ROBOTICS

Operating manual

Visual Servoing

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Operating manual
Visual Servoing

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Original instructions.

Table of contents

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Overview of the manual

About this manual

This manual contains instructions for installation, configuration, and operation of Visual Servoing.

Usage

This manual should be used during the work with Visual Servoing.

Who should read this manual?

This manual is intended for users working with vision servoing applications.

Prerequisites

The reader should have basic knowledge of:

- Industrial robots and their terminology
- Computer vision and image processing
- Externally Guided Motion (EGM)
- RAPID programming

Cybersecurity

This product is designed to be connected to and to communicate information and data via a network interface. It is your sole responsibility to provide, and continuously ensure, a secure connection between the product and to your network or any other network (as the case may be).

You shall establish and maintain any appropriate measures (such as, but not limited to, the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB Ltd and its entities are not liable for damage and/or loss related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

References

Documentation referred to in the manual, is listed in the table below.

General

Reference	Document ID
Safety manual for robot - Manipulator and IRC5 or OmniCore controller [i]	*3HAC031045-001*
Operating manual - RobotStudio	*3HAC032104-001*

[i] This manual contains all safety instructions from the product manuals for the manipulators and the controllers.

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OmniCore

Reference	Document ID
Operating manual - OmniCore	*3HAC065036-001*
Application manual - Controller software OmniCore	*3HAC066554-001*
Technical reference manual - Event logs for RobotWare 7	*3HAC066553-001*
Technical reference manual - RAPID Instructions, Functions and Data types	*3HAC065038-001*
Technical reference manual - RAPID Overview	*3HAC065040-001*
Technical reference manual - System parameters	*3HAC065041-001*
Application manual - Externally Guided Motion	*3HAC073318-001*

Revisions

Revision	Description
A	First edition
B	Published in release 22A. The following updates are made in Visual Servoing 1.0.1 revision: • Updated product page link to *http://new.abb.com/products/robotics/application-software/assembly/robotware-high-speed-alignment*.

Product documentation

Categories for user documentation from ABB Robotics

The user documentation from ABB Robotics is divided into a number of categories. This listing is based on the type of information in the documents, regardless of whether the products are standard or optional.

Tip

All documents can be found via myABB Business Portal, *www.abb.com/myABB*.

Product manuals

Manipulators, controllers, DressPack/SpotPack, and most other hardware is delivered with a **Product manual** that generally contains:

- Safety information.
- Installation and commissioning (descriptions of mechanical installation or electrical connections).
- Maintenance (descriptions of all required preventive maintenance procedures including intervals and expected life time of parts).
- Repair (descriptions of all recommended repair procedures including spare parts).
- Calibration.
- Decommissioning.
- Reference information (safety standards, unit conversions, screw joints, lists of tools).
- Spare parts list with corresponding figures (or references to separate spare parts lists).
- References to circuit diagrams.

Technical reference manuals

The technical reference manuals describe reference information for robotics products, for example lubrication, the RAPID language, and system parameters.

Application manuals

Specific applications (for example software or hardware options) are described in **Application manuals**. An application manual can describe one or several applications.

An application manual generally contains information about:

- The purpose of the application (what it does and when it is useful).
- What is included (for example cables, I/O boards, RAPID instructions, system parameters, software).
- How to install included or required hardware.
- How to use the application.
- Examples of how to use the application.

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Operating manuals

The operating manuals describe hands-on handling of the products. The manuals are aimed at those having first-hand operational contact with the product, that is production cell operators, programmers, and troubleshooters.

Safety

Safety of personnel

A robot is heavy and extremely powerful regardless of its speed. A pause or long stop in movement can be followed by a fast hazardous movement. Even if a pattern of movement is predicted, a change in operation can be triggered by an external signal resulting in an unexpected movement.

Therefore, it is important that all safety regulations are followed when entering safeguarded space.

Safety regulations

Before beginning work with the robot, make sure you are familiar with the safety regulations described in the manual *Safety manual for robot - Manipulator and IRC5 or OmniCore controller*.

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1 About Visual Servoing

Overview

Visual Servoing is a PC-based software which allows to increase the robot accuracy for high precision assembly applications.

- Vision: Identify objects and object features that can be used for alignment.
- Control: configuration and parametrization for the integration and necessary controls for the end-users
- Functionality: Proof of concept for demonstration of the functionality of the system

Accuracy and repeatability are different measures. Repeatability is usually the most important criterion for a robot. ISO 9283 (Manipulating industrial robots - Performance criteria and related test methods) sets out a method whereby both accuracy and repeatability can be measured. Typically, a robot is sent to a taught position several times and the error is measured at each return to the position after visiting 4 other positions. Repeatability is then quantified using the standard deviation of those samples in all three dimensions.

Industrial robots handle small and delicate parts with precision in the electronics industry and can virtually be used in any stage of the production. This increase in robotic automation in the electronics industry has led to an increase in the use of robotic vision.

Robots can move efficiently with high uptime and minimal waste, manufacturing a greater volume of products over longer periods with fewer defects, with the use of robotic guidance system.

The accuracy of the traditional 'look-then-move' approach depends directly on the accuracy of the visual sensor and the robot manipulator. An alternative to increasing the accuracy of these sub-systems is to use a visual-feedback control loop which will increase the overall accuracy of the system. Taken to the extreme, machine vision can provide closed-loop position control for a robot end-effector - this is referred to as Visual Servoing.

The camera(s) may be stationary or held in the robot's 'hand'. The latter case, often referred to as the eye-in-hand configuration, results in a system capable of providing endpoint relative positioning information directly in Cartesian or task space. This presents opportunities for greatly increasing the versatility and accuracy of robotic automation tasks.

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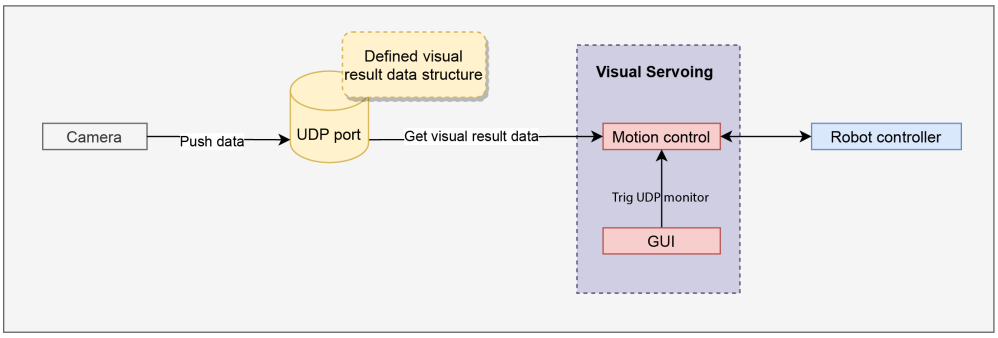
Visual Servoing involves the use of one or more cameras and a computer vision system to control the position of the robot's end-effector relative to the workpiece as required by the task.

System communication



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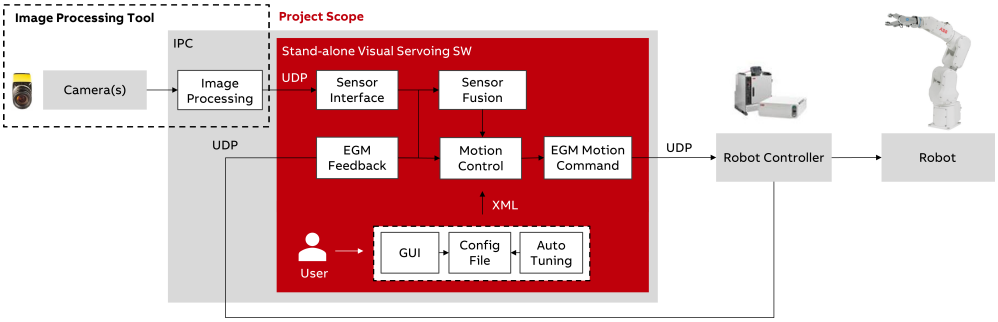
System topology



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Note

Image processing tool should be installed and configured by user.

Main features

Visual Servoing provides the following main features:

- Unique offering.
- Greatly improved alignment speed compared to traditional look-then-move approach.
- Variance of alignment speed is much lower as traditional method spent exact number of cycles for alignment.
- Easy commissioning with auto calibration and tuning for servoing purpose.
- Enables new application possibilities.
- Through camera and robot data synchronization for frame rate variation adaptability and delay compensation, it is more compatible towards a wider range of cameras for variety of vision based applications.

Example in 3C

This is an example which has been made and verified for a 3C customer.

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Prerequisites:

- IRB 1100 with OmniCore C30
- The camera's effective recognition range is 5 mm and frame rate is 7.5 Hz.
- Image acquisition and processing time is 50 ms.
- The camera is fixed on the bracket (required by Visual Servoing), not on the robot.
- Communication with UDP between Visual Servoing and the image processing tool.
- EGM cycle time is 4 ms.

Result:

- Accuracy: 0.01 mm - 0.02 mm

  Accuracy - is how closely a robot can reach a commanded position. When the absolute position of the robot is measured and compared to the commanded position the error is a measure of accuracy. Accuracy can be improved with external sensing for example a vision system or Infra-Red. See robot calibration. Accuracy can vary with speed and position within the working envelope and with payload (see compliance).
- Cycle time: 1.4 s - 1.7 s

Prerequisites

Requiring	Note
Robotware 6.13 or 7.4 and later	Required to make sure the communication with the robot can be set up.
.Net Core Desktop Runtime 3.1 and later	Available in *https://dotnet.microsoft.com/download/dotnet/3.1*.
Visual Servoing installation package	Available in *http://new.abb.com/products/robotics/application-software/assembly/robotware-high-speed-alignment*.

Recommended hardware

The recommended hardware configuration are listed in the following table.

Items	Part Number	Quantity	Brand
Camera (with global shutter)	5.0MP	2	Balser
Lens	X0.22 300±10mm	2	OPT
Light	4 Channel	6	OPT
Light Controller	4 Channel	1	OPT
Board	License	1	Cognex
PC	i7/8GB/1TB/1920*1080	1	Advantech
Ethernet Cable	GigE Ethernet Cable	2	N/A
Monitor	Touch Screen	1	Advantech

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Available applications

Visual Servoing can be used in the following applications to enhance the robot accuracy:

- Assembly

Supported robots

Visual Servoing has been verified with following robots to enhance the robot accuracy:

- IRB 1100
- IRB 120

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1.1 Visual Servoing terms

About these terms

Some words have a specific meaning when used in this manual. Definitions of these words in this manual are listed below. Some of the terms are put in their context when describing a picking and placing process.

Term list

Term	Definition
Visual Servoing	The market name of Visual Servoing PC engineering software that is used for aligning the items with EGM (Externally Guided Motion) and sensors.
Look-then-move	The cameras take a picture first, then the robot moves; take another picture after the robot stops, and then the robot moves until the accuracy meets the requirements.
UDP	User datagram protocol, provides process-to-process communication.
IPC	The computer where the Visual Servoing and image processing tool is installed.
EGM Delay	The delay time between the moment when EGM command is sent and this command has actually been executed.
Sensor Delay	The delay time between the moment when the image has been captured by the image processing tool and Visual Servoing receives the analysis result from image processing tool.

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2 Getting started

Install ABB Robot Communication Runtime

To install ABB Robot Communication Runtime, see *https://developercenter.robotstudio.com/api/pcsdk/articles/Manual/Deployment-of-a-PC-SDK-application/Deployment-of-a-PC-SDK-application-overview.html*.

Install .Net Core Desktop Runtime

Available .Net Core Desktop Runtime versions:

- .Net Core Desktop Runtime 3.1 or later

To download .Net Core Desktop Runtime installation file, see *https://dotnet.microsoft.com/download/dotnet/3.1*.

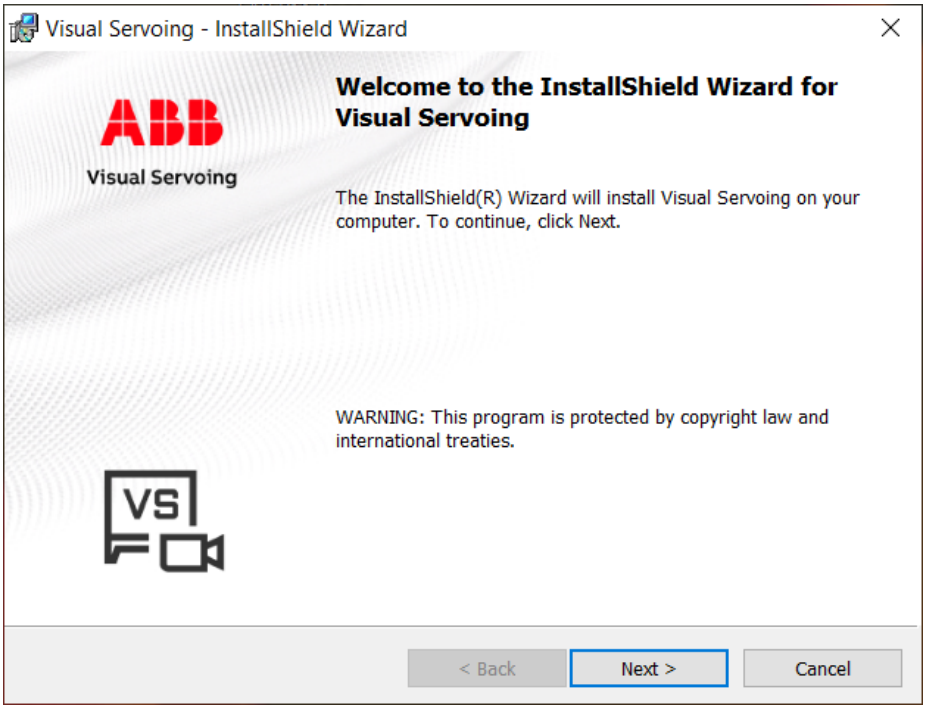
Installing Visual Servoing

Use the following procedure to install and activate Visual Servoing:

1. Browse to the Visual Servoing installation package and double-click **Visual Servoing.msi**.

   The installation starts.

   The Visual Servoing is installed in *C:\Program Files (x86)\ABB\Visual Servoing* by default.
2. Click **Next** to start.



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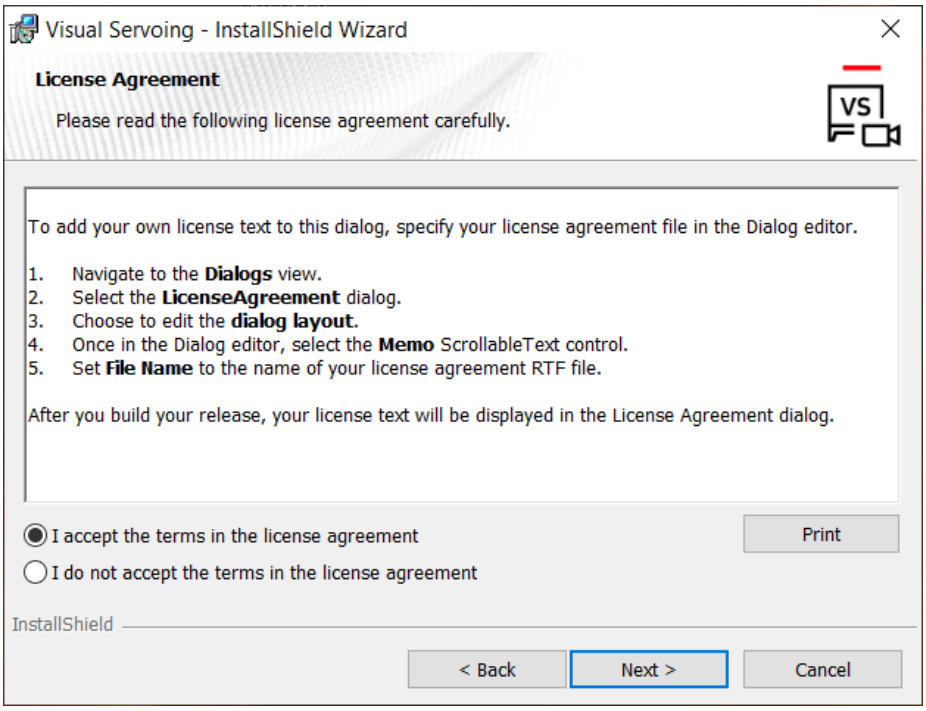
3 Read the **license agreement** and accept the terms.



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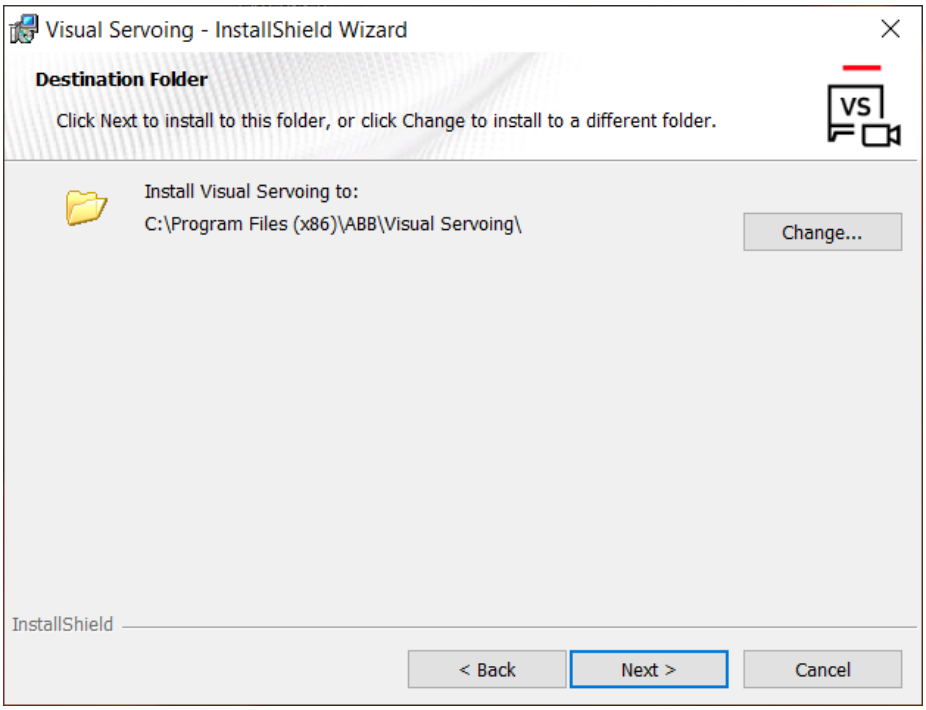
4 Choose a **Destination Folder** and click **Next**.



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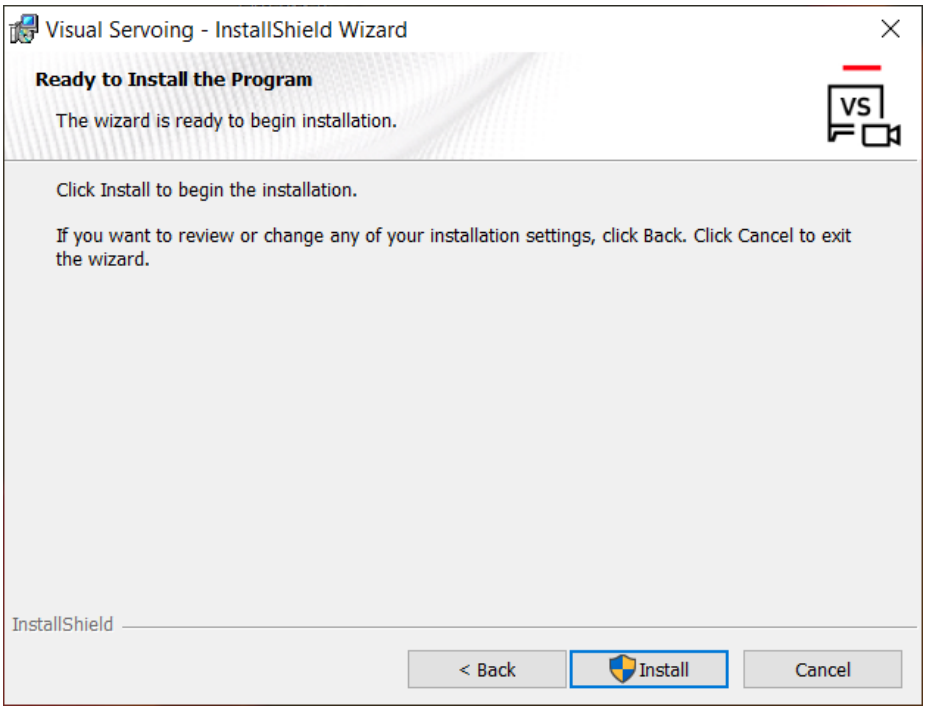
5 Click **Install** to start the installation.



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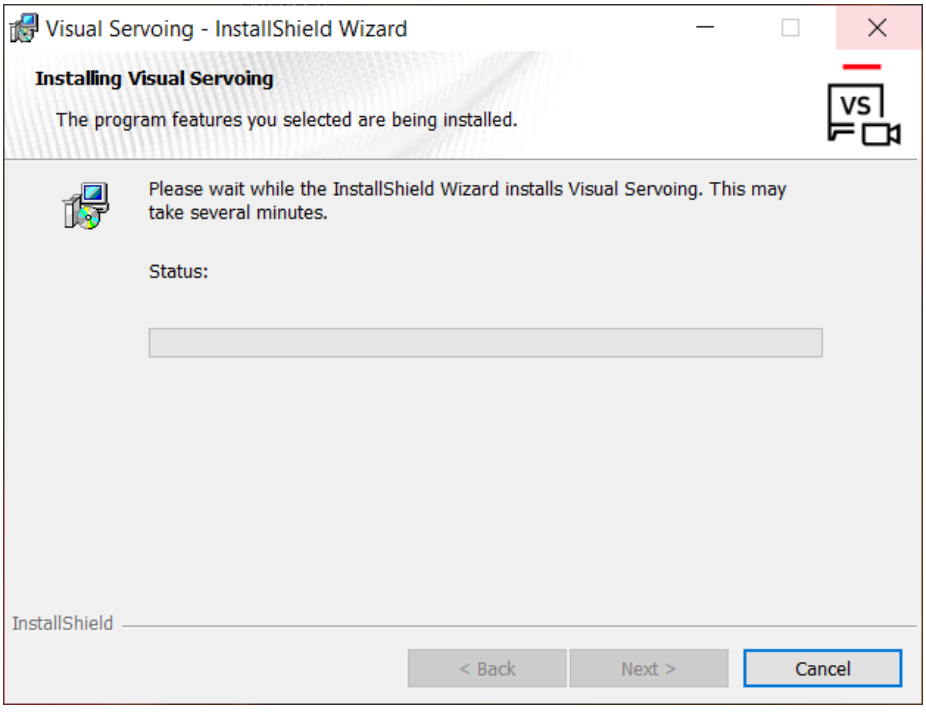

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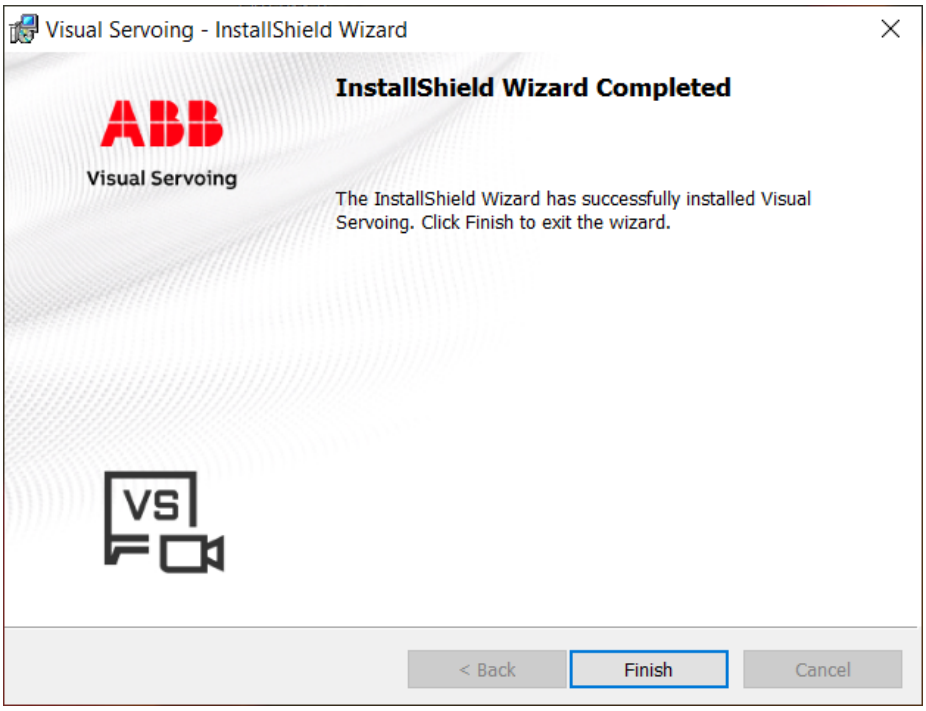
6 When the installation is complete, click **Finish**.



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Tip

When the installation is finished, an installation folder will be created in **Destination Folder** automatically.

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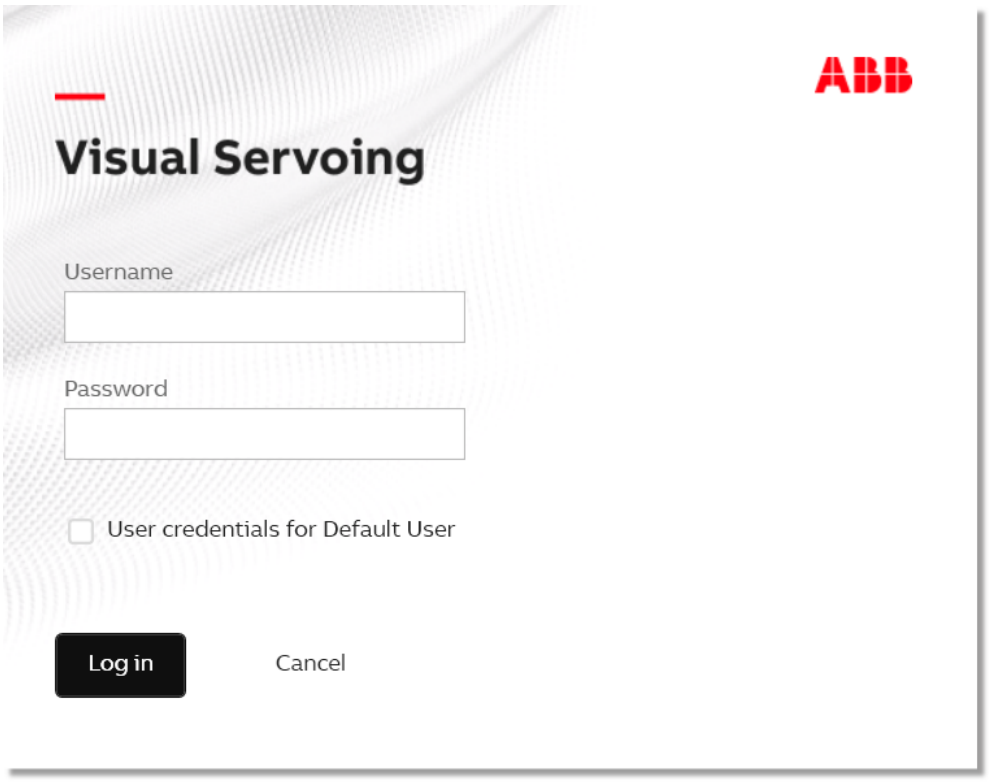
Logging in Visual Servoing



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Note

Make sure that the whole system is connected and powered on.

Use the following procedure to log in Visual Servoing:

1 Double click the .exe file to open Visual Servoing.

Tip

The .exe file is in the installation folder.

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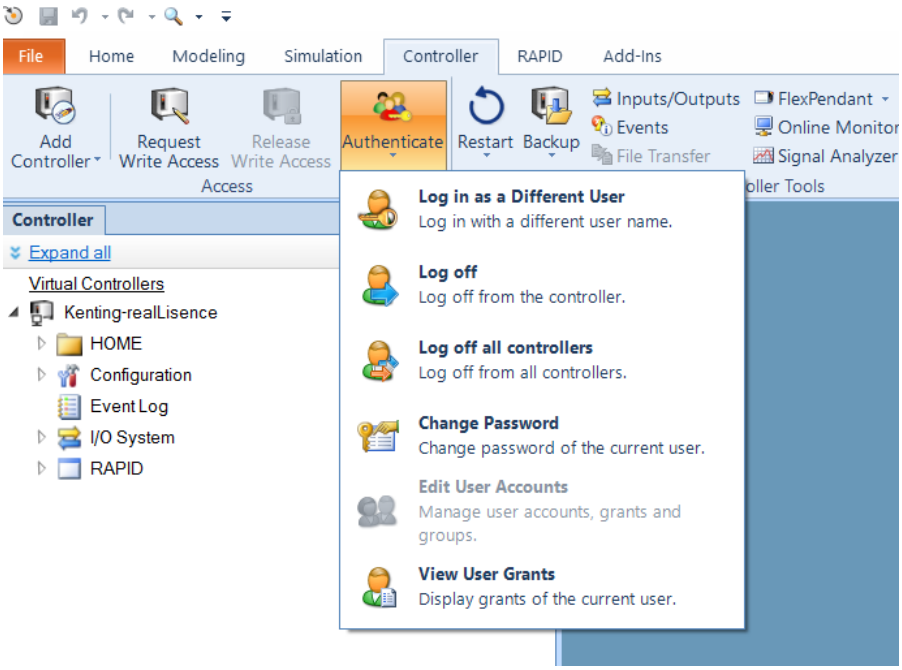
2 Click the **Username** text box and type a valid username in the required user role.

Tip

Visual Servoing share the accounts from **RobotStudio**.

The **Username** and **Password** are granted by **RobotStudio**.



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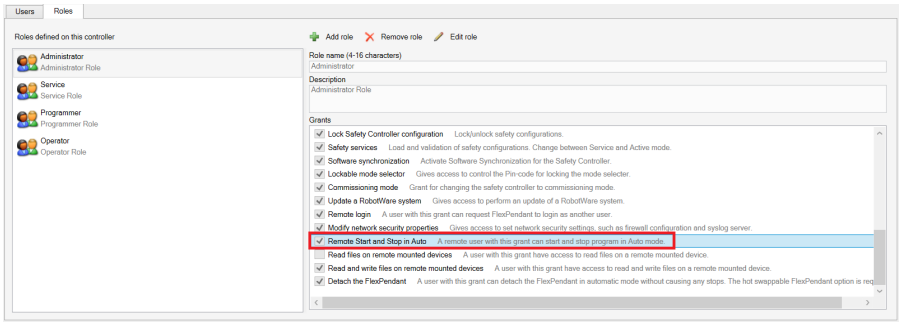
Note

Only the role with **Remote Start and Stop in Auto** grants, can run **Sync now->** and **Improve now->** function normally.



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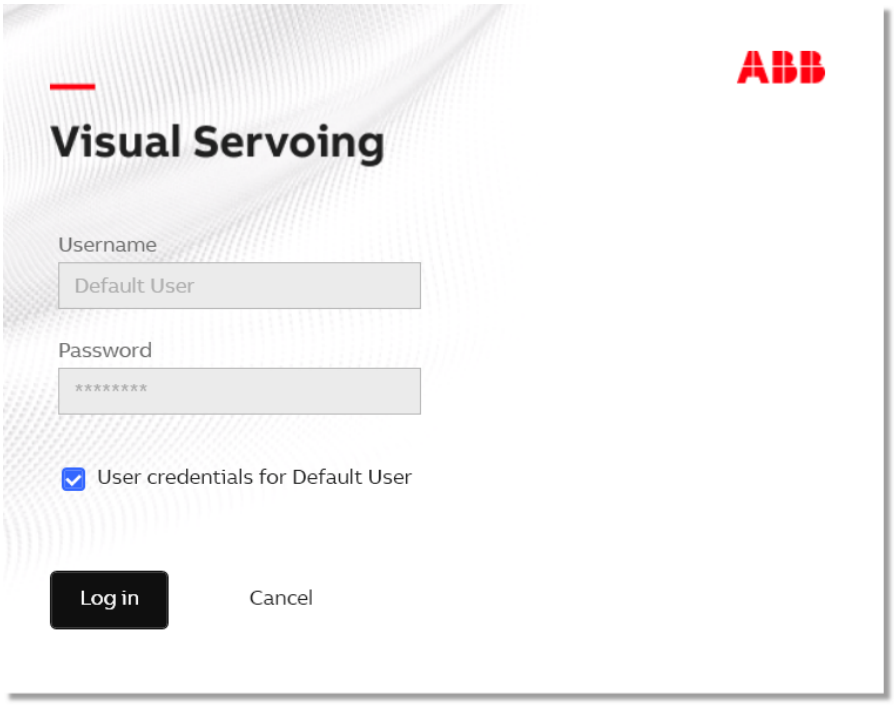
Tip

If a default user is used, click to select the **User credentials for Default User** check box.



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Tip

If the default user cannot be logged in with the **User credentials for Default User** check box, check the password for default user and type the password in **Password** text box.

3 Click the **Password** text box and type password for the user.

4 Click **Log in**.

Updating Visual Servoing

If a new version of the Visual Servoing is available, download the latest version from *http://new.abb.com/products/robotics/application-software/assembly/robotware-high-speed-alignment*.

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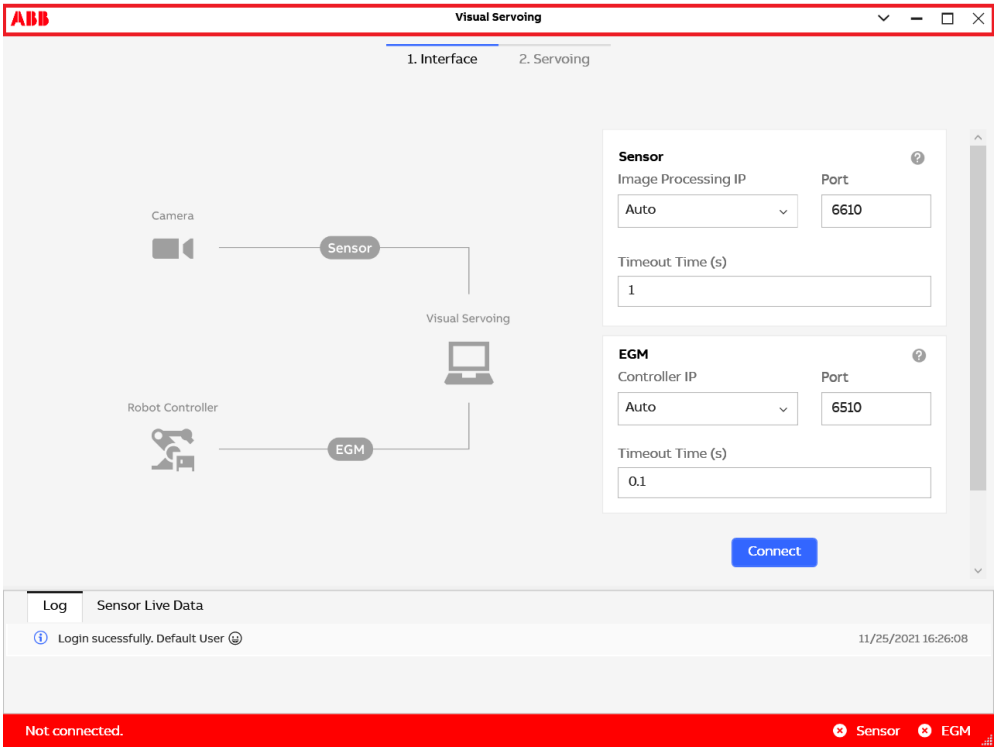
3 Navigating Visual Servoing

Information bar

Information bar is on the top of the interface.



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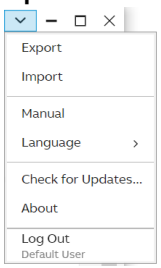
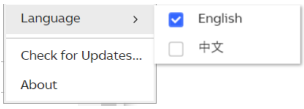
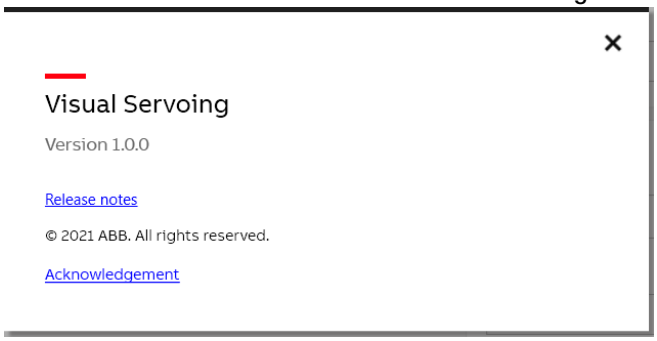
Item	Icon	Description
Additional Operation  xx2100002501	**Export**	Export the configured parameters in Visual Servoing as XML files.
	Import	Import the configured parameters in XML files.
	Manual	Open the Visual Servoing operating manual.
	Language	Select the language of the interface. The following languages are supported: • English • Chinese  xx2100002502
	Check for updates...	Open the download page of this product *http://new.abb.com/products/robotics/application-software/assembly/robotware-high-speed-alignment*.
	About	Get the further information about the Visual Servoing.  xx2100002503
	Log out	Log out current account.
Minimize		Minimize the Visual Servoing interface.
Maximize		Maximize the Visual Servoing interface.
Close		Close the Visual Servoing.

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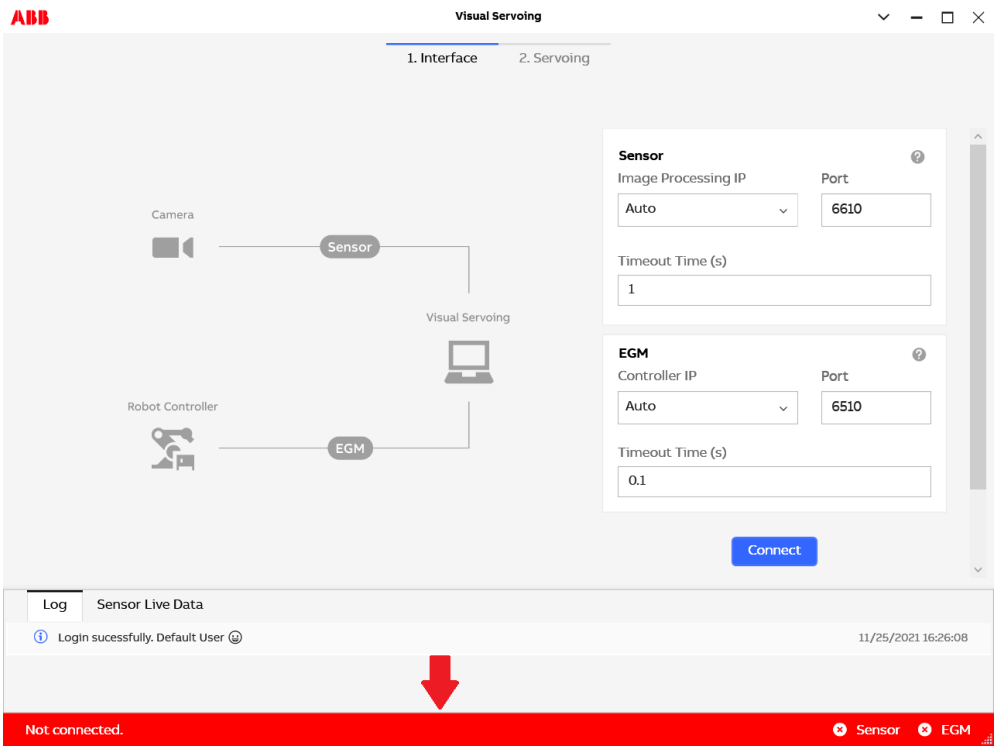
Status color bar

Status color bar is on the bottom of the interface.



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Color	Definition
Green	Indicates that Visual Servoing is receiving data or image data from EGM.
Blue	Indicates that Visual Servoing is connected with EGM and image processing tool but not receiving data.
Red	Indicates that Visual Servoing is not connected to the EGM or image processing software

Interface page

Tip

All parameters will be saved automatically to a local file after any modification.

Visual Servoing will use the local file parameters as default when start Visual Servoing.

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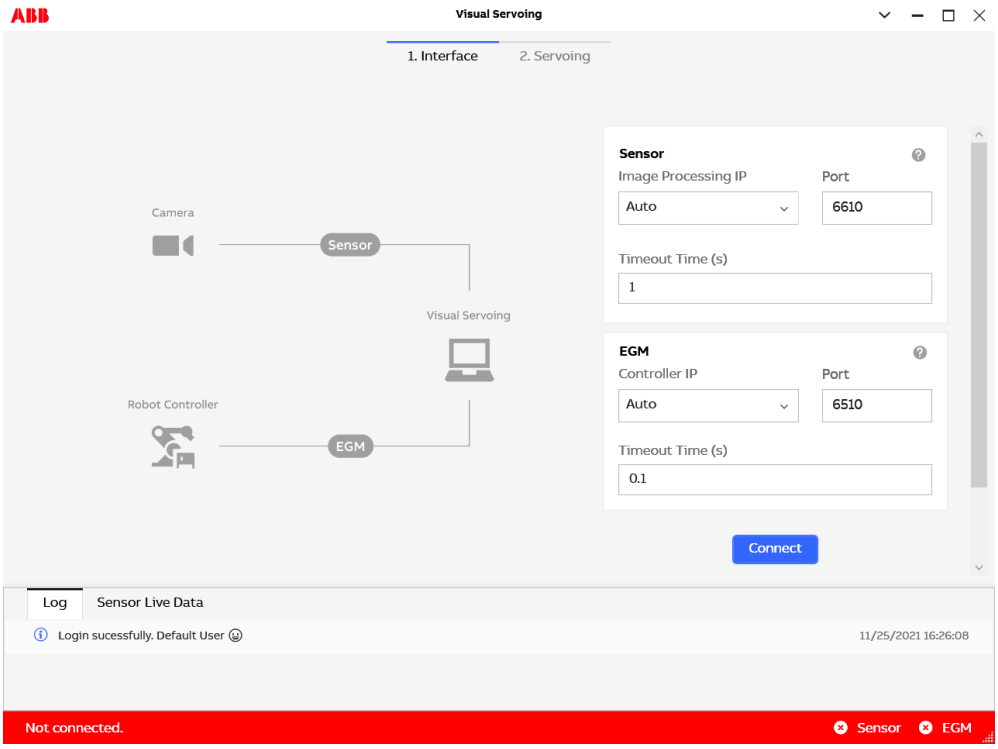

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Item		Description
Sensor	**Image processing IP**	Select the IP address of the image processing tool. The following options can be selected: • 127.0.0.1 • Auto **Tip** The default IP address is Auto. **Note** The image processing software must be installed on the same computer as Visual Servoing.
	Port	Enter the port of the image processing tool. **Note** Make sure the port is same with the one defined in the image processing tool.
	Timeout Time (s)	Define the maximum waiting time before disconnecting.

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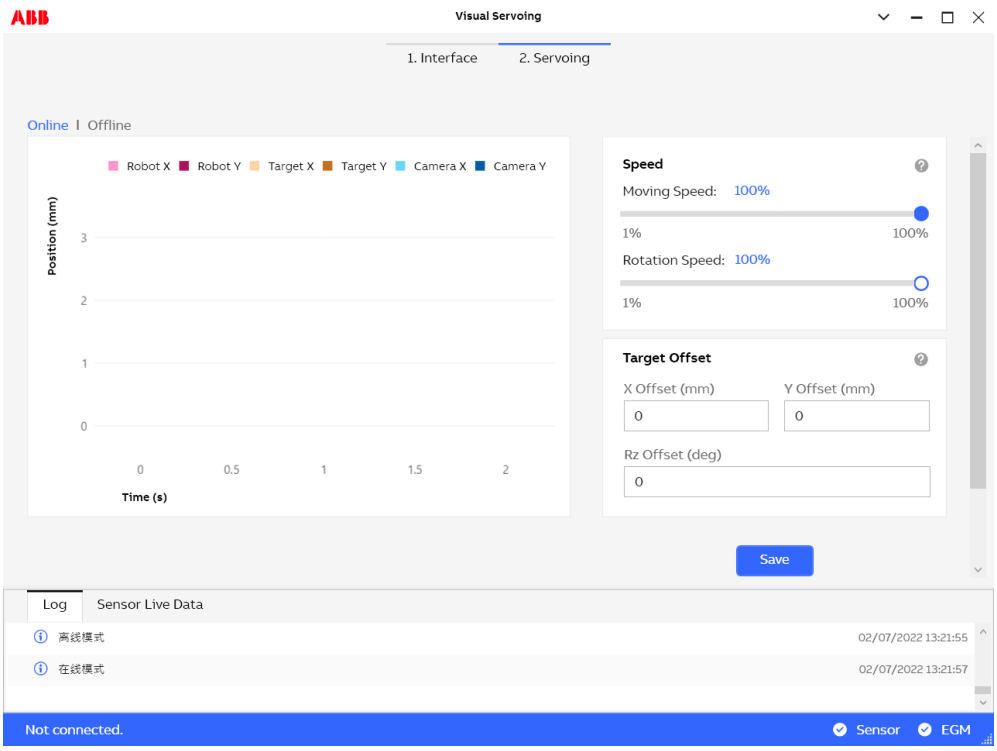
Continued

Item		Description
EGM	**Controller IP**	Select the IP address of the connected controller. **Tip** The default IP address is Auto.
	Port	Enter the port of the connected controller for Visual Servoing. **Note** This port is defined in RobotStudio, see *Configuring EGM communication on page 39*.
	Timeout Time (s)	Define the maximum waiting time before disconnecting.
Connect/Disconnect		Connect/disconnect the IPC to/from the image processing tool and controller.
Sync now->		Perform the calibration. For more details, see *Performing calibration on page 45*. **Note** Action with a FlexPendant is needed to perform this function.

Servoing page

Online



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Item		Description
Online		Show an intuitive curvilinear view of a real-time servoing data. • **Robot X**: Showing the position of the robot on X axis. **Tip** The current position of TCP. • **Robot Y**: Showing the position of the robot on Y axis. • **Target X**: Showing the position of the target on X axis. **Tip** The position that TCP is expected to reach. • **Target Y**: Showing the position of the target on Y axis. • **Camera X**: Showing the deviation value on X axis. **Tip** The deviation that calculated with position of the robot and target. It will eventually approach 0 (target-robot). • **Camera Y**: Showing the deviation value on Y axis. **Tip** Click on the text to hid/show the curve of each data.
Speed	**Moving Speed**	Adjust the moving speed of the robot.
	Rotation Speed	Adjust the rotation speed of the robot.
Target Offset	**X Offset (mm)**	Set the offset value of the target on the X axis.
	Y Offset (mm)	Set the offset value of the target on the Y axis.
	Rz Offset (deg)	Set the offset value of the target on the Rz axis.
Save		Save the tuning data to the controller.
Improve now->		Tune the other related servoing data with the adjusted parameters. For more details, see *Tuning on page 49*. **Note** Action with a FlexPendant is needed to perform this function. **Note** **Improve now** is intended for optimization of cycle time by automatically tuning the EGM delay and sensor delay.

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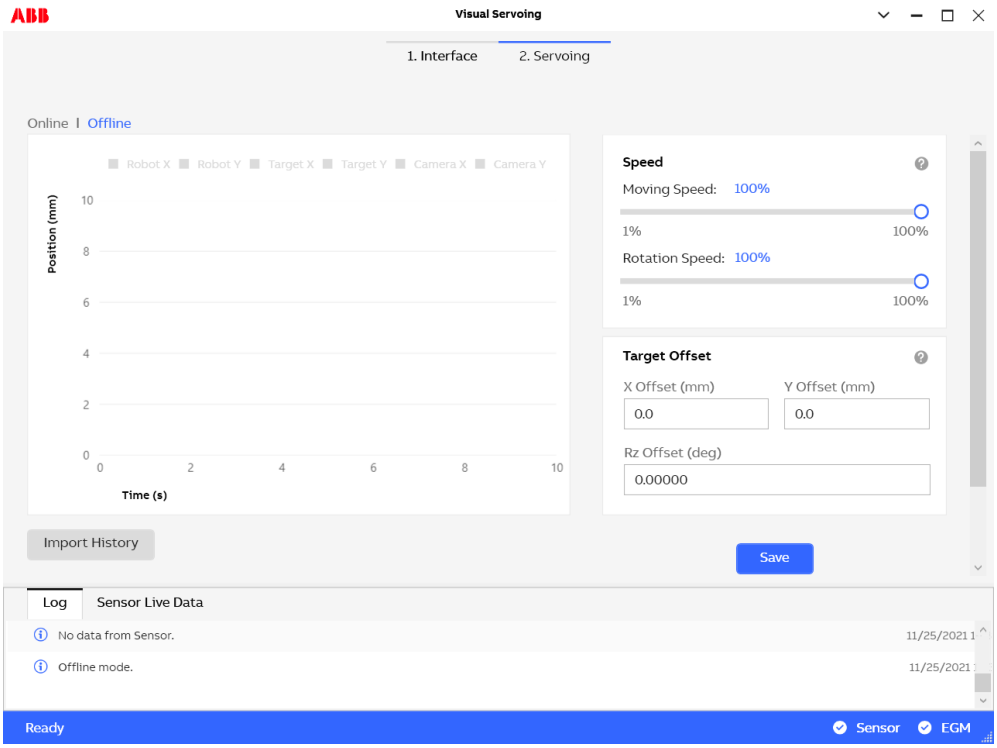
Offline



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Item	Description
Offline	Show an intuitive curvilinear view of a historical servoing data. • **Robot X**: Showing the position of the robot on X axis. **Tip** The current position of TCP. • **Robot Y**: Showing the position of the robot on Y axis. • **Target X**: Showing the position of the target on X axis. **Tip** The position that TCP is expected to reach. • **Target Y**: Showing the position of the target on Y axis. • **Camera X**: Showing the deviation value on X axis. **Tip** The deviation that calculated with position of the robot and target. It will eventually approach 0 (target-robot). • **Camera Y**: Showing the deviation value on Y axis. **Tip** Click on the text to hid/show the curve of each data.

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Continued

Item		Description
Import History		Import historical data from your local folder.  **Note** Do not run the robot when importing historical data. Otherwise it may cause importing error.
Speed	**Moving Speed**	Adjust the moving speed of the robot.
	Rotation Speed	Adjust the rotation speed of the robot.
Target Offset	**X Offset (mm)**	Set the offset value of the target on the X axis.
	Y Offset (mm)	Set the offset value of the target on the Y axis.
	Rz Offset (deg)	Set the offset value of the target on the Rz axis.
Save		Save the tuning data to the controller.
Improve now->		Tune the other related servoing data with the adjusted parameters.  **Note** Action with a FlexPendant is needed to perform this function.  **Note** **Improve now** is intended for optimization of cycle time by automatically tuning the EGM delay and sensor delay.

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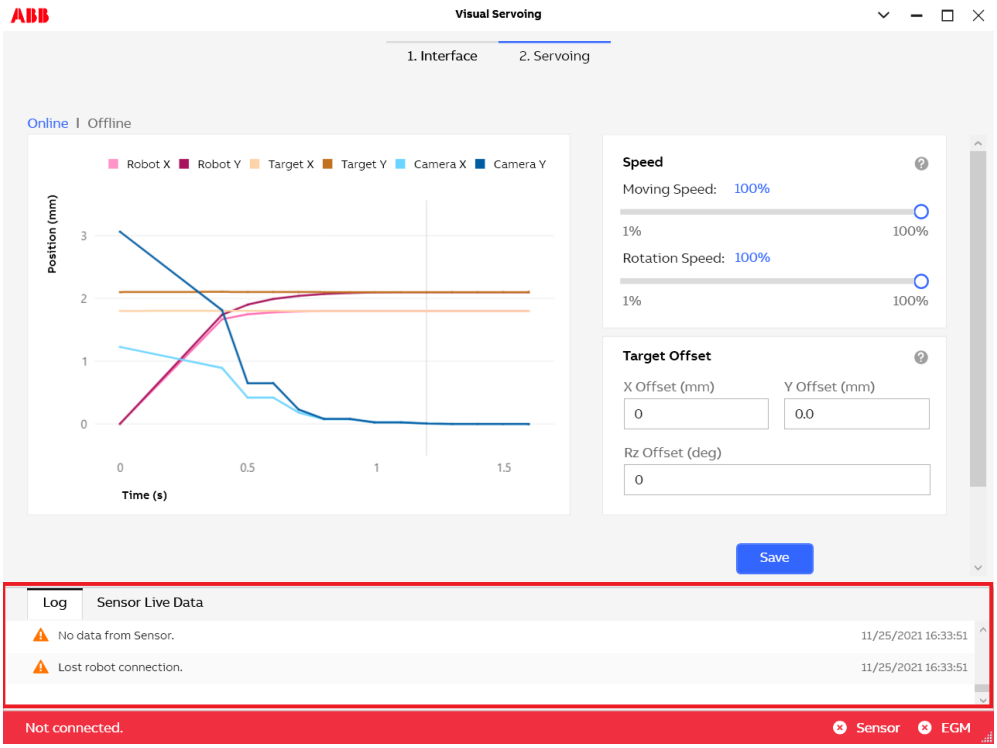
Log view



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Item	Description
Log	Allows you to view all log message. **Tip** The latest log is showing up at the bottom. It will jump to the latest one automatically. **Tip** The logs will reset every time when the Visual Servoing window is closed.

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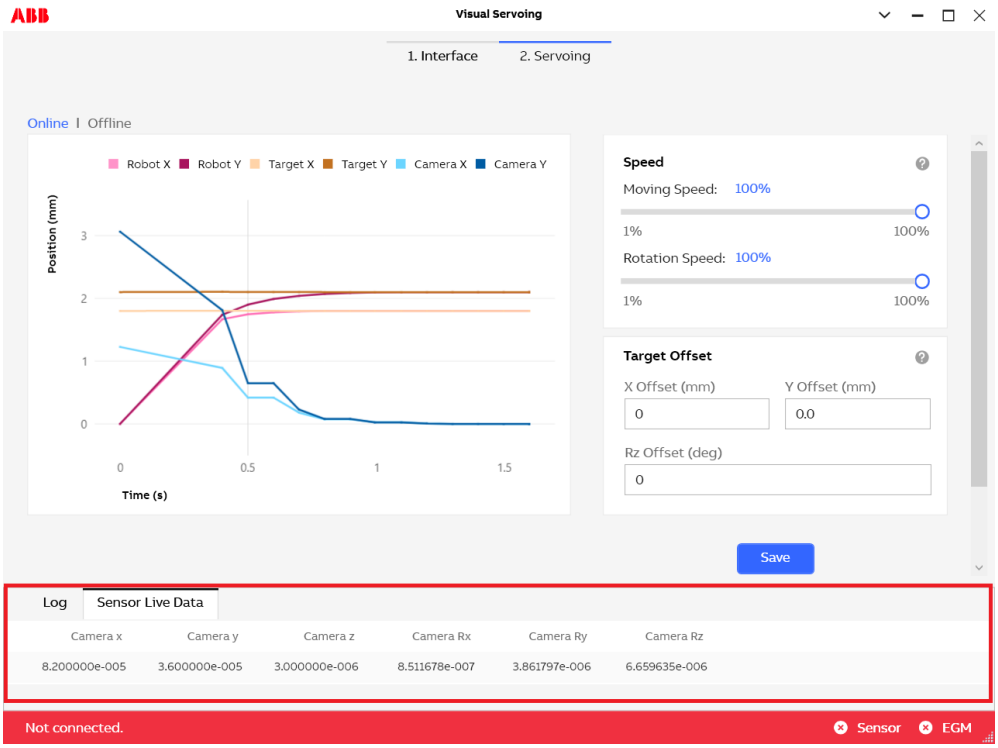
Continued

Sensor Live Data



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Item	Description
Sensor Live Data	Allows you to view the real-time data from the image processing tool in the user defined coordinate system of current servoing circle. **Note** Only when the image processing tool is connected and the data is transferred successfully, the data will be displayed.

4 Configuring camera and robot data

Preparing the image processing tool

Image processing tool performance requirement

The camera's frame rate range is from 5 Hz to 100 Hz. The frame rate is faster, the cycle time is shorter. The data size of one frame should be less than 50 KB.

Image acquisition and processing time should be less than 200 ms. The time is less, the cycle time is shorter.

For more detailed example, see *Example in 3C on page 14*.

Data format of result from image processing tool

The communication of the data between Visual Servoing and the image processing tool uses UDP.

Data (in user defined coordinate system) from image processing tool should contain following information:

- Timestamp of when the image is captured (**in CPU ticks**)
- The planar position (denoted as x and y) of target (where the feature is supposed to be after alignment)
- The orientation of target (only the rotation angle along the vertical axis, denoted as θ)
- The planar position and orientation of detected feature.
- Whether the feature is within accuracy requirement and remains still or not:
  - 1 -> feature is within accuracy requirement and remains still (converged)
  - 0 -> feature is not within accuracy requirement or moving

Note

The unit of planar positions is millimeter, and unit of orientation angle is degree.

Note

Only translational movement on X,Y axes (user defined coordinate system) and rotational movement around Z axis are supported for alignment.

Note

The image processing tool must be installed on the same computer with Visual Servoing, otherwise the value of timestamp will be meaningless.

These data are connected as following (without any spaces)

Timestamp:target.x,target.y,target.θ,feature.x,feature.y,feature.θ,0,0,0,0,converged

For example:

Continues on next page

Continued

105136:149.0262,58.2394,-0.689,151.0156,59.6067,-0.5383,0,0,0,0,1

WARNING

Make sure that the format and sequence of data are correct, otherwise the motion of robot will be unpredictable.

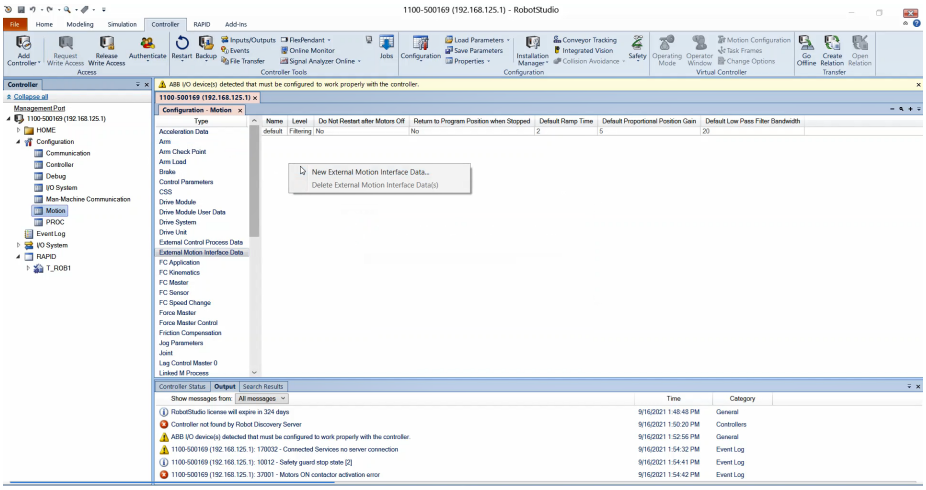
Preparing EGM

Use the following procedure to get the EGM prepared.

Creating new EGM interface

Perform the following procedure to create a new EGM interface for communicating:

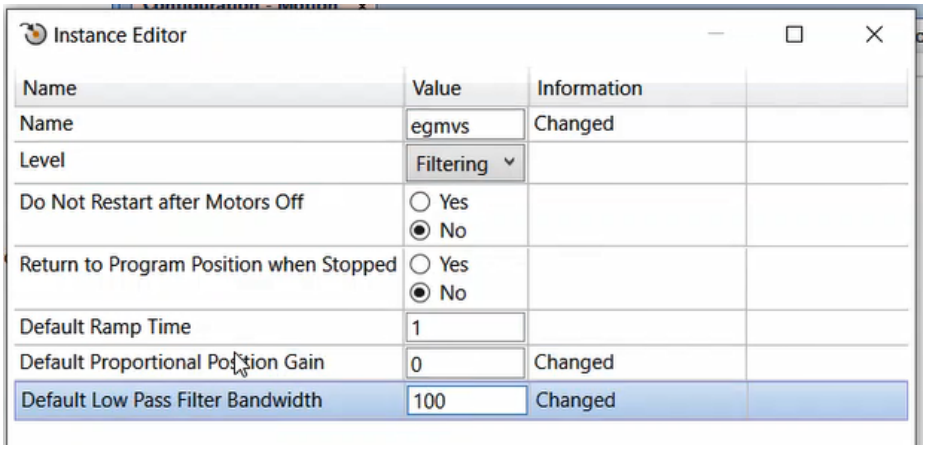
1. Open RobotStudio and the required robot system.
2. In the **Controller** tab page, choose **Motion** from the **Configuration** list in the **Configuration** group.
3. In the displayed **Configuration - Motion** window, choose **External Motion Interface Data** in the **Type** navigation tree.
4. Right-click and choose **New External Motion Interface Data...**.



xx2100002298

Continues on next page

5 Create a new data naming **egmvs**. Set **Default Proportional Position Gain** to **0** and **Default Low Pass Filter Bandwidth** to **100** with other values leaving as their default.



xx2100002299

6 Click **OK** to save the new data.

Configuring EGM communication

Note

The controller and **IPC** must be in the same network segment.

Tip

IPC need to connect to **WAN** port on the controller. The default IP address for the **WAN** port on the controller is **192.168.1.100**.

Perform the following procedure to configure the EGM communicating:

1 Open RobotStudio and the required robot system.

2 In the **Controller** tab page, choose **Communication** from the **Configuration** list in the **Configuration** group.

3 In the displayed **Configuration - Communication** window, choose **UDP Unicast Device** in the **Type** navigation tree.

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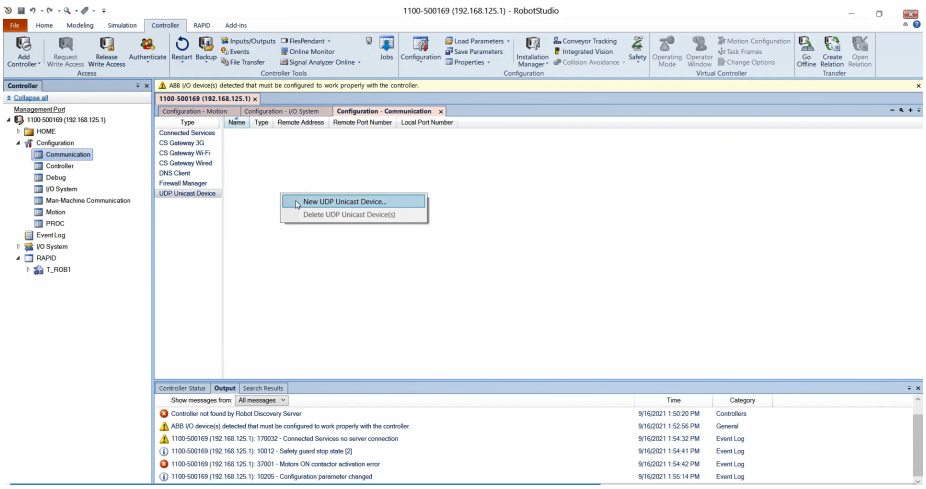
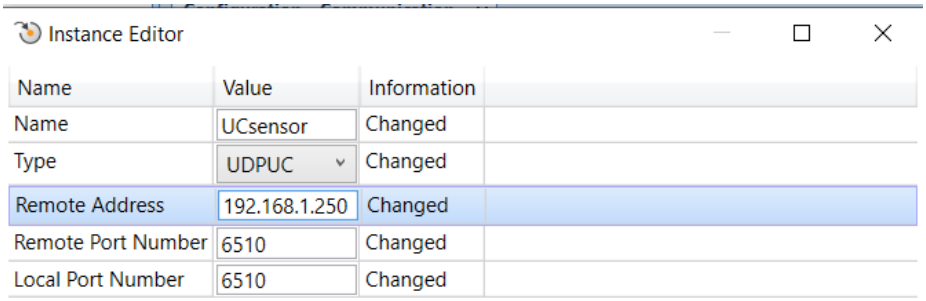
Continued

4 Right-click and choose **New UDP Unicast Device...**.



xx2100002300

5 Create a new device naming **UCsensor**. Set **Type** to **UDPUC**, **Remote Address** to the IPC IPv4 Address (i.e. **192.168.1.250**) and **Remote Port Number** to the desired port number (i.e. **6510**).



xx2100002301

Tip

This **Remote Address** is the IPC address of the Visual Servoing.

Note

The **Remote Port Number** and **Local Port Number** should be the same.

6 Click **OK** to save the new device.

Continues on next page

Editing RAPID code of EGM

Perform the following steps to add the EGM program into the RAPID program.

1. Call function `bool EGM_tune_parameters(tooldata tool_in, wobjdata wobj_in)`.

   Note

   - `tool_in` is the actual tool data.
   - `wobj_in` should be the same coordinate as used in calibration.

   Make sure that the tool data and the work object coordinate are set correctly.

2. If the return value is true, call `Proc EGM_ALIGNMENT()`. Otherwise, an error will be reported, and EGM will not be started.

A code template is provided, see the `EGM_MOTION.mod` file in the installation destination folder.

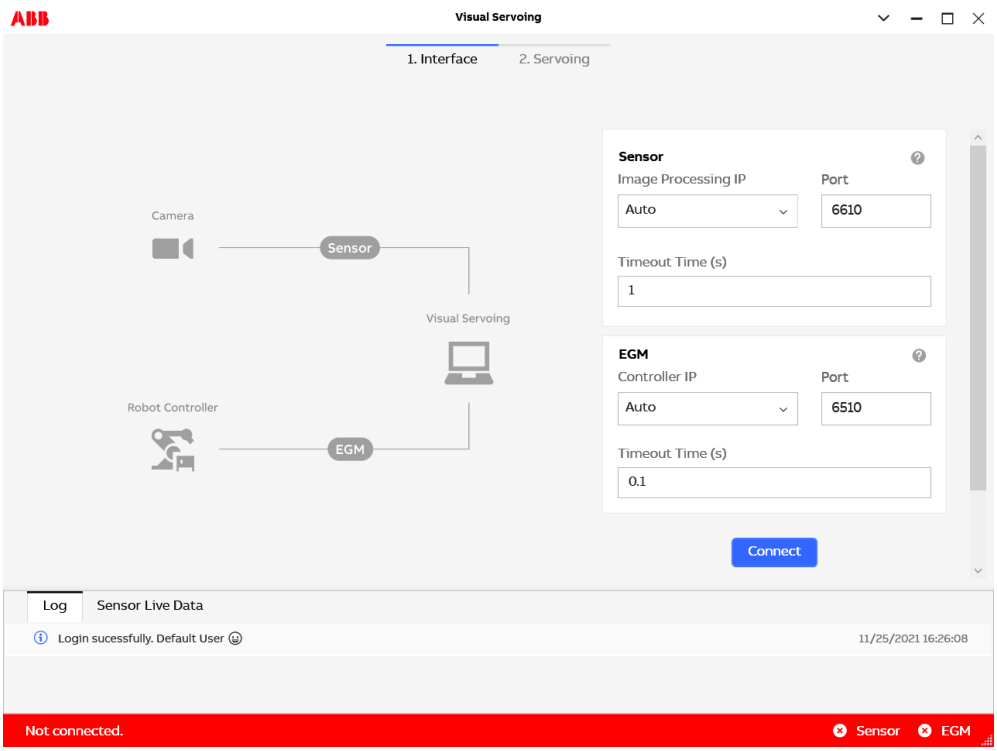
Note

EGM cycle time should be 4 ms.

For more information on EGM, see *Application manual - Externally Guided Motion*.

Connecting to image processing tool and EGM

The communication with the image processing tool and EGM must be set up before performing any operation on the Visual Servoing.



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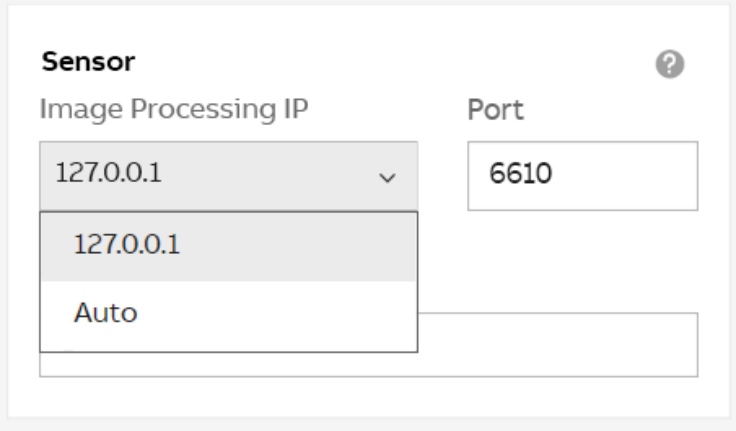
Continued

Procedure

Perform the following procedure to connect with the image processing tool and EGM:

1 Open Visual Servoing.

2 In the **1.Interface** tab page, choose the correct IP address from the drop-down list for **Sensor**.



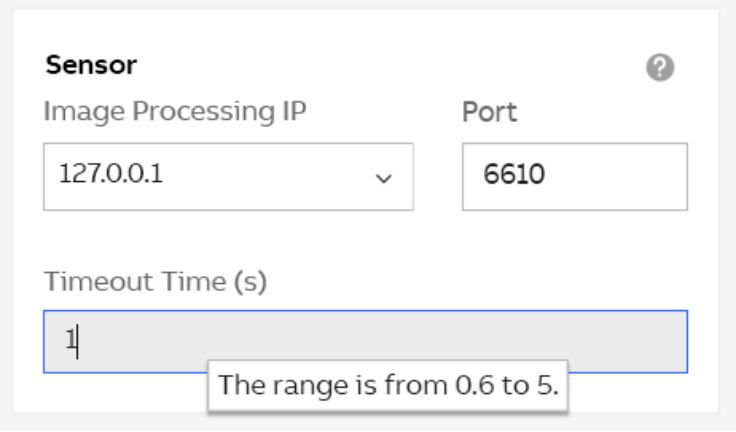
xx2100002109

3 Input the required port in the **Port** text box.

> **Note**
>
> Make sure the port is same with the one defined in the image processing tool.

4 Input the desired value in **Timeout Time** text box.

> **Tip**
>
> The valid value for **Timeout Time** is 0.6-5.



xx2100002110

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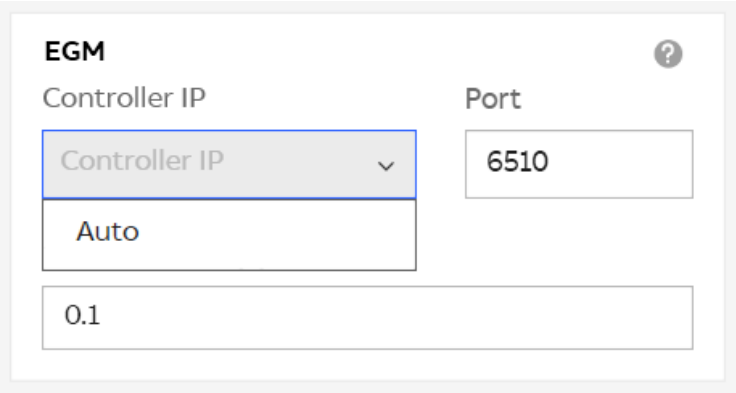
5 In the **1.Interface** tab page, choose the correct IP address from the drop-down list for **EGM**.



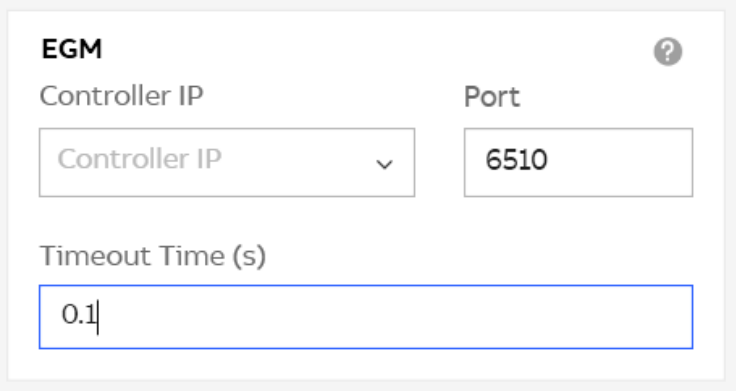
xx2100002111

6 Input desired port number (i.e. **6510**) in the **Port** text box.

> **Note**
>
> Make sure the port is same with the one defined in the RobotStudio.

7 Input the desired value in **Timeout Time** text box.

> **Tip**
>
> The valid value for **Timeout Time** is 0.6-5.



xx2100002112

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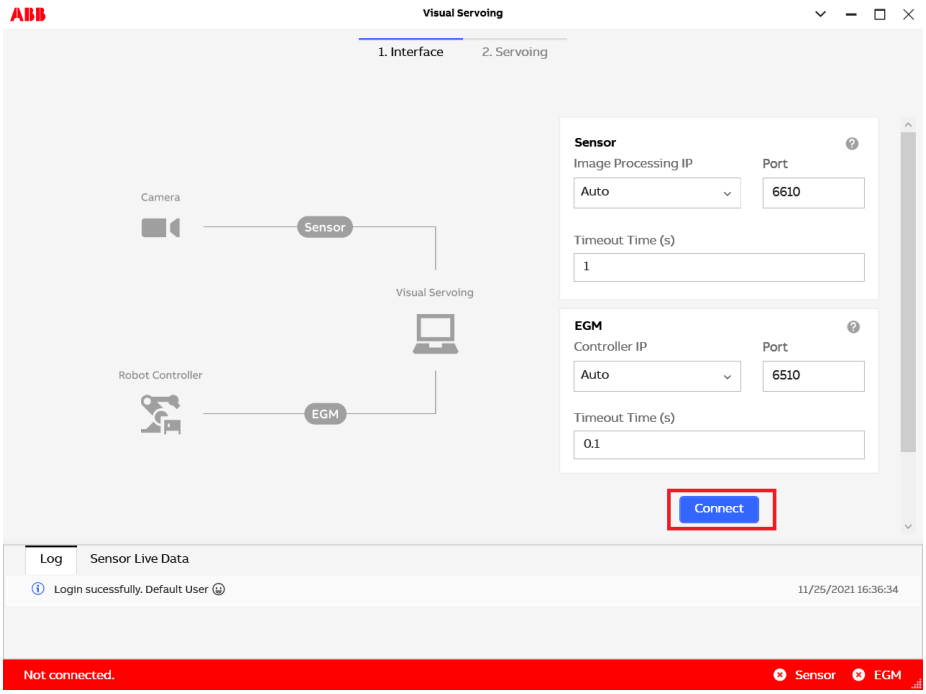
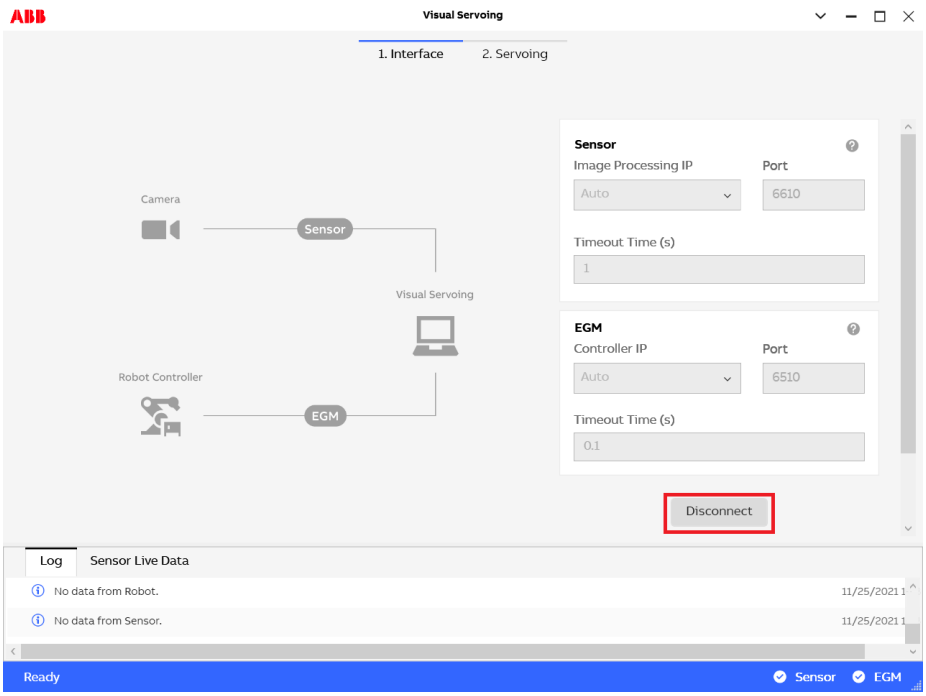
Continued

8 Click **Connect**.



xx2100002113

The status of the image processing tool and EGM are checked as **Ready** in the **Log** bar at the bottom of the window. To disconnect with the image processing tool and EGM, click **Disconnect**. The status is crossed off as **Not connected**.



xx2100002114

5 Performing calibration

Overview

Calibration is to calculate the relative relationship between the camera coordinate system and the workobject coordinate system.

The Visual Servoing software converts the received image processing tool results (based on the user defined coordinate system) into data based on the robot workobject coordinate system using the obtained coordinate system relative relationship, and then calculates with the received robot position feedback.

WARNING

Make sure that there are no obstacles in the working area (1 mm x 1 mm) of the tuning path to avoid any collision.

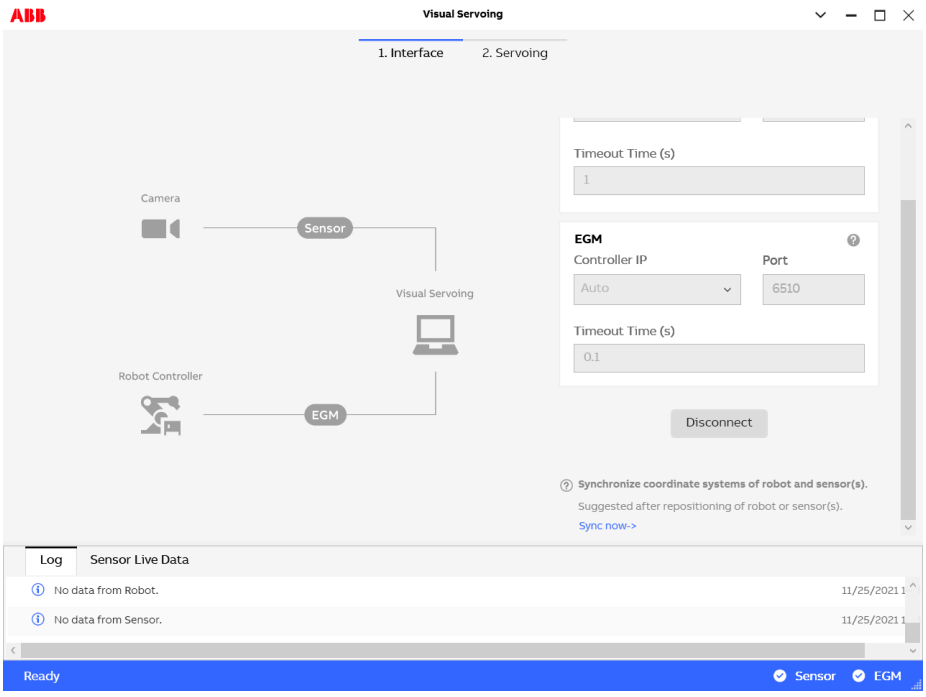
Syncing the coordinate system

Tip

Stop the robot using the FlexPendant before calibration. Otherwise the parameter cannot be edited.

Use the following procedure to load calibration board file and set point data.

1 Click **Sync now->**.



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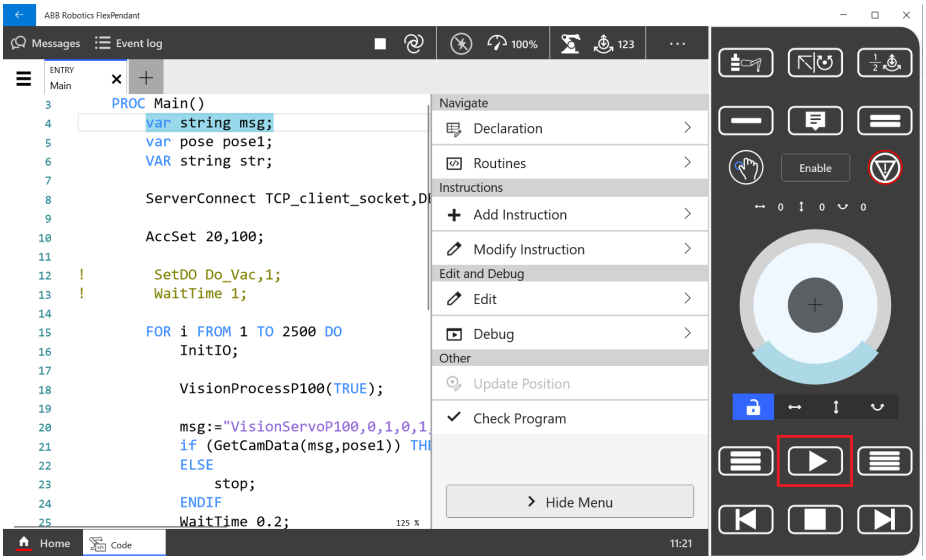
Continued

The following dialog will pop up.

xx2100002116

2 Press **Play** on the FlexPendant to start the robot.

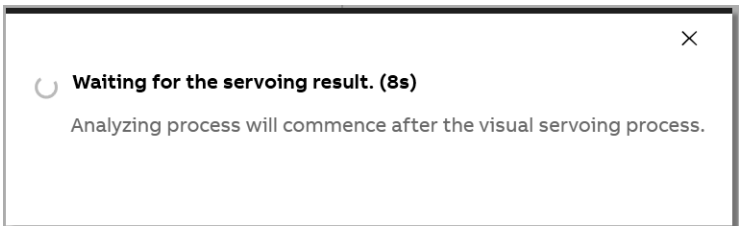


xx2100002303

During this process, the following dialogs will pop up.

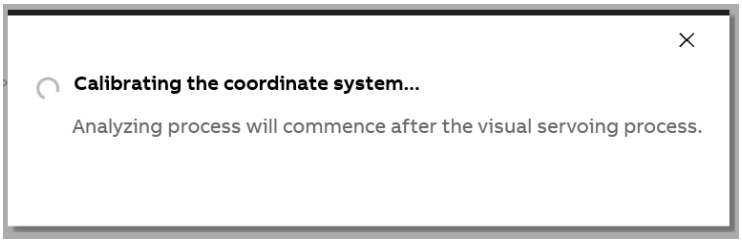
Note

If the following dialog box keep waiting, it means that the servoing result data has not been obtained yet.



xx2100002302

Continues on next page



xx2100002117

3 Click **Done**.

The calibration is done.

xx2100002118

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6 Tuning

6.1 Tuning the robot speed

Overview

Users can run the tuning process on the robot speed and check the workpiece deviations in their application.

Users can define the speed of the robot according to their needs. Under normal circumstances, the speed is faster, the convergence is faster.

WARNING

Make sure that there are no obstacles in the working area (1 mm x 1 mm) of the tuning path to avoid any collision.

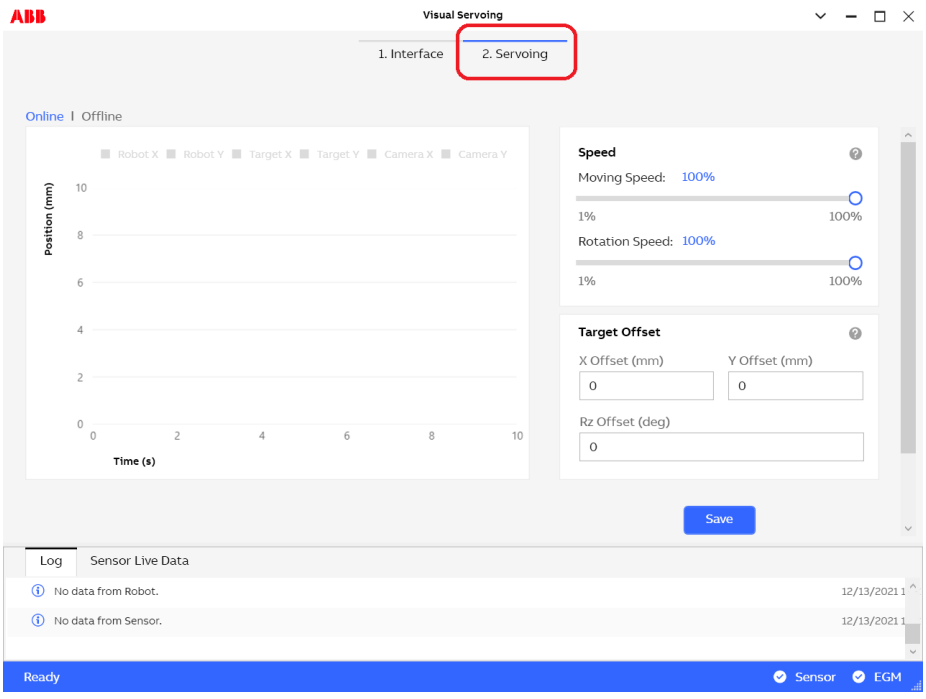
Procedure

Tip

Stop the robot using the FlexPendant before calibration. Otherwise the parameter cannot be edited.

Connect first and then open the vision software.

1 Click the **2.Servoing** tab page.



xx2100002119

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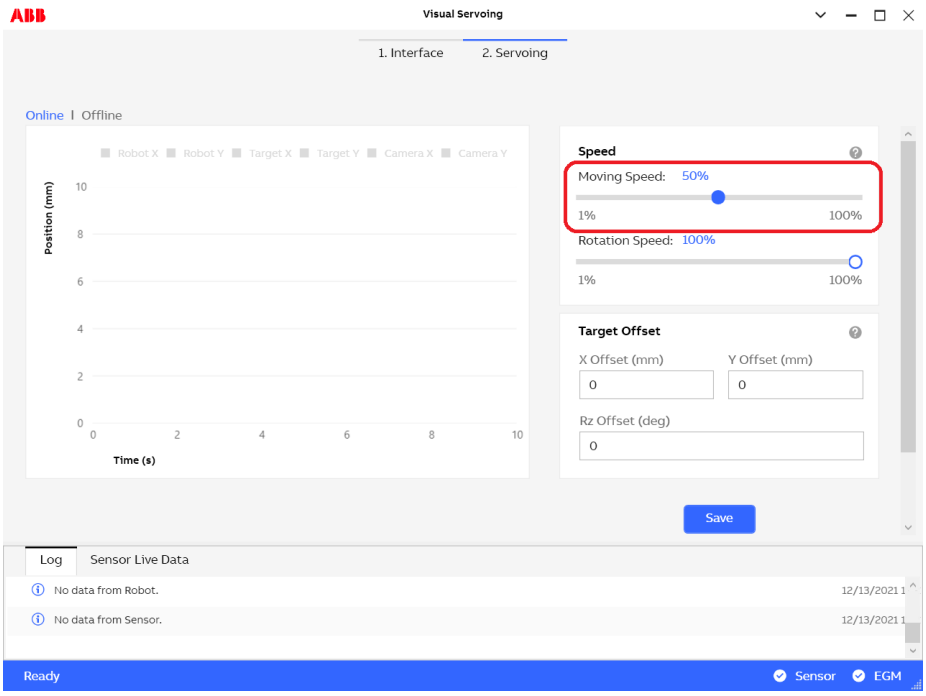
2 Drag the ball on the slider bar of **Moving Speed** on the right pane to adjust the moving speed of the robot.

> **Tip**
>
> 100% is the maximum allowed moving speed of TCP by Visual Servoing. The default value for the maximum is 10 mm/s.

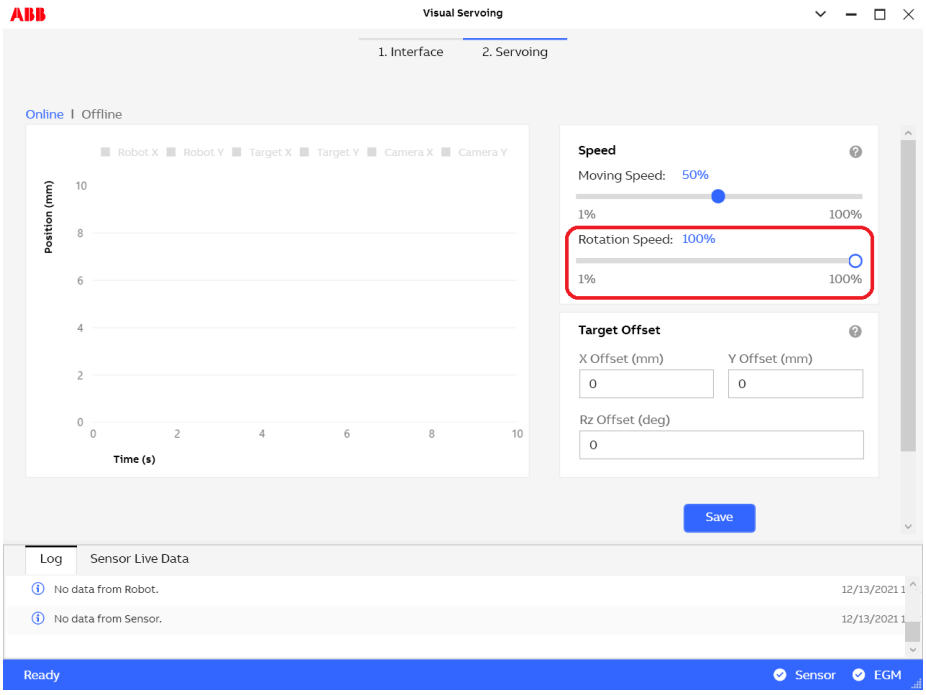


xx2100002120

3 Drag the ball on the slider bar of **Rotation Speed** on the right pane to adjust the rotation speed of the robot.

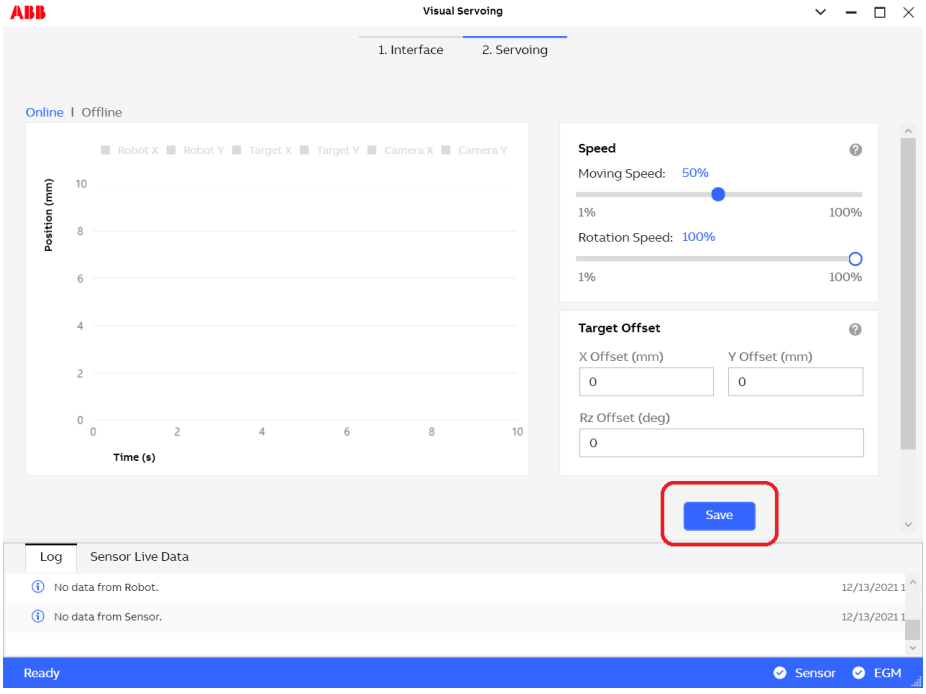
> **Tip**
>
> 100% is the maximum allowed rotation speed by Visual Servoing. The default value for the maximum is 10 °/s.

Continues on next page



xx2100002121

4 Click **Save**.



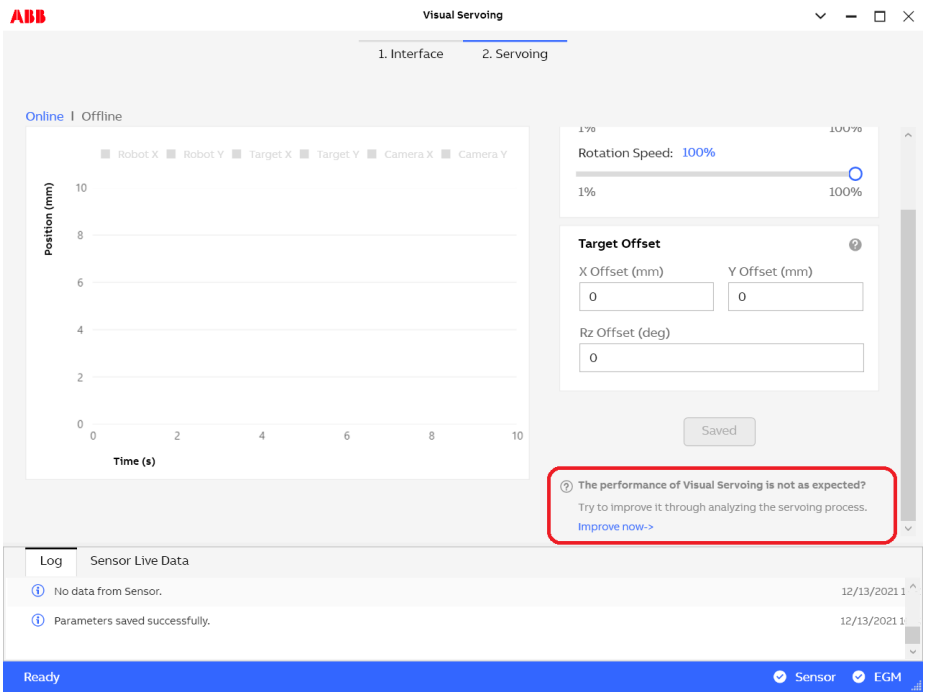
xx2100002122

Continues on next page

6.1 Tuning the robot speed

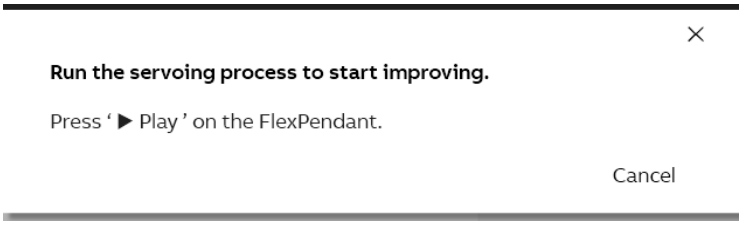
Continued

5 Click **Improve now->**.



xx2100002123

The following dialog will pop up.



xx2100002124

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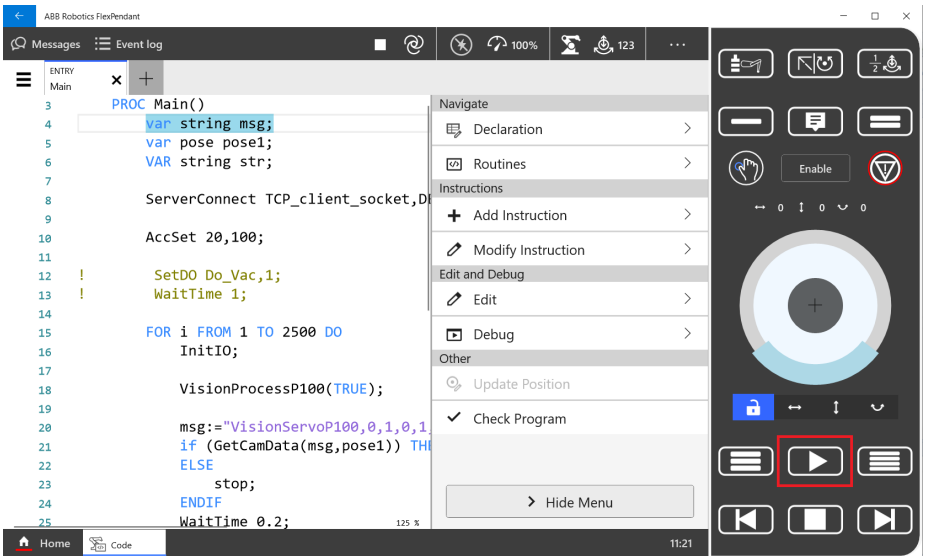
6 Press **Play** on the FlexPendant to start the robot.

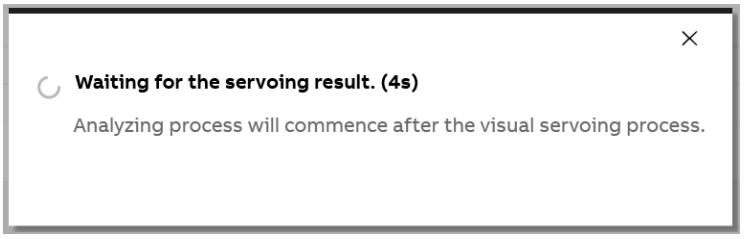


xx2100002303

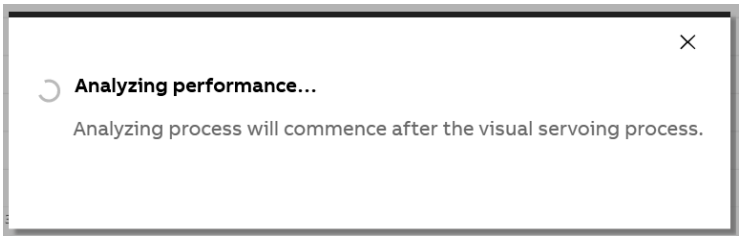
During this process, the following dialog will pop up.

Note

If the following dialog box keep waiting, it means that the servoing result data has not been obtained yet.



xx2100002506



xx2100002304

7 Click **Done**.

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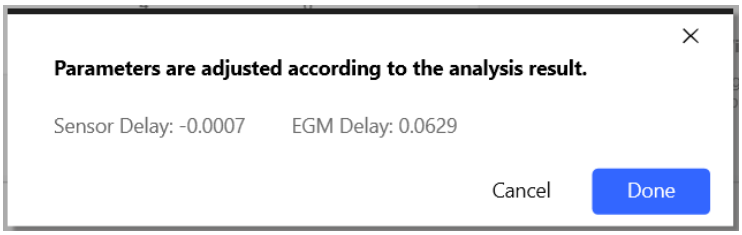
6.1 Tuning the robot speed

Continued

The tuning process is done.



xx2100002305

6.2 Tuning the target offset

Overview

If the actual alignment task always has a constant deviation, users can run the tuning process on the target offset to make up the deviation.

Deviation is existing in normal cases and the target offset is defaulted as 0.

WARNING

Make sure that there are no obstacles in the working area (1 mm x 1 mm) of the tuning path to avoid any collision.

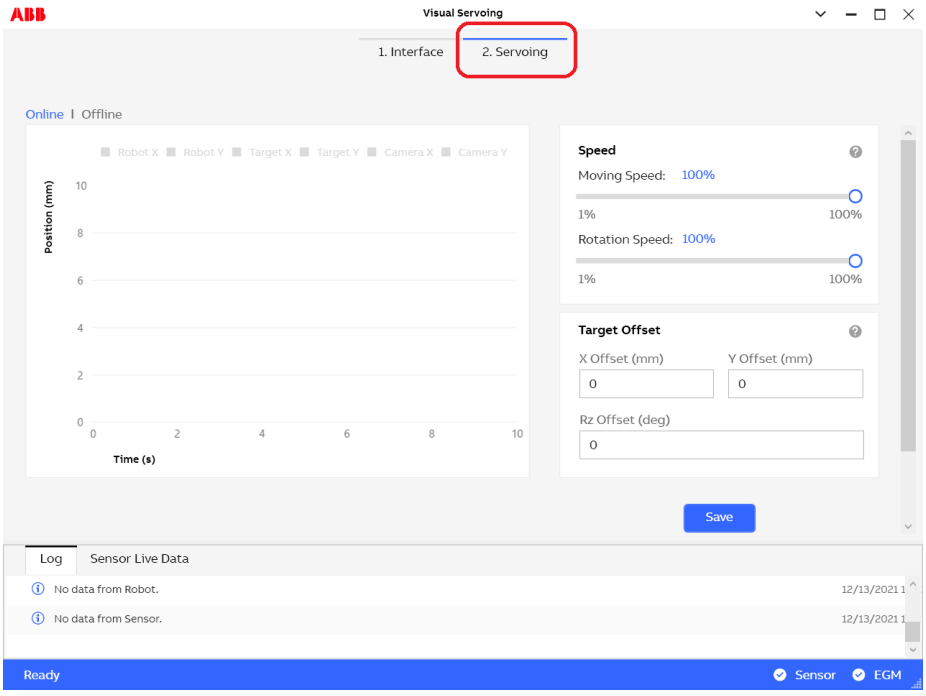
Procedure

Tip

Stop the robot using the FlexPendant before calibration. Otherwise the parameter cannot be edited.

Connect first and then open the vision software.

1 Click the **2.Servoing** tab page.



xx2100002119

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2 Input the value of **X Offset (mm)** on the right pane to set the offset on X axis in the robot coordinate system.

> **Tip**
>
> The valid value for **X Offset (mm)** is -998.9 to 998.9.

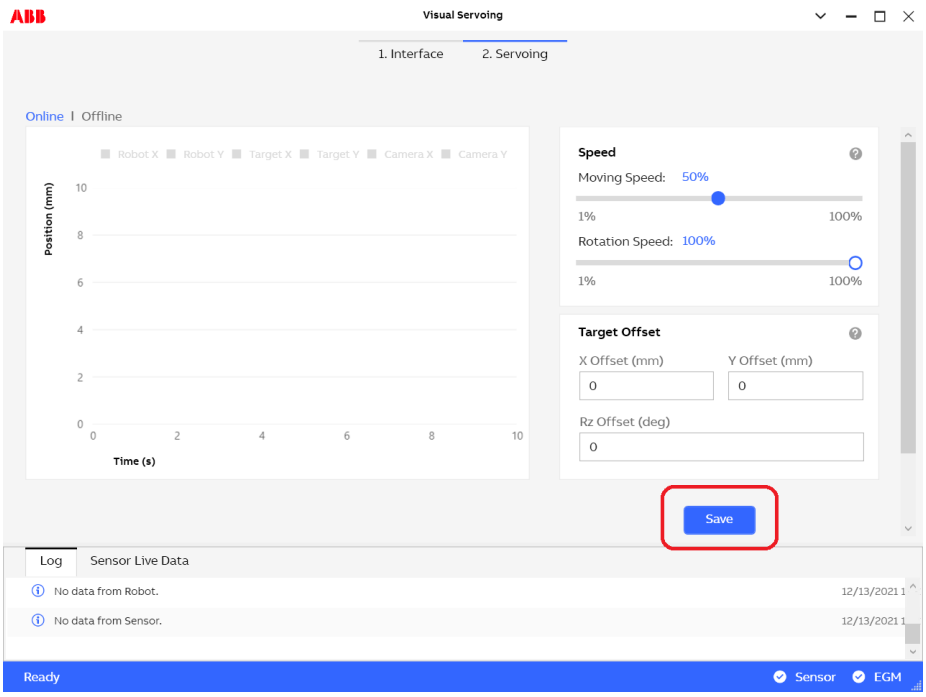
3 Input the value of **Y Offset (mm)** on the right pane to set the offset on Y axis in the robot coordinate system.

> **Tip**
>
> The valid value for **Y Offset (mm)** is -998.9 to 998.9.

4 Input the value of **Rz Offset (deg)** on the right pane to set the rotation offset on Z axis in the robot coordinate system.

> **Tip**
>
> The valid value for **Rz Offset (deg)** is -44.99999 to 44.99999.

5 Click **Save**.



xx2100002122

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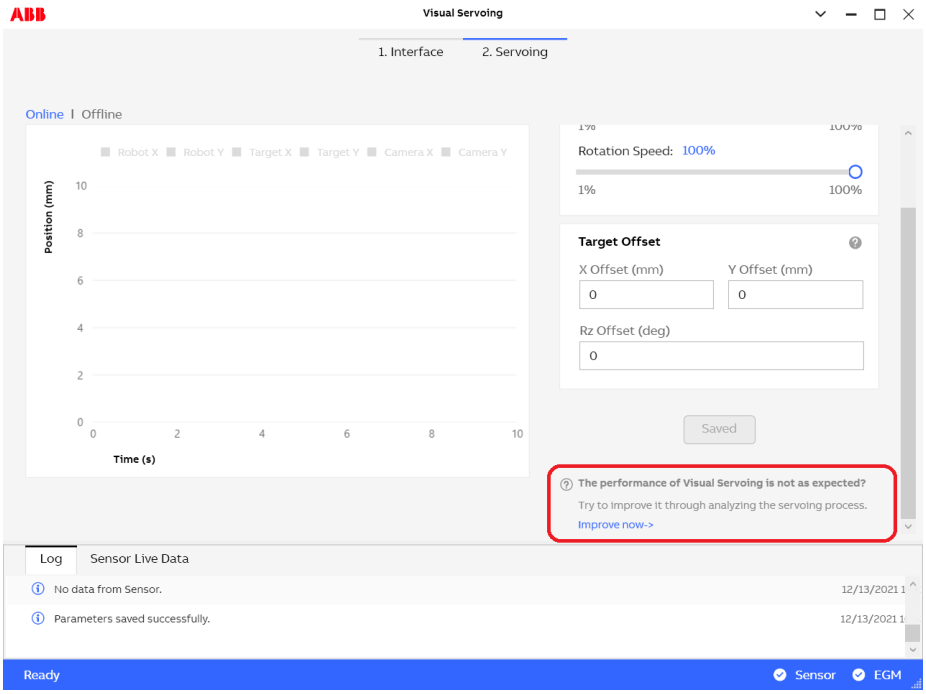
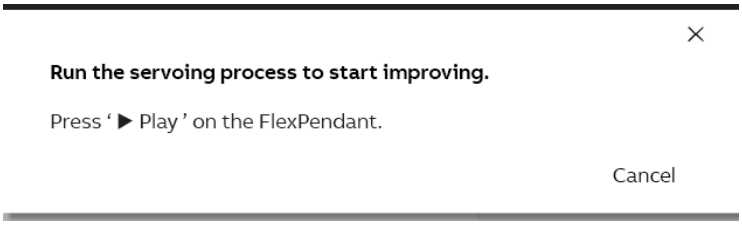
6 Click **Improve now->**.



xx2100002123

The following dialog will pop up.



xx2100002124

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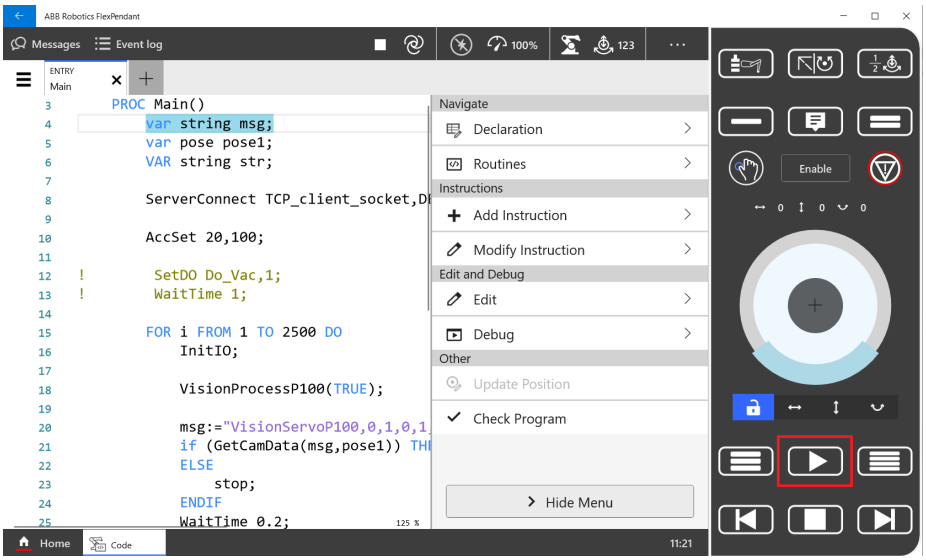
7 Press **Play** on the FlexPendant to start the robot.

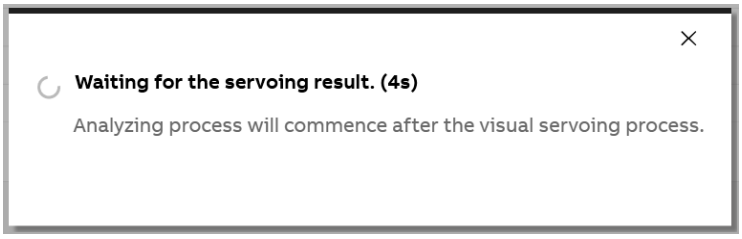


xx2100002303

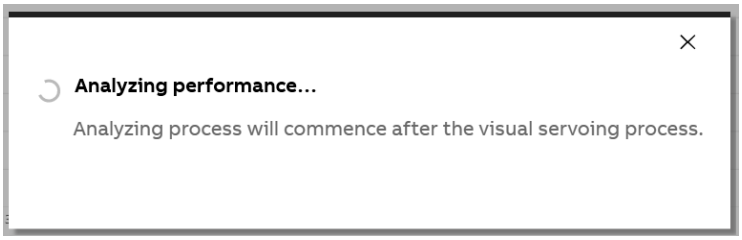
During this process, the following dialog will pop up.

Note

If the following dialog box keep waiting, it means that the servoing result data has not been obtained yet.



xx2100002506



xx2100002304

8 Click **Done**.

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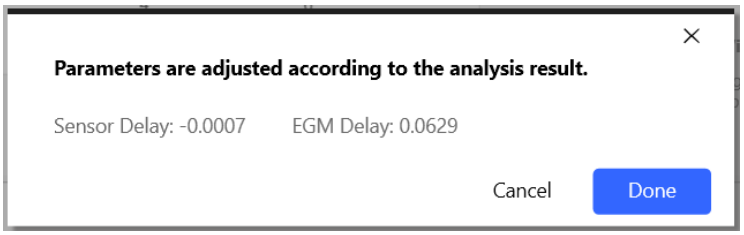
The tuning process is done.



xx2100002305

6.3 Tuning Externally Guided Motion (EGM)

Tuning Externally Guided Motion

For high accuracy alignment applications, the TuneServo instruction can be used to improve the performance when robot executes short movement. Typical program of using the TuneServo command before starting the servoing is:

```
TuneServo ROB_1,2,130\Type:=TUNE_KV;
TuneServo ROB_1,2,80\Type:=TUNE_TI;
TuneServo ROB_1,3,130\Type:=TUNE_KV;
TuneServo ROB_1,3,80\Type:=TUNE_TI;
TuneServo ROB_1,6,130\Type:=TUNE_KV;
TuneServo ROB_1,6,80\Type:=TUNE_TI;
```

And reset the servo parameter after the seroving:

```
TuneServo ROB_1,2,100\Type:=TUNE_KV;
TuneServo ROB_1,2,100\Type:=TUNE_TI;
TuneServo ROB_1,3,100\Type:=TUNE_KV;
TuneServo ROB_1,3,100\Type:=TUNE_TI;
TuneServo ROB_1,6,100\Type:=TUNE_KV;
TuneServo ROB_1,6,100\Type:=TUNE_TI;
```

These parameters can be used for changing the behavior of the joint motor servo controller. TUNE_KV affects the equivalent gain of the speed controller, and TUNE_TI affects the integral action of the controller.

Note

Increasing the tune value for TUNE_KV increases the servo stiffness of the robot. This can be useful in contact applications since the total stiffness of the robot system depends on both the servo stiffness and the mechanical stiffness.

An increased tune value for TUNE_KV also reduces the path errors at low speed. A tune value which is too high causes motor vibrations and must be avoided.

Always be careful and be observant for increased motor noise level when adjusting TUNE_KV. Do not use higher tune values than needed for fulfilling the application requirement. Too high tune value can also increase vibrations due to mechanical resonances.

Note

A decreased tune value for TUNE_TI increases the servo stiffness and reduces low speed path errors in the low frequency region. Too low tune value for TUNE_TI can also increase vibrations due to mechanical resonances.

7 Working with servoing process

Tip

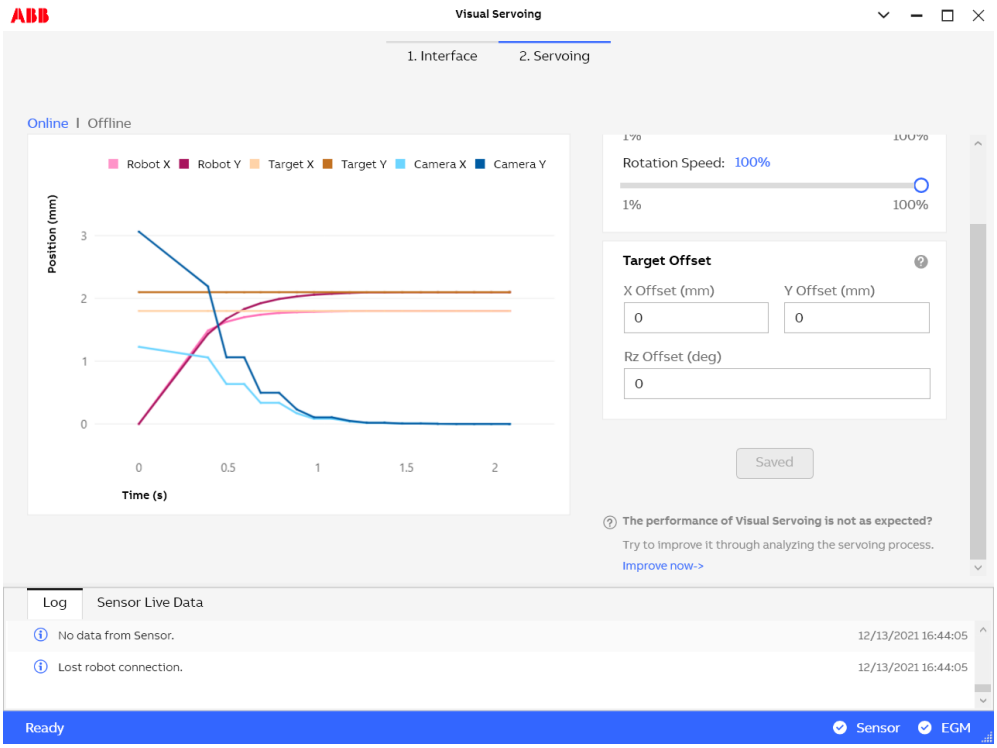
The robot speed will influence the servoing time for each cycle.

If the robot speed is set as very slow, the servoing time for the cycle will be longer.

Overview

Users can read the automatically generated diagram and check the workpiece deviations in their application.

The following figure shows an example view of the servoing process.



xx2100002125

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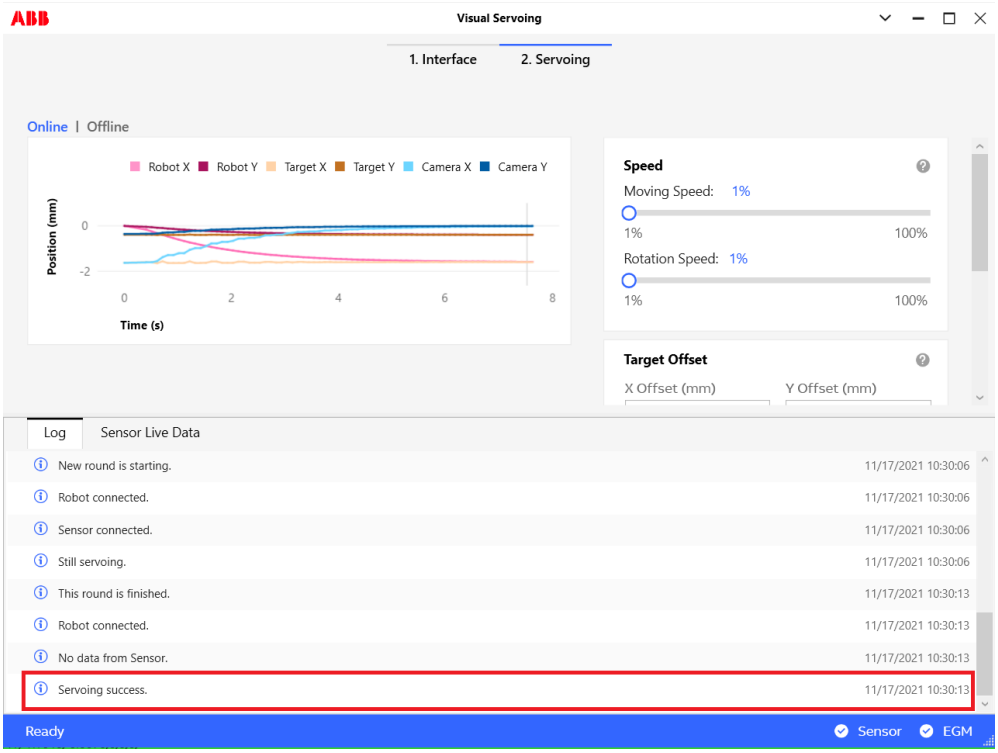
Servoing successful

If the servoing is successful, the following messages and diagrams will show up.



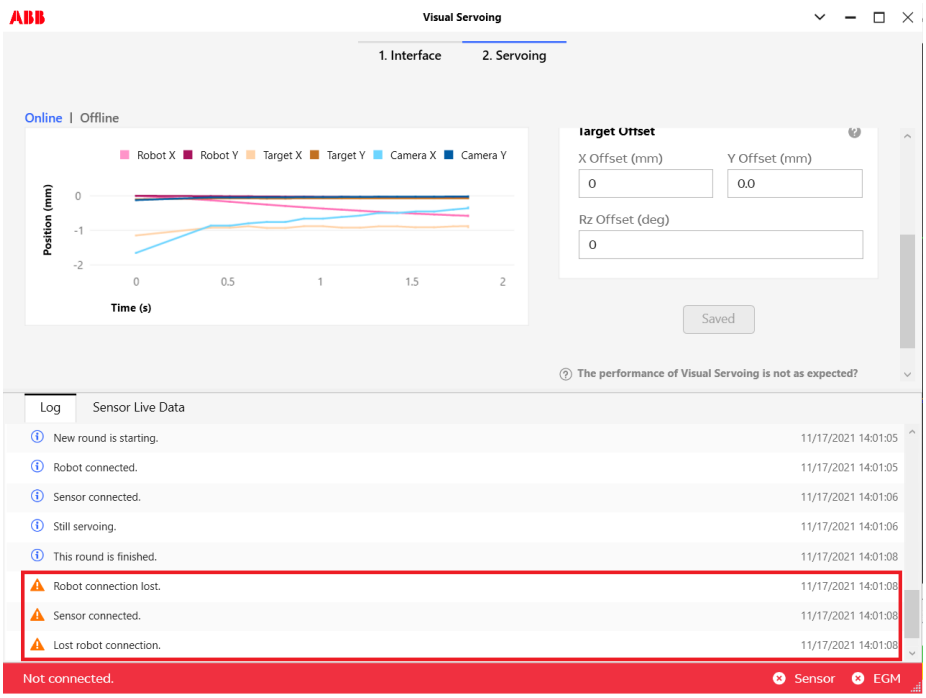
xx2100002551

Continues on next page

Servoing failed

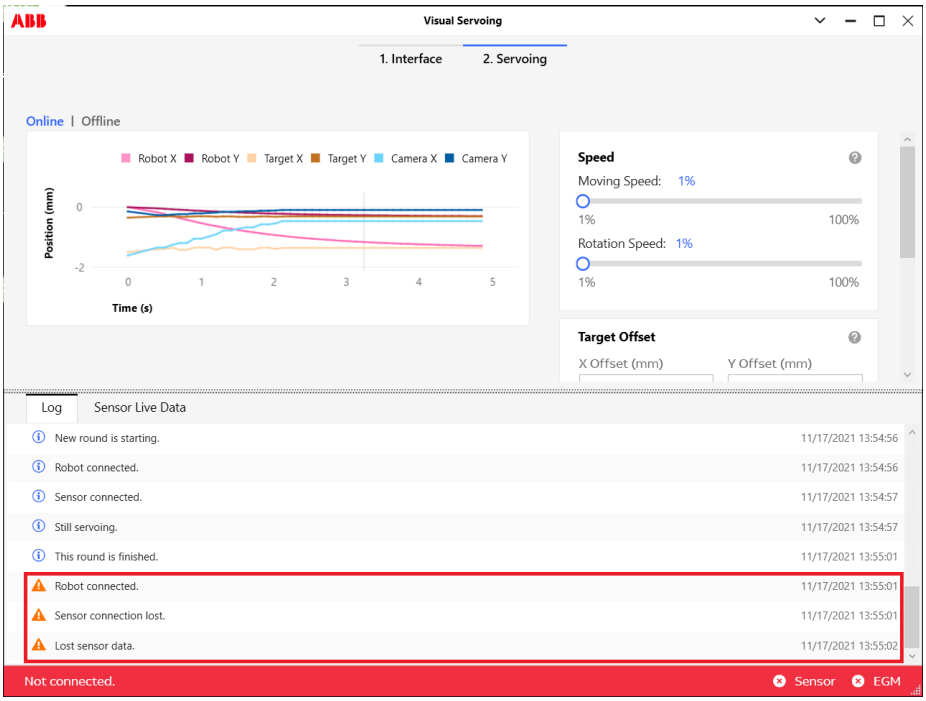
If the servoing is failed, one of the following messages and diagrams will show up.

- EGM lost connection



xx2100002552

- Sensor lost connection



xx2100002553

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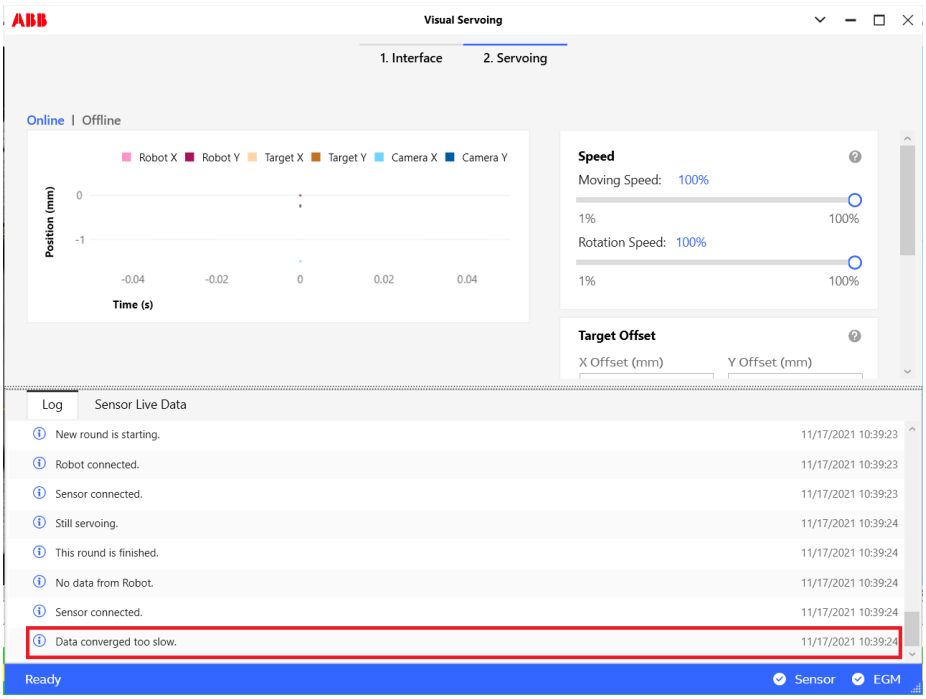
Continued

- Converge too slow



xx2100002554

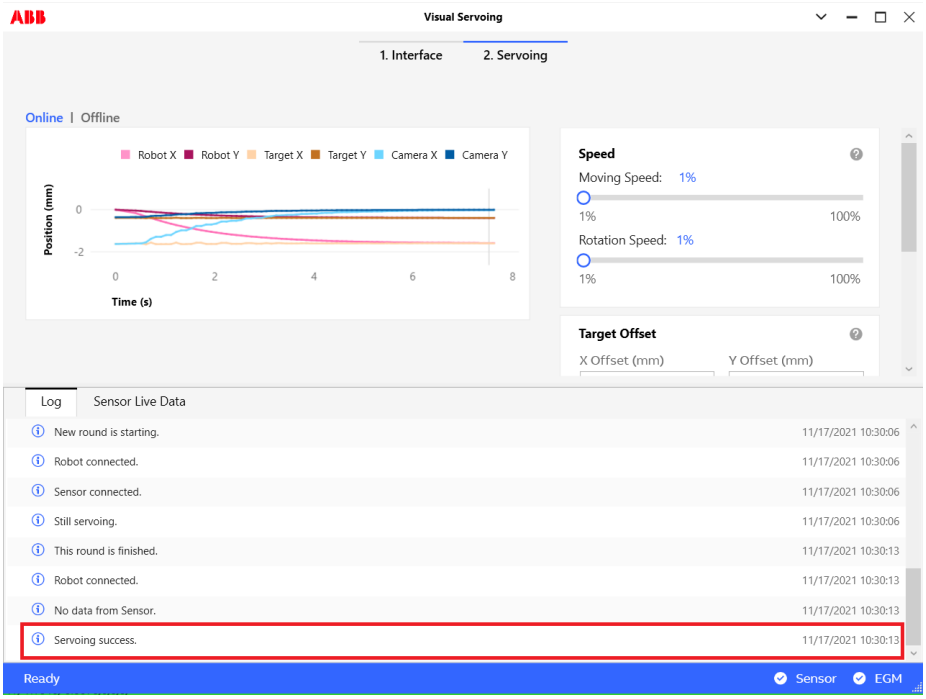
Servoing online

Connect first and then open the vision software.

1. Open Visual Servoing.
2. Click **Connect** on **1.Interface** tab page.
3. Click to choose the **2.Servoing** tab page.
4. The default mode is **Online** mode.
5. Open the image processing tool.
6. When the data from the image processing tool starts the transmission, the diagram will generated automatically in the **Online** area.

Continues on next page

7 When the cycle is finished, this message shows up in the **Log** view.



xx2100002551

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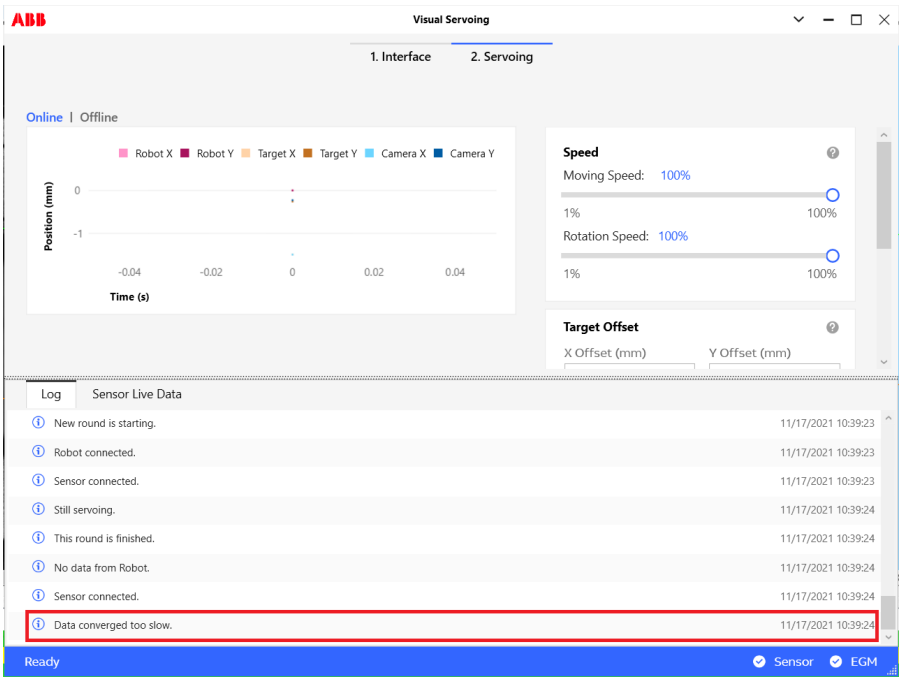
Tip

The Timeout time for converging the data from image processing tool is 10 seconds.

Once the Timeout time is up and the data cannot meet the accuracy requirements which is defined by the customer in the vision software, the following error will pop up.



xx2100002554

Servoing offline

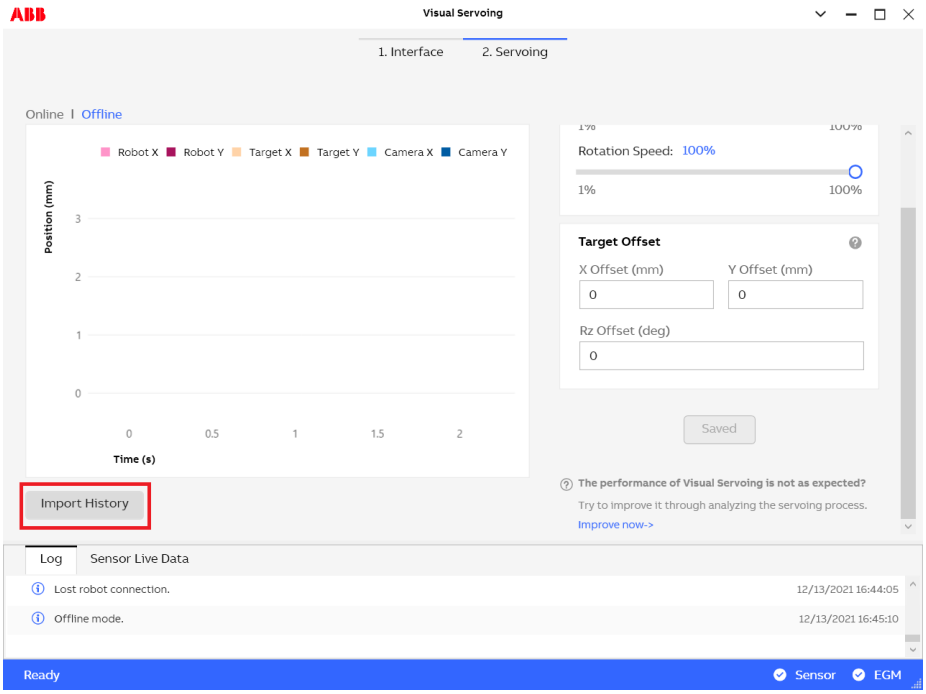
Importing one piece of data

Connect first and then open the vision software.

1. Open Visual Servoing.
2. Click **Connect** on **1.Interface** tab page.
3. Click to choose the **2.Servoing** tab page.
4. Click to choose the **Offline** mode

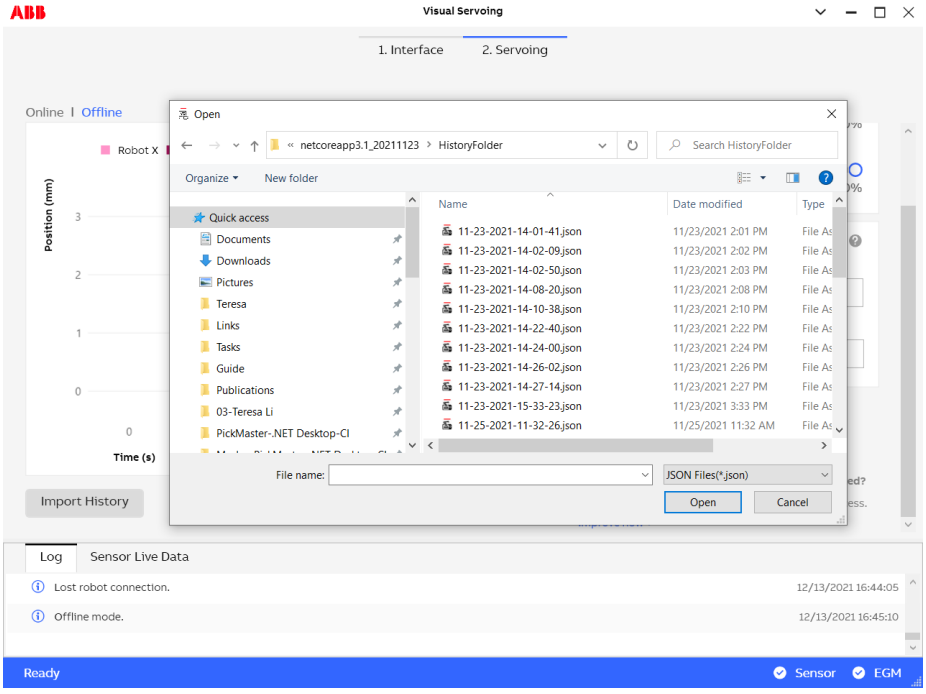
Continues on next page

5 Click the **Import History** button to import the desired offline data.



xx2100002306

6 Choose the desired `.json` file and click **Open**.



xx2100002307

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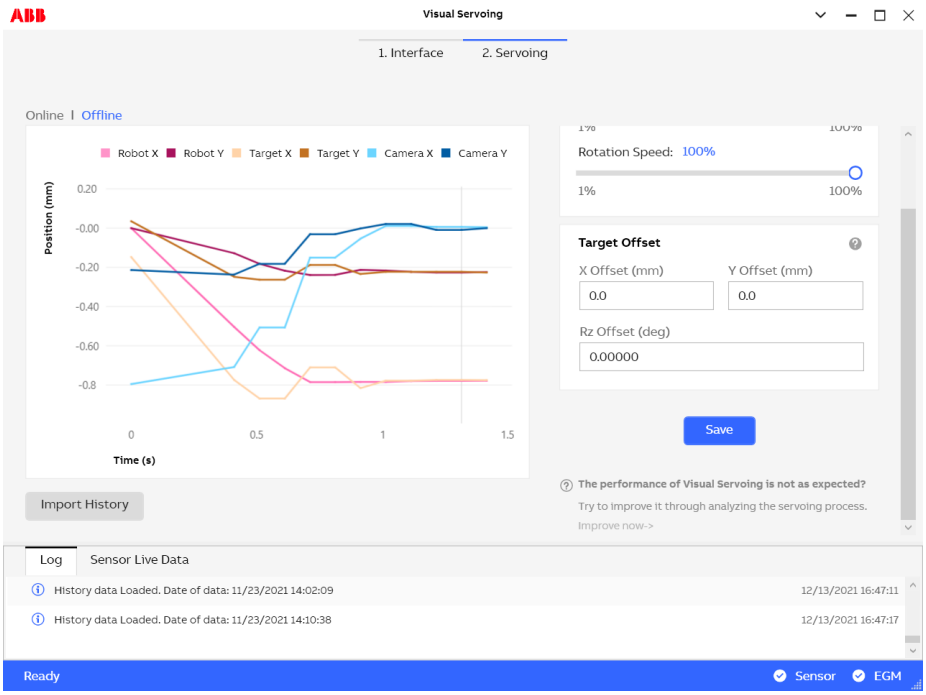
Continued

7 When the data is imported, the diagram will generated automatically in the **Offline** area.



xx2100002308

Importing 2-100 pieces of data

Note

If there are more than 100 pieces of data selected:

1 The first 100 pieces of data selected will be displayed.

2 If the user select all data in the historical folder, the first 100 pieces of data sorted by the current sort method will be displayed.

Connect first and then open the vision software.

1 Open Visual Servoing.

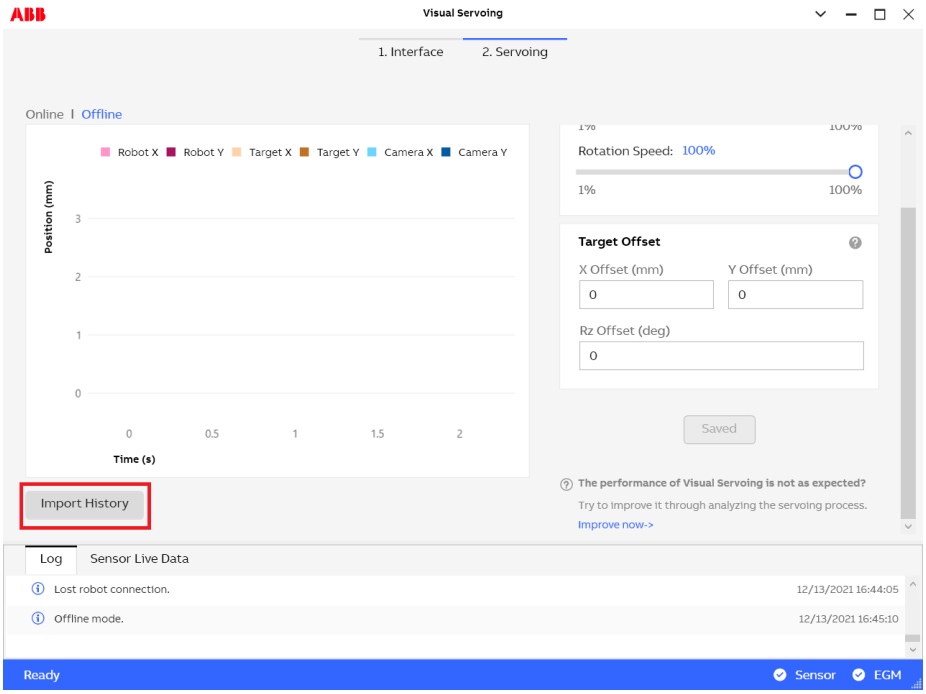
2 Click **Connect** on **1.Interface** tab page.

3 Click to choose the **2.Servoing** tab page.

4 Click to choose the **Offline** mode

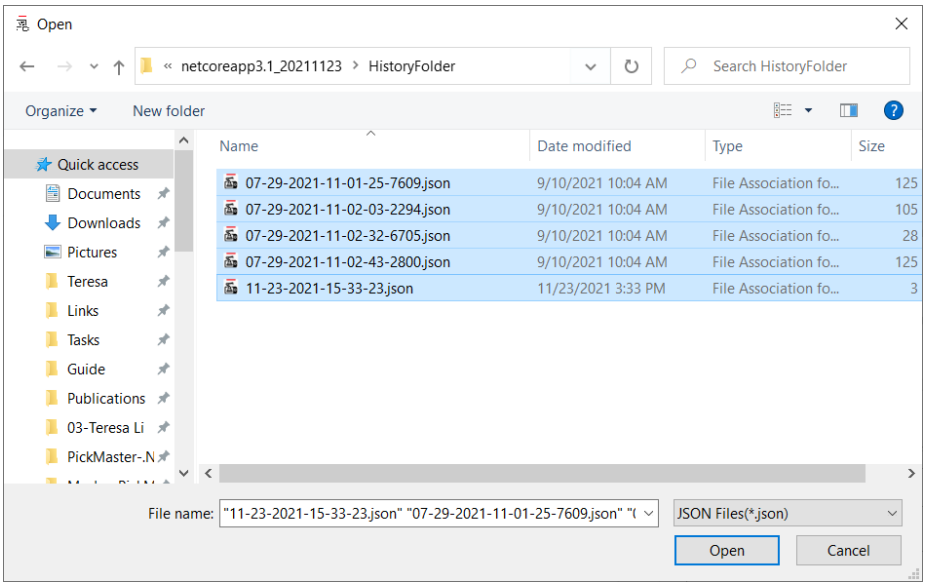
Continues on next page

5 Click the **Import History** button to import the desired offline data.



xx2100002306

6 Choose the desired `.json` files and click **Open**.



xx2100002641

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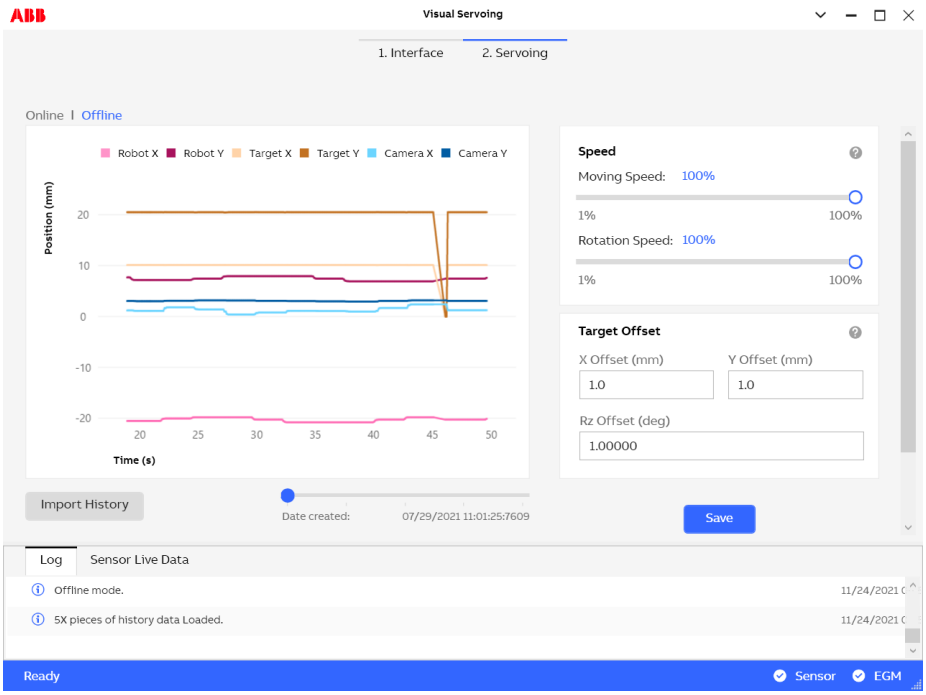
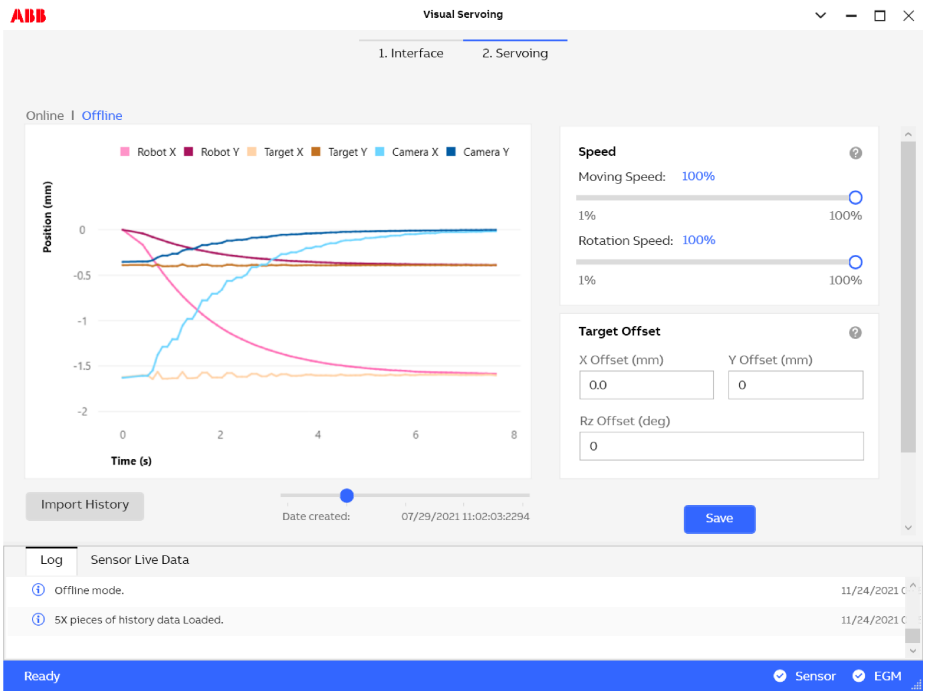
Continued

7 When the data is imported, the diagram will generated automatically in the **Offline** area.



xx2100002642

8 Drag the ball on the slider bar to select the desired file.



xx2100002643

8 Troubleshooting

8.1 Fail to enter Visual Servoing

First-time run

If it is the first time you install the Visual Servoing, make sure all of the following actions are done.

- The Visual Servoing program is run as the administrator.
- The license is purchased in RobotWare.
- All relevant software is installed to the IPC.
- The IPC is connected to a real controller cabinet.

Changing an IPC

If you have the IPC changed, download and install the Visual Servoing to the new IPC. After installation, run the Visual Servoing program as the administrator.

In this case, you also need to check the license is valid when opening the Visual Servoing for the first time on the new IPC.

8.2 Fail to set up communication with the robot

Description

If Visual Servoing fails to communicate with the robot, for more details on how to configure the signals, see *Preparing EGM on page 38*.

8.3 Error logs

150000, Please first stop the robot.

Description

Configurations (including calibration and tunning) cannot be changed while robot is still moving.

Recommended actions

Stop the robot, and then retry.

150010, Error loading xml.

Description

cannot find the xml file or the file is corrupted.

Recommended actions

check whether the path of file is correct and the file is valid. (do not edit the xml file by your own)

150020, Port Out of Range sensor node error.

Description

Sensor's port is out of range. (1~65535)

Recommended actions

Fill in the correct number!

150030, Timeout Out of Range sensor node error.

Description

Sensor's timeout setting is out of range. (0.6~5)(unit s)

Recommended actions

Set the timeout value within the range.

150040, sensor socket error sensor node error.

Description

Cannot open the socket for sensor.

Recommended actions

The socket is occupied. Check whether there might be other applications using this socket and close them. Or try another port or IP.

150050, Port Out of Range robot node error.

Description

Robot's port is out of range. (1~65535)

Recommended actions

Fill in the correct number!

150060, Timeout Out of Range robot node error.

Description

Robot's timeout setting is out of range. (0.01~1)(unit s)

Recommended actions

Set the timeout value within the range.

150070, robot socket error robot node error.

Description

Cannot open the socket for robot.

Recommended actions

The socket is occupied. Check whether there might be other applications using this socket and close them. Or try another port or IP.

150080, loading data error for sensor tunning.

Description

collected data is not valid for analysis of sensor tunning.

Recommended actions

Retry the tunning process again. make sure that the setup is correct.

150090, need more data of sensor tunning.

Description

collected data is not enough for analysis of sensor tunning.

Recommended actions

collect more data. (e.g. let sensor stop sending data only after robot finishes its entire motion)

150100, data analysis error for sensor tunning (maybe wrong frame setting).

Description

the analysis result is not reasonable. probably caused by wrong parameters.

Recommended actions

Try Calibration in advance.

150110, loading data error for robot tunning.

Description

collected data is not valid for analysis of robot tunning.

Continues on next page

Recommended actions

Retry the tunning process again. make sure that the setup is correct.

150120, need more data of robot tunning.

Description

collected data is not enough for analysis of robot tunning.

Recommended actions

collect more data (e.g. let the robot finish its motion, and then start analyzing).

150130, data analysis error for robot tunning (maybe wrong frame setting).

Description

the analysis result is not reasonable. probably caused by wrong parameters.

Recommended actions

Check the tool setting in RAPID.

150140, loading data error for calibration.

Description

collected data is not valid for analysis of calibration.

Recommended actions

Retry the calibration process again. make sure that the setup is correct and robot's motion has finished.

150150, need more data of calibration.

Description

collected data is not enough for analysis of calibration.

Recommended actions

collect more data (e.g. let the robot finish its motion, and then start analyzing).

150160, data analysis error for calibration.

Description

the analysis result is not reasonable. probably caused by wrong parameters.

Recommended actions

make sure that the correct configuration file (.xml) is used.

150170, target offset (translation) too large. (-999 ~ 999)(unit mm)

Description

Values for target offsets are out of range.

Recommended actions

Fill in the correct number!

150180, target offset (rotation) too large. (-45 ~ 45)(unit deg)

Description

Values for target offsets are out of range.

Recommended actions

Fill in the correct number!

Note

If there is any symptoms besides the existing error logs, restart the whole system first.

9 Specification of variants and options

9.1 Introduction to variants and options

General

The different variants and options for the Visual Servoing are described in the following sections. The same option numbers are used here as in the specification form.

9.2 Visual Servoing License

IRC5

Option	Description
1586-1	Prep. Visual Servoing Requires: 616-1 PC interface 689-1 EGM

OmniCore

Option	Description
3135-1	Prep. Visual Servoing Requires: 3124-1 EGM

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