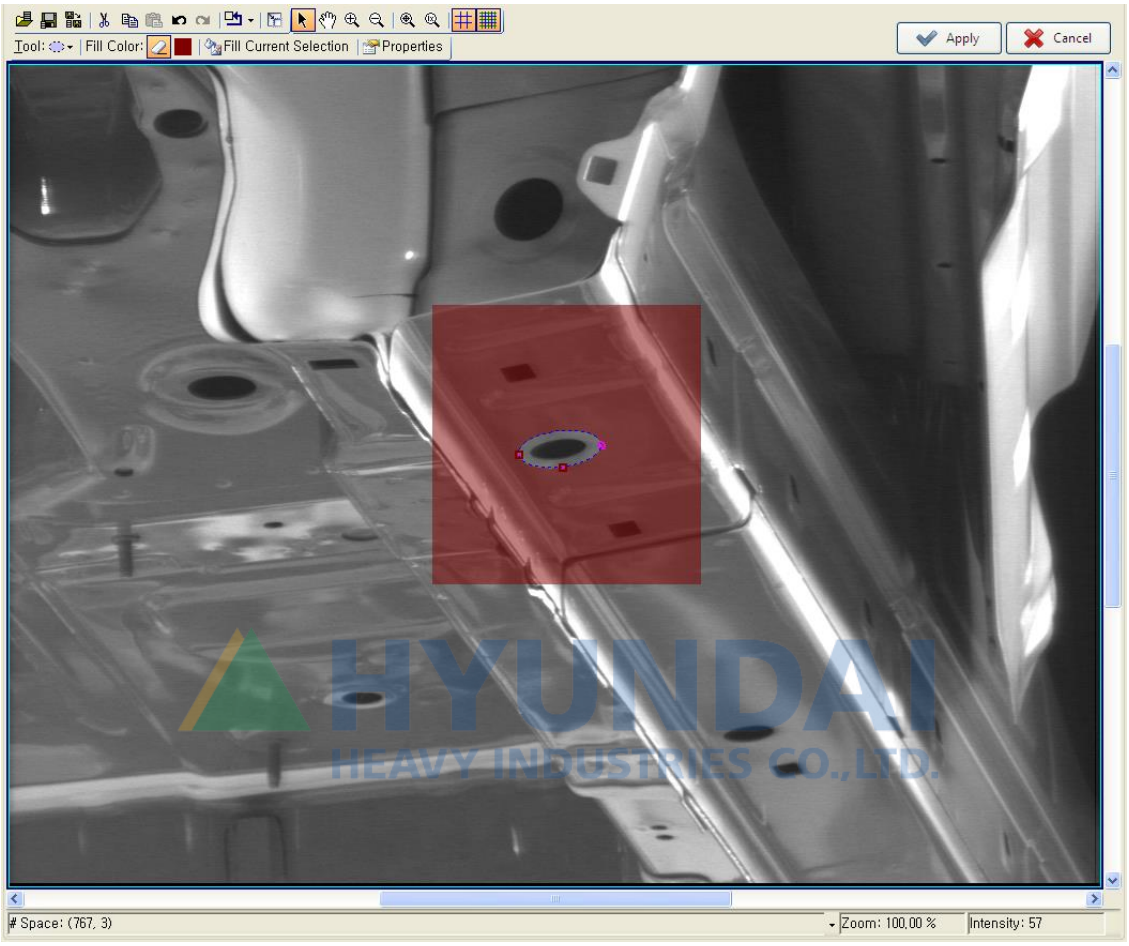
Select “Ellipse Select” to display a circle on the upper left of the image.



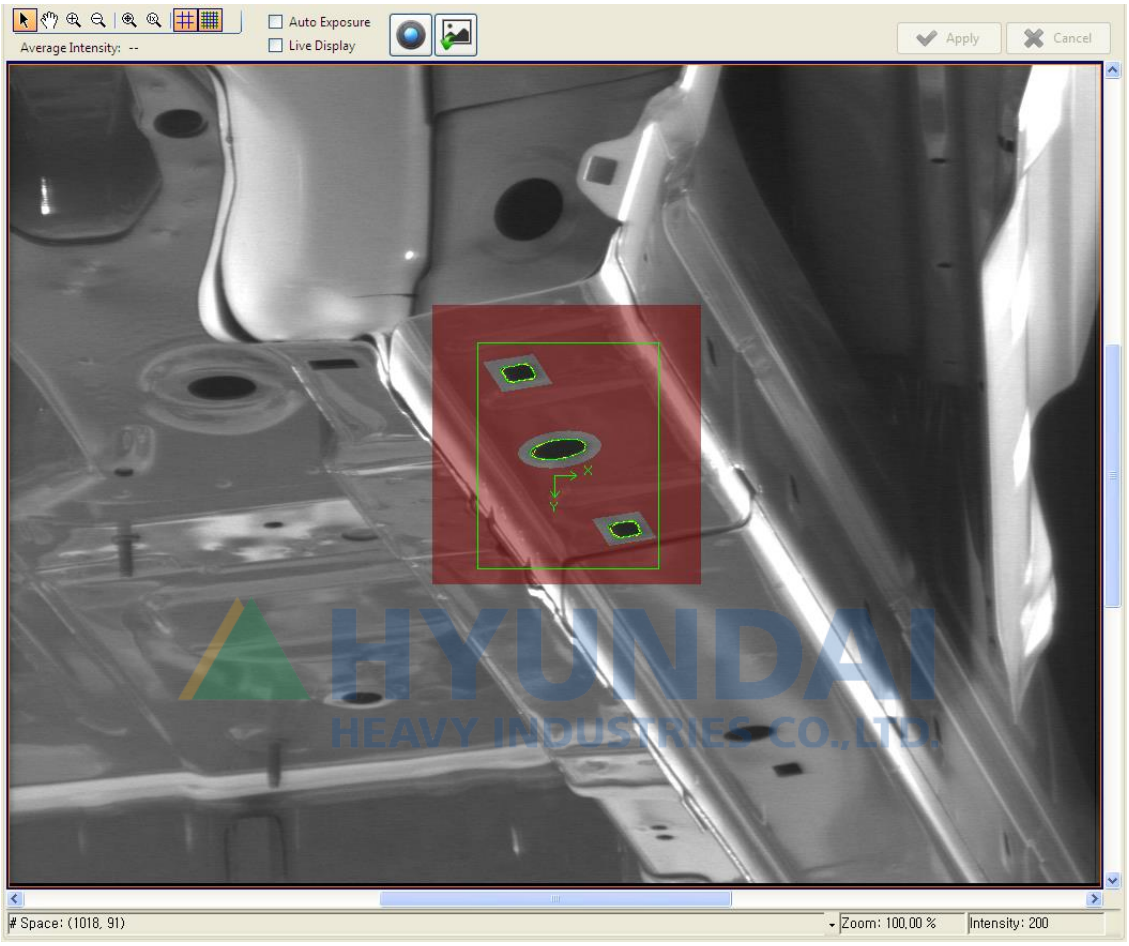
Move the circle to an area to be removed from Mask. Select “Care (unmasked) pixel color” from the menu and press “Fill Current Selection” button.



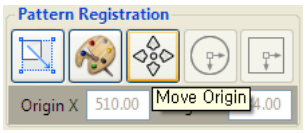
The configured area is removed from Mask as shown below.



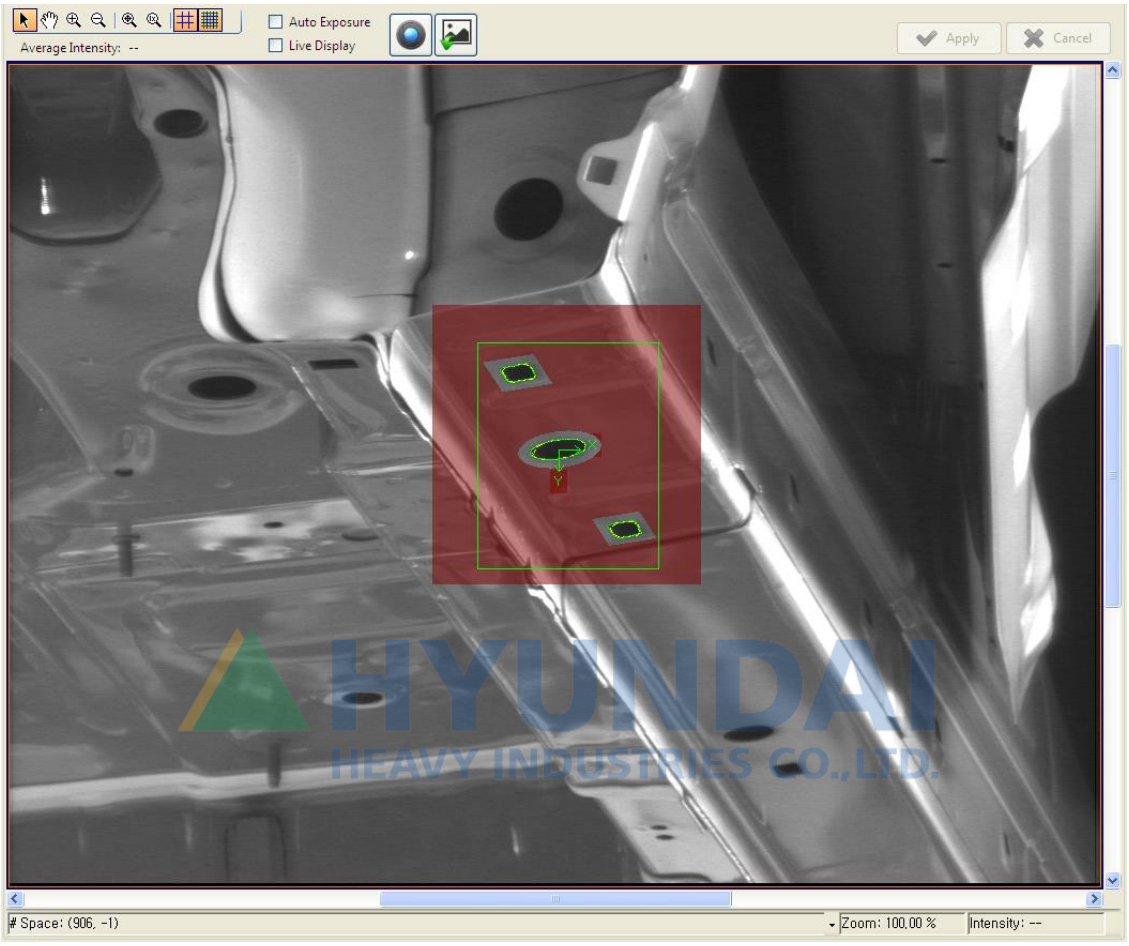
To remove the Mask area in different shape, select “Rectangle Select”, “Affine Rectangle Select”, or “Ellipse Select” from “Tool” and repeat the process. When finished, press “Apply” button.



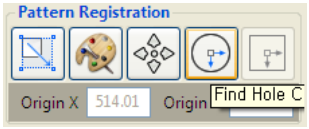
The starting point of pattern is located in a random point so it needs to be moved. Press “Move Origin” button to enable the movement of coordinate axis.



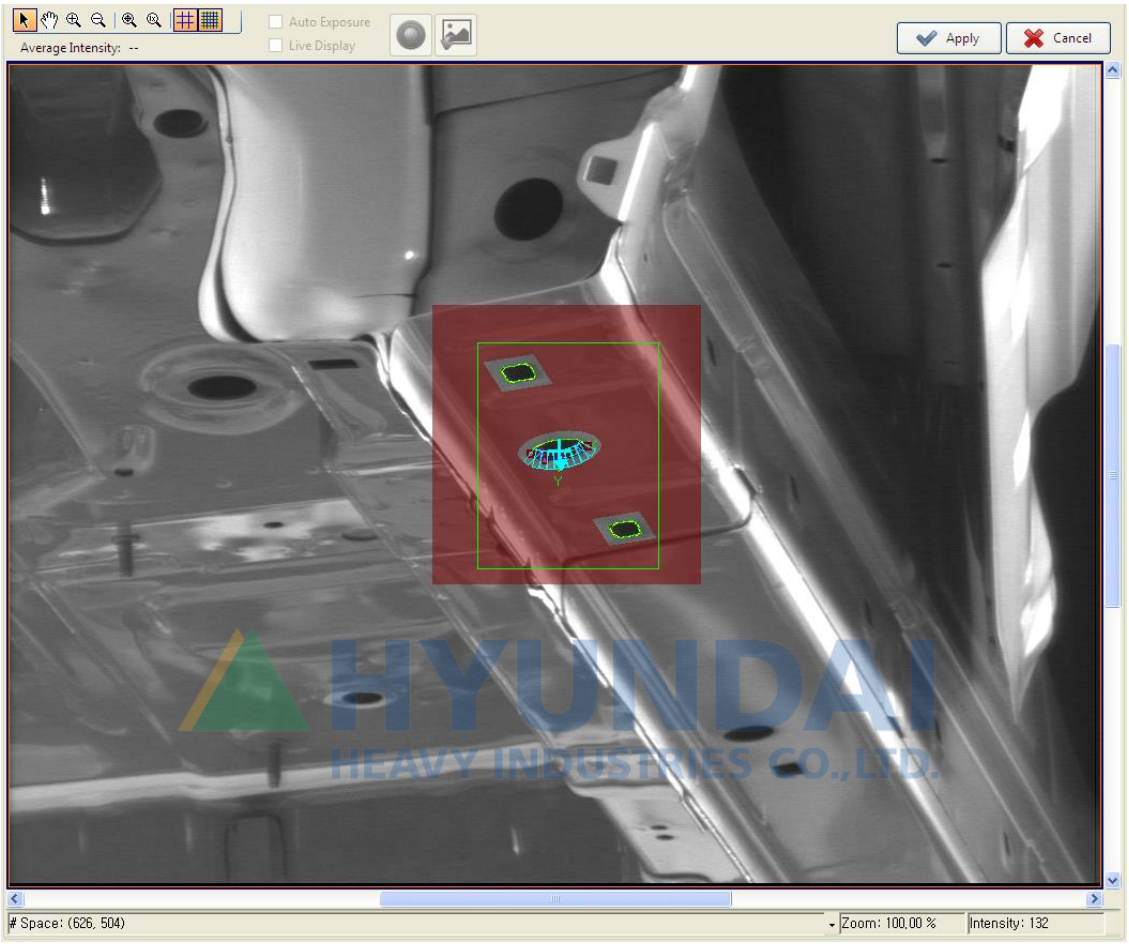
Move the coordinate axis to a hole to be registered as the starting point and press “Apply” button.



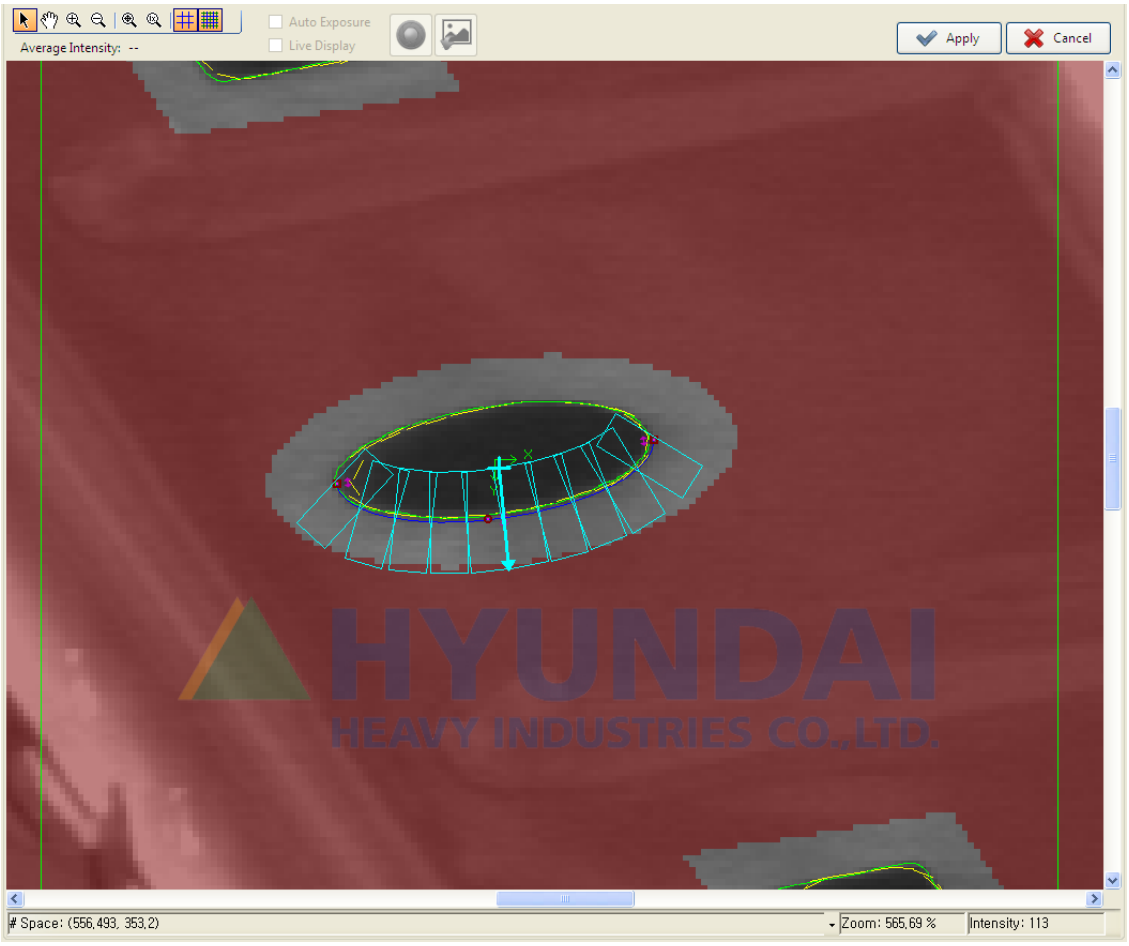
To find the exact center of the hole, press “Find Hole Center” button.



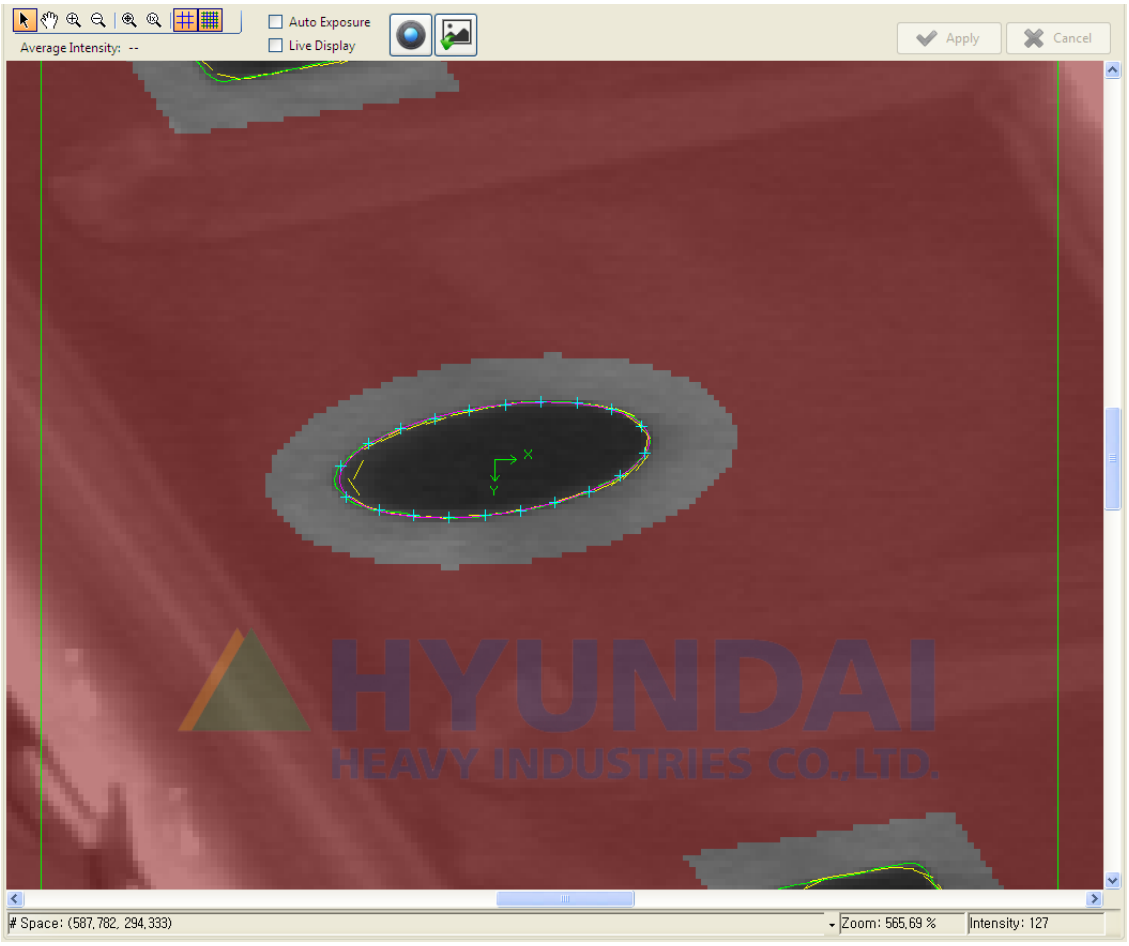
Caliper is displayed around the hole to detect an ellipse.



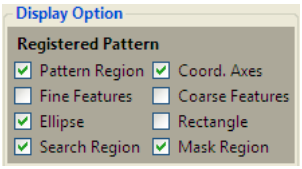
Zoom in the screen by rolling the mouse wheel. Make sure that the caliper is located around the hole. If it is not, change the shape of caliper.



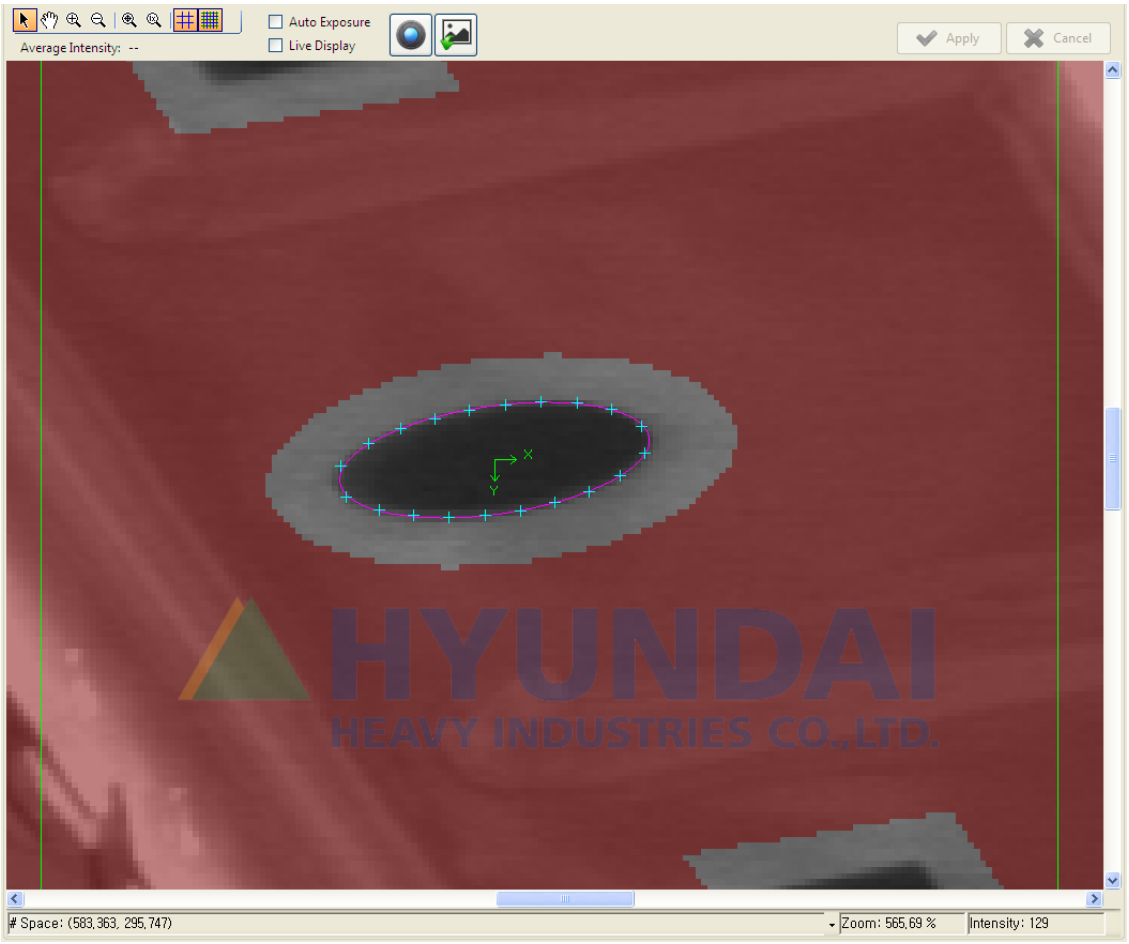
Press “Apply” button to extract the center of ellipse and to display the point for detection as “+.”



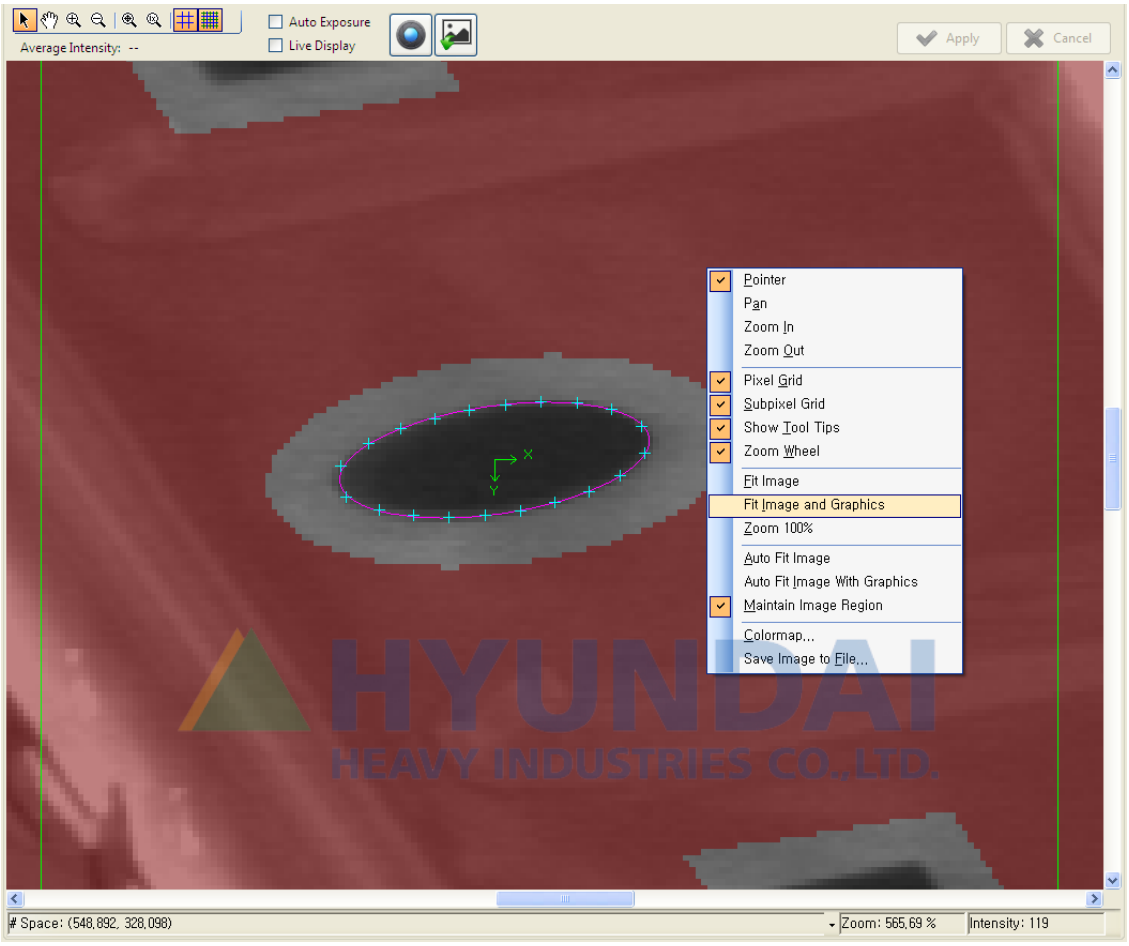
To check if the ellipse is correctly extracted, uncheck “Fine Features” and “Coarse Features” in “Display Option.”



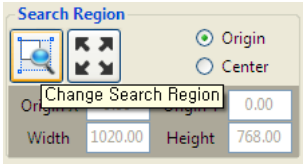
In the image, the characteristics that were extracted as patterns are not displayed but only the points to detect the ellipse and the ellipse are displayed.



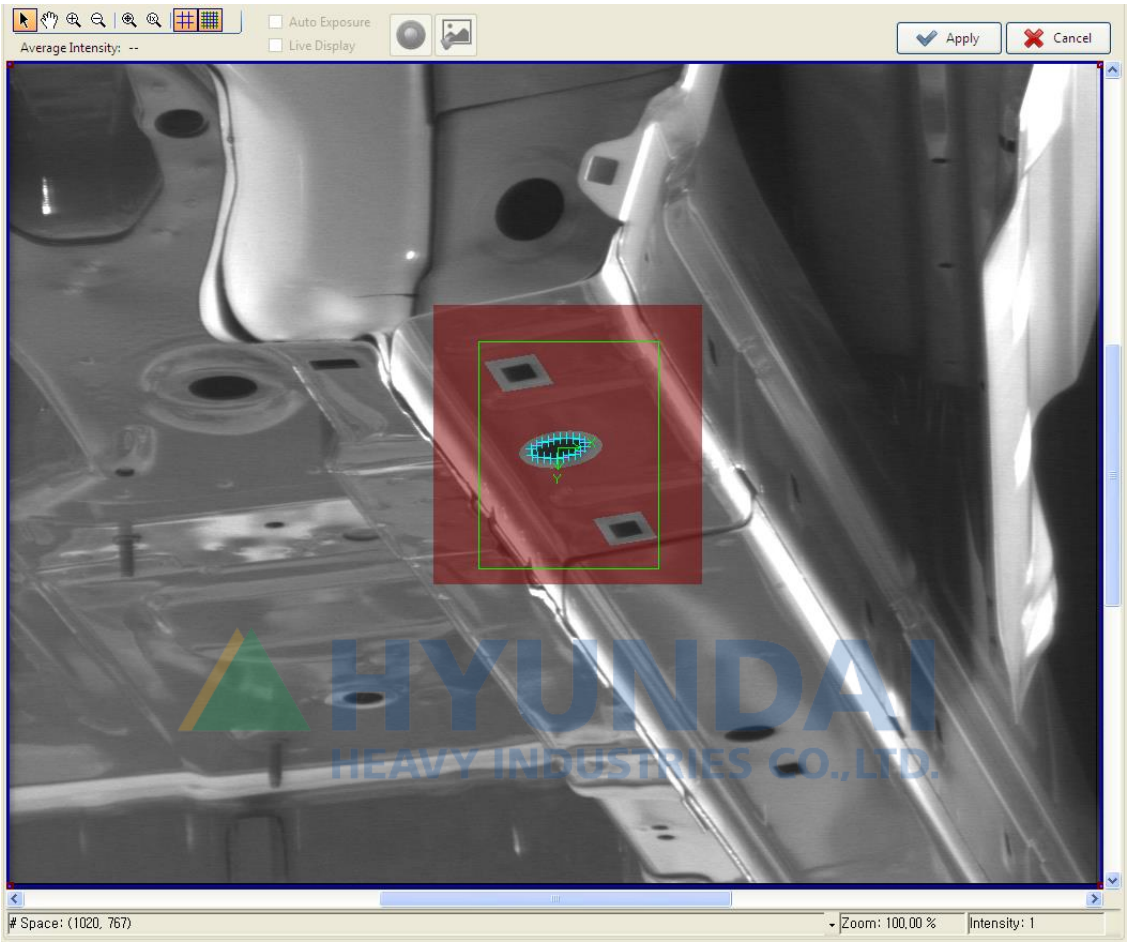
In the context menu, press “Fit Image and Graphics” to go back to normal scale screen.



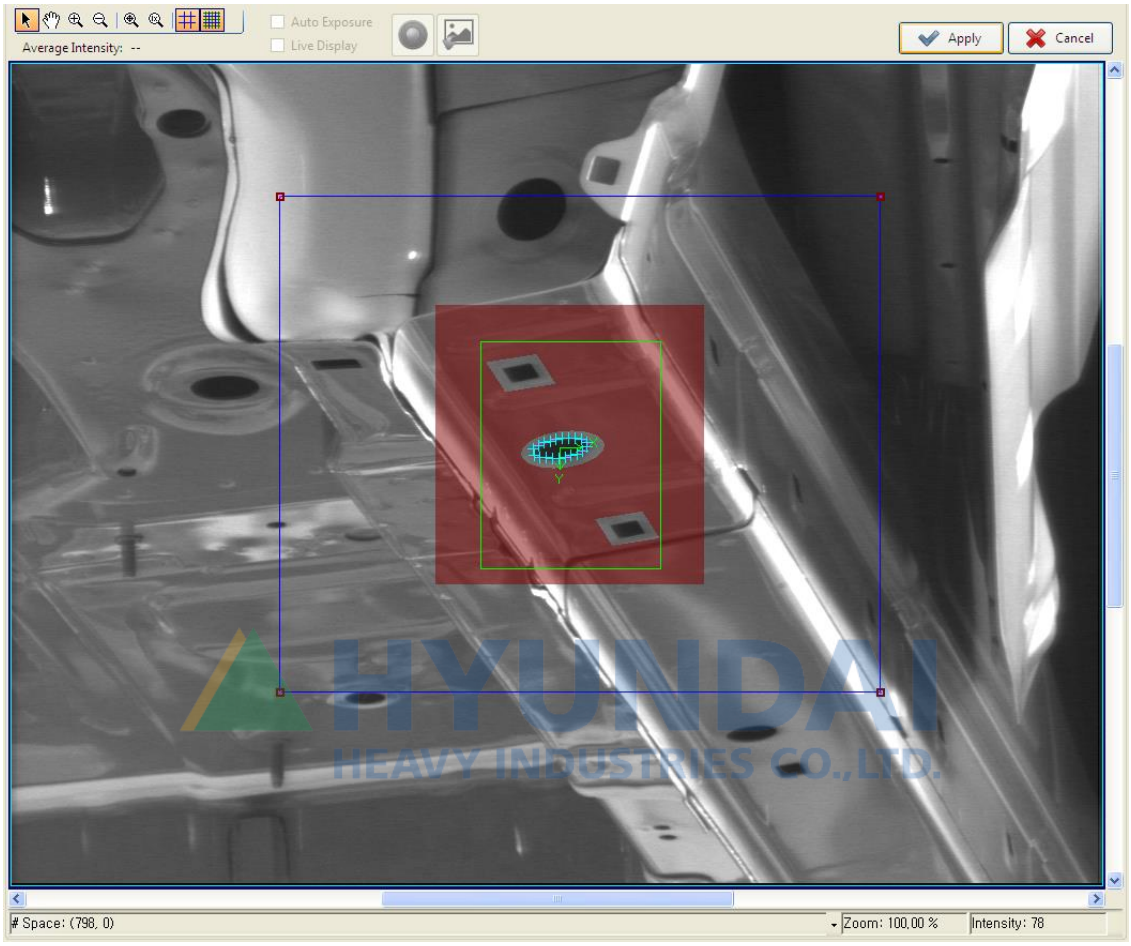
Initially, the pattern exploration section is the image as whole. Press “Change Search Region” to change the exploration section.



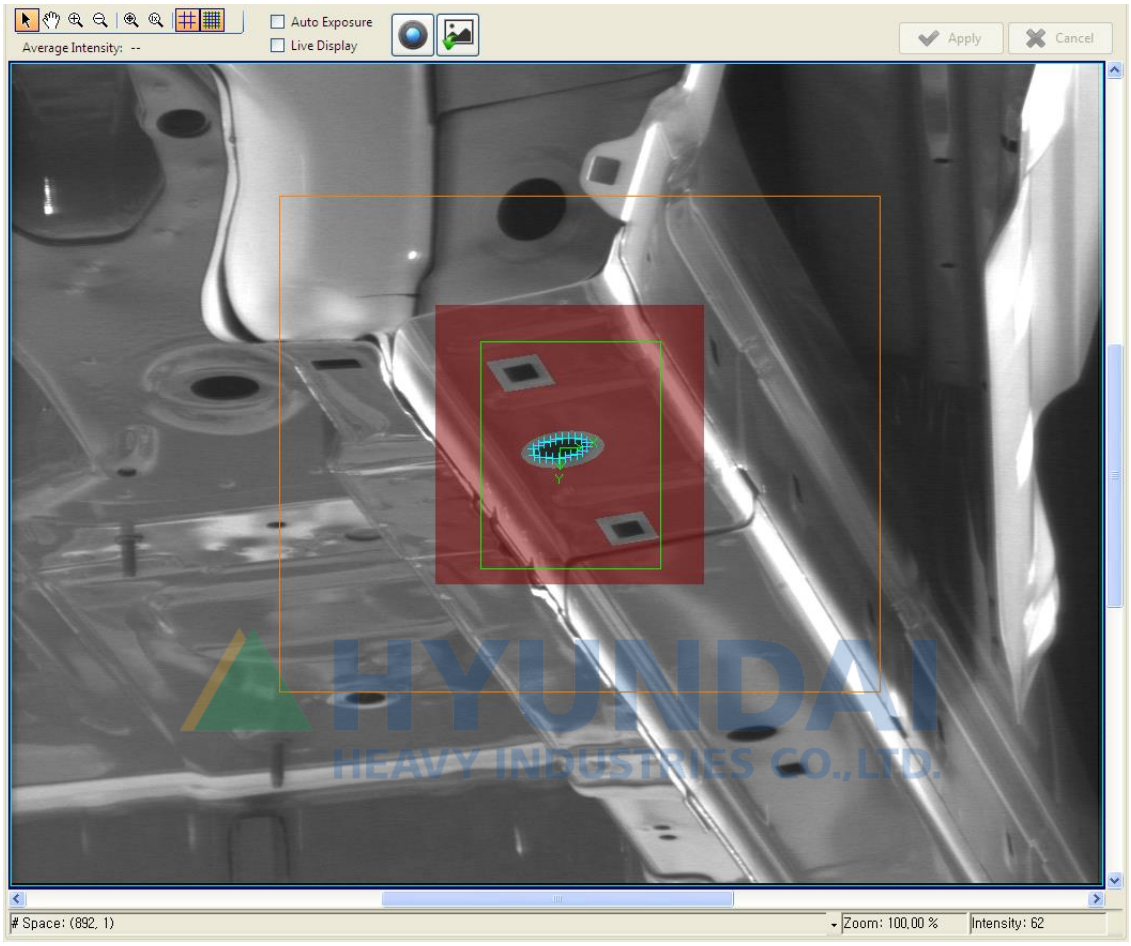
Now, the pattern exploration section can be changed.



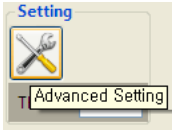
Change the pattern exploration section.

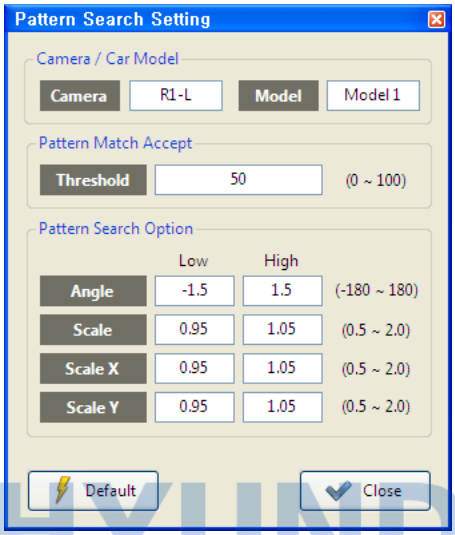


Press “Apply” button to configure the pattern exploration section.

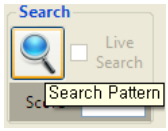


To configure the pattern detection threshold value, press “Advanced Setting” button.

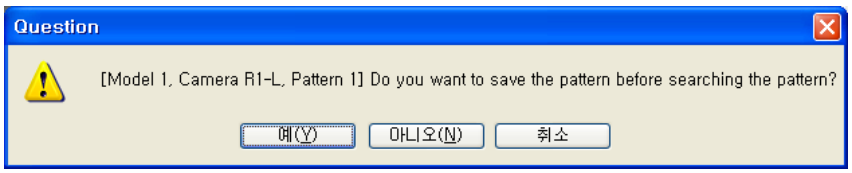




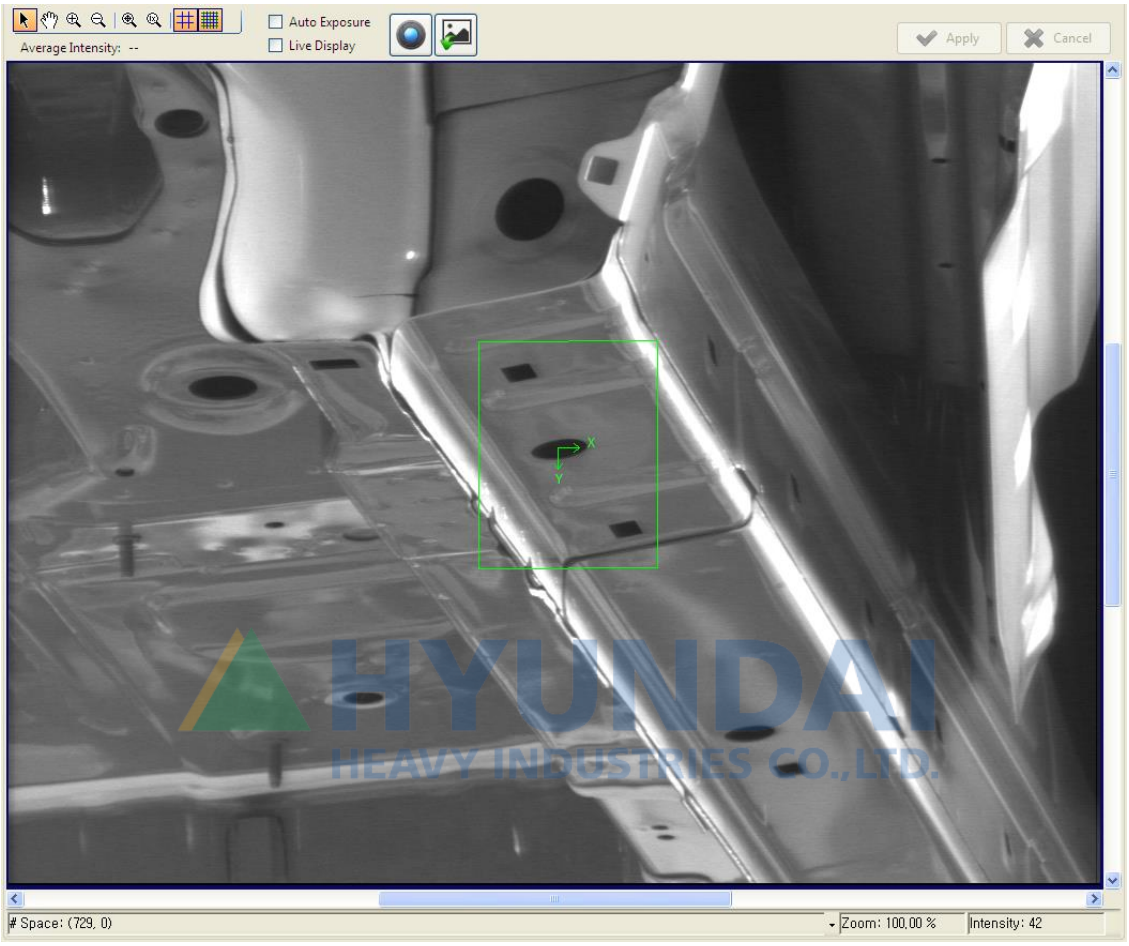
Press “Save” button to register the configured pattern and check if the pattern is registered by pressing “Search Pattern” button.



If a pattern is not registered, the following message window is displayed:

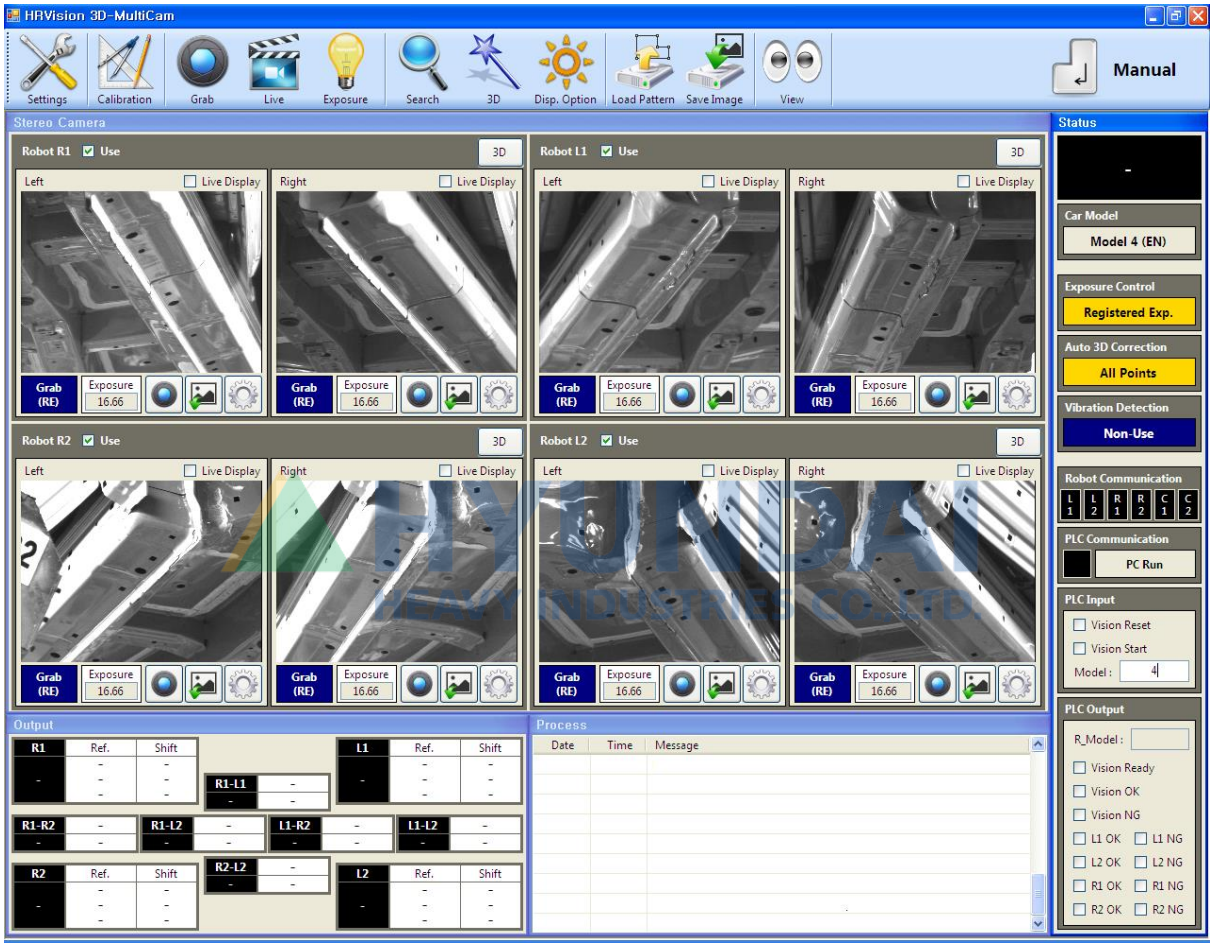


If the pattern registration is OK, the explored pattern is displayed on the screen.



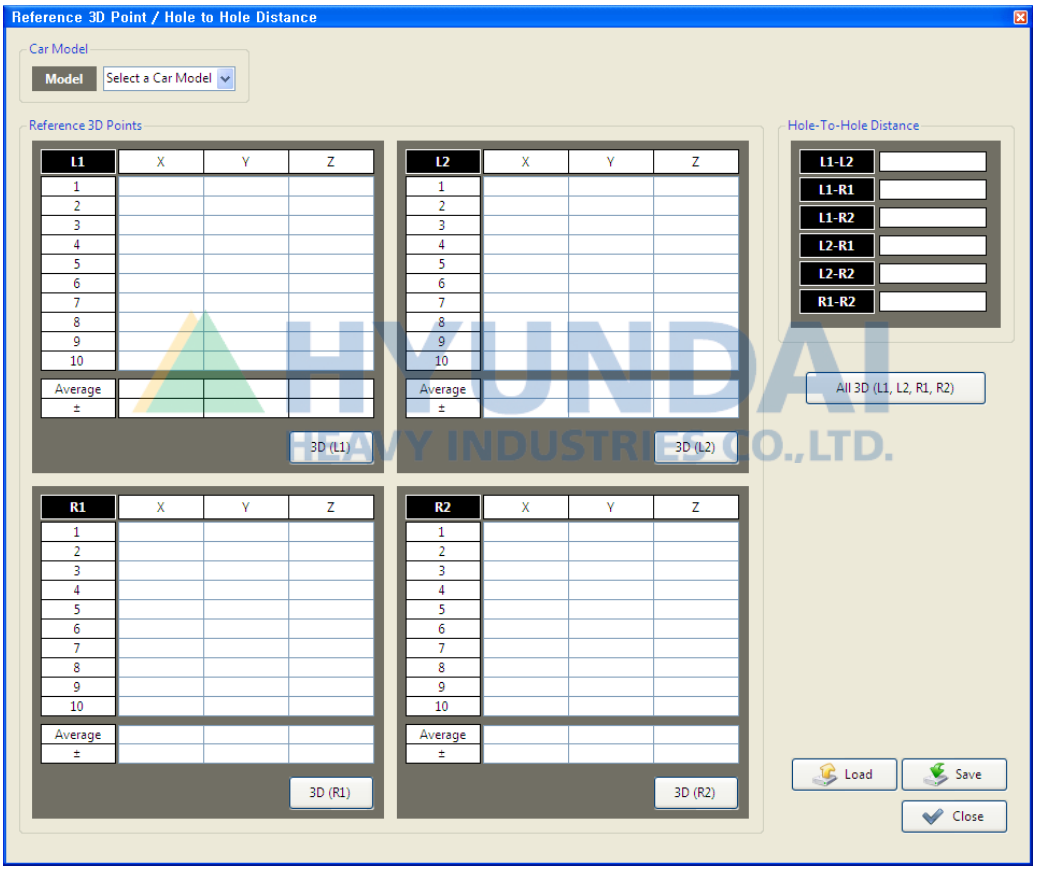
4.5.3. Pattern Recognition & 3D Location Measurement Test

Pattern recognition and 3D location measurement are performed for a registered pattern.
Click “3D of Image Window” button, or “Search” or “3D” button of “Control Button”. Pattern recognition area and the recognition result are displayed on the image window. Configure the optimal pattern models by considering the pattern recognition result and editing/adding a pattern.



4.6. Registration of Reference point

If 3D location measurement is completed for each stereo camera, register the measured points as reference points. Click “Settings → Reference Point” menu of the control button. Select a car model in “Car Model” panel and then press 3D button of a camera for each robot. To obtain the 3D location measured with a camera for robot L1, for example, press “3D (L1)” button. Whenever the button is pressed, the measured average 3D location and accuracy is calculated. To improve the accuracy of reference car body location, make 10 measurements. Because the accuracy is affected by different factors, check the external lighting, camera aperture, cable, or registered pattern if ± value is large. Repeat the process above for robot L2, R1, and R2. Press “Save” button to save it as a reference car body.



4.7. Creation of Work Coordinate System & Teaching/Conversion of Working Point

If a reference point is registered, the robot controller receives the location of reference point through serial or Ethernet communication to create the work coordinate system.

Operator teaches Hyundai robot to log the working location in the robot operation program on the basis of work coordinate system.

If there is a working point taught on the basis of base coordinate system or encoder coordinate system, use the log coordinate system conversion function of Hi5 controller change the coordinate system of robot operation program on the basis of created work coordinate system.

4.8. Auto Operation

When all the setup is completed, “HRVision 3D-MultiCam” will run automatically.
Click “Manual” button of the control button. At the moment, “Manual” button is switched to “Auto” button while the other buttons are disabled.
“HRVision 3D-MultiCam” can only be operated with the communication with PLC and Hyundai robot.

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