



Instruction manual

**For PhoXi 3D Scanner and PhoXi Control Application
(Firmware version 1.1.12)**

Thank you for purchasing Photoneo PhoXi 3D Scanner!

The Photoneo PhoXi 3D Scanner is a compact yet powerful 3D scanner with unbeatable performance in the terms of precision, noise and overall efficiency. It can be used for scanning a wide variety of subjects in various configurations, making it an universal tool for all kind of industrial applications. The scanner is controlled by a supplied software - PhoXi Control Application - that provides both a GUI and an API.

The contents in this manual are based on firmware version 1.1.4 for this scanner. Visit the Photoneo website for the latest information.

Please read this instruction manual before use.

Safety instructions

Photoneo PhoXi 3D Scanner is a Class 3R laser product. Do not deliberately look or stare into the laser beam. Laser protective eyewear is normally not necessary, but recommended. Handle the product carefully and follow all necessary safety instructions.



This device contains laser. Please follow the necessary safety instructions.



Warning: This device is Laser class 3R product. Do not look into direct laser light! Use of protective eye glasses is recommended.



The laser projector aperture is located at the right side of the front panel of the device, as shown on the picture. The aperture is clearly marked by a warning label. Do not look into laser projector unit while the device is in use.



Wavelength: 639nm
Peak / CW Power: 314uW
Pulse Energy: 382nJ
Pulse Length: 960us

IEC / EN 60825-1 (2014)

Information according to IEC / EN 60825-1 (2014):

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Do not remove the labels affixed to the product. Do not open or disassemble the product. Always follow the instructions in this user guide. **Caution - Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.**

Assembly and installation

- Mount the scanner to the desired position
- Connect the scanner to the computer or local network via ethernet cable
- Plug the scanner into the power outlet (AC adapter is included in the shipment)
- Download PhoXi Control Application from the Photoneo website <https://www.photoneo.com/download/> and install it
- Run the PhoXi Control Application and try to make your first scan
 - after the start, the application list all scanners found in the network
 - doubleclick on the scanner to establish a connection, new window is open
 - click the button **SoftTrig** to make the first scan
- Please read this manual for further information and tips how to achieve best quality scans.

Contact

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Technical support

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PhoXi Control Application

Introduction

PhoXi Control Application enables user to control PhoXi 3D Scanner manually through GUI or programmatically through provided API.

All communication between the control application and the scanner is carried out over the Ethernet. One application can establish connections to multiple scanners at once, but one scanner can have only one active connection with the control application at a time.

The main use of the GUI is in setting up the scanning environment, configuring the advanced scanner parameters and testing out the output. Furthermore, the GUI can be used as a powerful debugging tool for developing with the API, because calls to the API trigger the same response in the GUI as the user input. After triggering the scan by calling the API method, the application will execute the scan, send it as the output of the call and displays it simultaneously in the GUI.

The API was designed to be a central platform for building custom industry applications for PhoXi 3D Scanners. To facilitate the development process and reduce computing resources, all the computations are performed on the device.

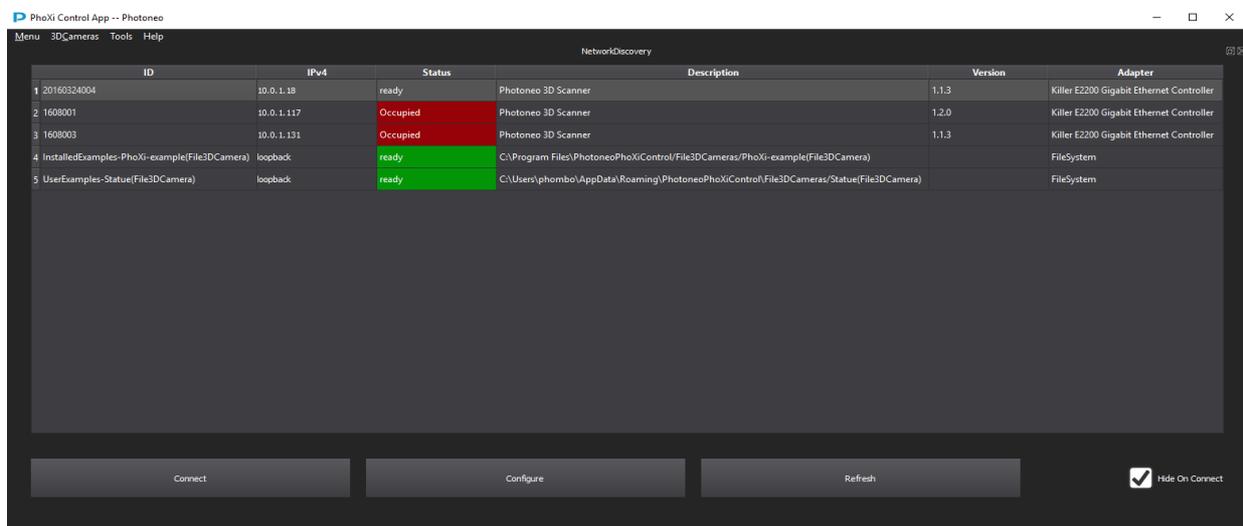
Graphical User Interface

Overview

The main window of the application is called [Network Discovery](#) and displays the list of all PhoXi 3D scanners available on the network. After choosing the scanner to work with, new [Scanner window](#) is open for that particular scanner. Windows can be organised by dragging the title of the window like in standard windows applications.

In Windows OS, the application minimizes to system tray. To close the application, use the Menu or right click on the tray icon and choose turning off the application.

Network Discovery window



Listing scanners

Network Discovery window list all available scanners on the network. After the application starts, please wait a moment until all scanners are found.

In the case your scanner is not listed, please make sure that your scanner is turned on and connected to the network. Then click Refresh button and wait for the scanner to appear in the list.

Connecting to the scanner

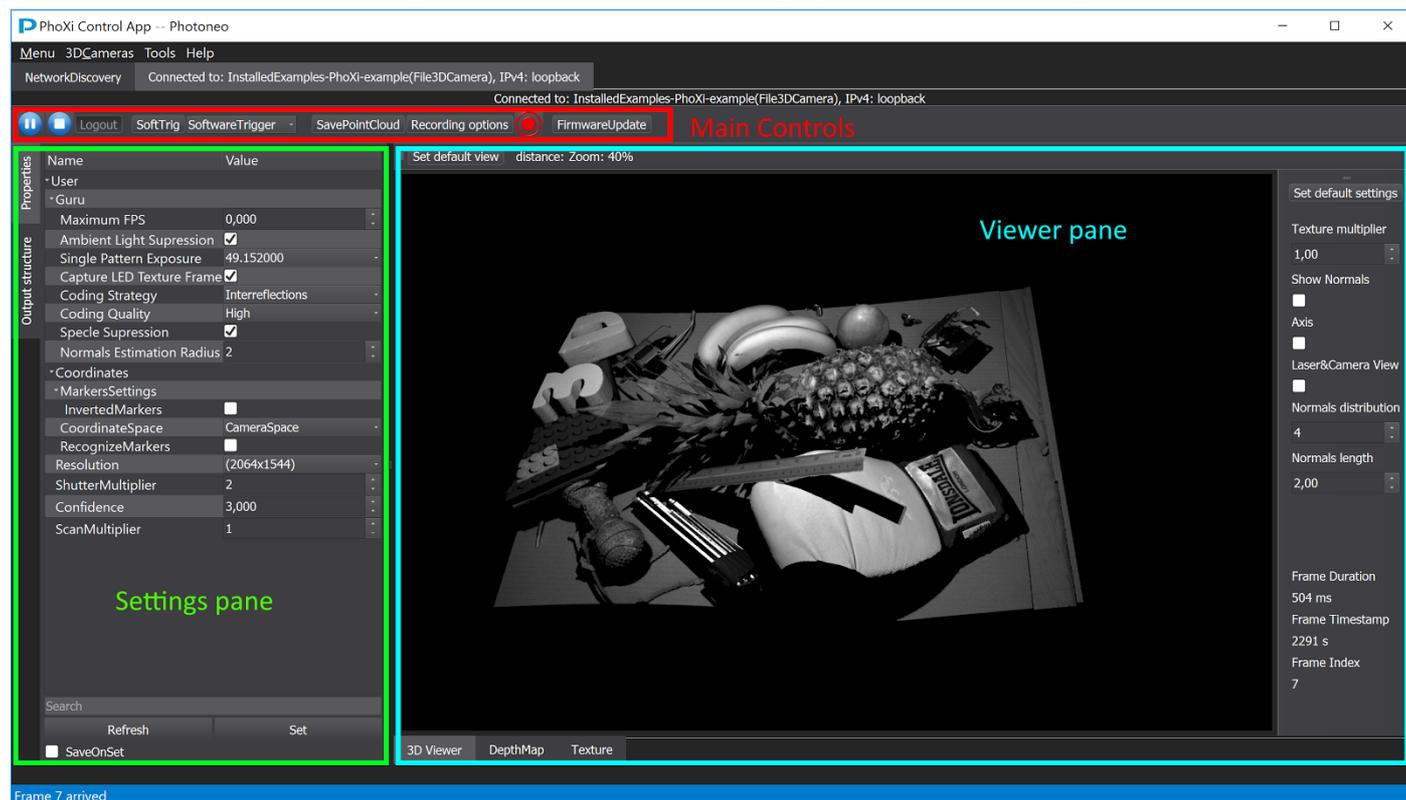
To start controlling the scanner, double click on the scanner in the list or select the scanner and click Connect. Application will connect to the scanner and open Scanner window. For the other users on the network, the status of the scanner will change from Ready to Occupied. Therefore when you share the scanner with multiple users, make sure you disconnect from the scanner when not in use.

Configuring the scanner network settings

To switch between static and dynamic IP of the scanner in the network, select the scanner in the list and click the button **Configure**. Use the DHCP for dynamic IP allocation or Static IP for manual configuration.

Scanner window

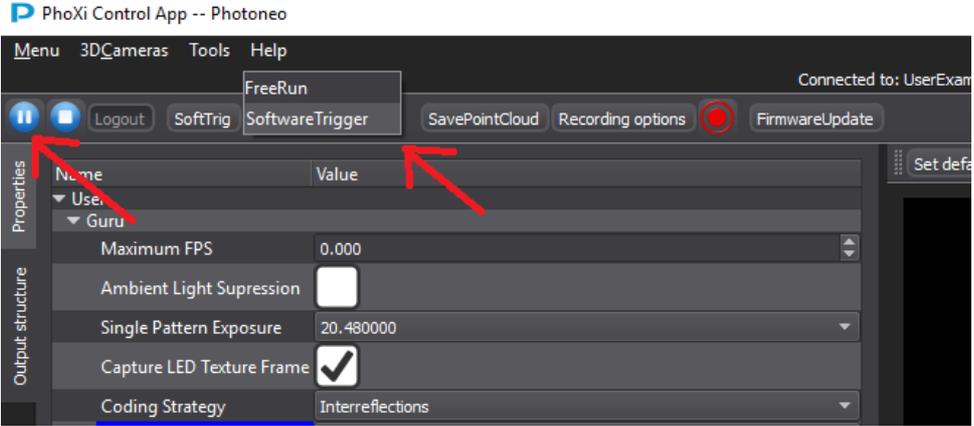
Scanner window consists of 3 parts: Main Controls, Settings pane and a Viewer pane.



*TIP: After the window opens, hit F5 or button **SoftTrig** to trigger the scan.*

Main Controls

Control	Explanation
Pause	Pauses the acquisition mode (useful in FreeRun mode)
Stop	Safely stops the acquisition mode before disconnection

Logout	Disconnect from the scanner
SoftTrig	Trigger new scan and display the pointcloud
Mode <ul style="list-style-type: none"> - SoftwareTrigger - FreeRun 	Software trigger - single scan is triggered manually FreeRun - the device is scanning consecutively until you press pause or stop button 
SavePointCloud	Saves current point cloud to the file. Supported formats: <ul style="list-style-type: none"> - Stanford's PLY - Leica's PTS - Photoneo RAW data format (*.praw) - Expanded Photoneo RAW data format (*.prawf) - Raw images in tif Use "RecordingOptions" to define which data you want to save.
TestSpeed	Tests the speed of the connection to the device
RecordingOptions	Use "Options" button next to the file format to set which data will be stored when saving the point cloud in this file format. This settings are applied when saving the data by "SavePointCloud" button and also in recording mode. When checkbox on the left (next to the name of file format) is checked, then the point cloud is stored in this file format in recording mode. You can check multiple file formats.
Record	Starts recording mode. Every captured point cloud is saved in the directory and file formats specified in "RecordingOptions".
FirmwareUpdate	Starts the process of updating the firmware on the device.

Settings pane

This pane displays settings that are stored locally in the scanner and are used to configure the scanning and output process.

Controls

- Button **Set** - sets the properties of the scanning process. When the checkbox **SaveOnSet** is checked, the settings are written to the scanner memory. Otherwise the settings will be used only for the current session and remain until the scanner is disconnected.
- Button **Refresh** - retrieves actual settings from the scanner memory.

Settings are divided into two groups:

- **Properties** - settings that affect the scanning process
- **Output structure** - settings that affect which output properties of the computation are retrieved with the scan

Properties settings

Setting	Explanation
ShutterMultiplier	controls the shutter of the camera in multiplies of the base scan time (integer value 1-8)
Confidence	controls the amount of output points based on point reliability. This enables the user to set preference based on the application. Some applications require a more complete output at the expense of lower precision. Other applications are meant to work with precise data only and need to filter out regions where the precision does not meet certain threshold
ScanMultiplier	The device will perform multiple scans and aggregate the result to achieve a better precision and a more complete coverage.
Coordinates	you can change Coordinate space (markers space, camera space,...)

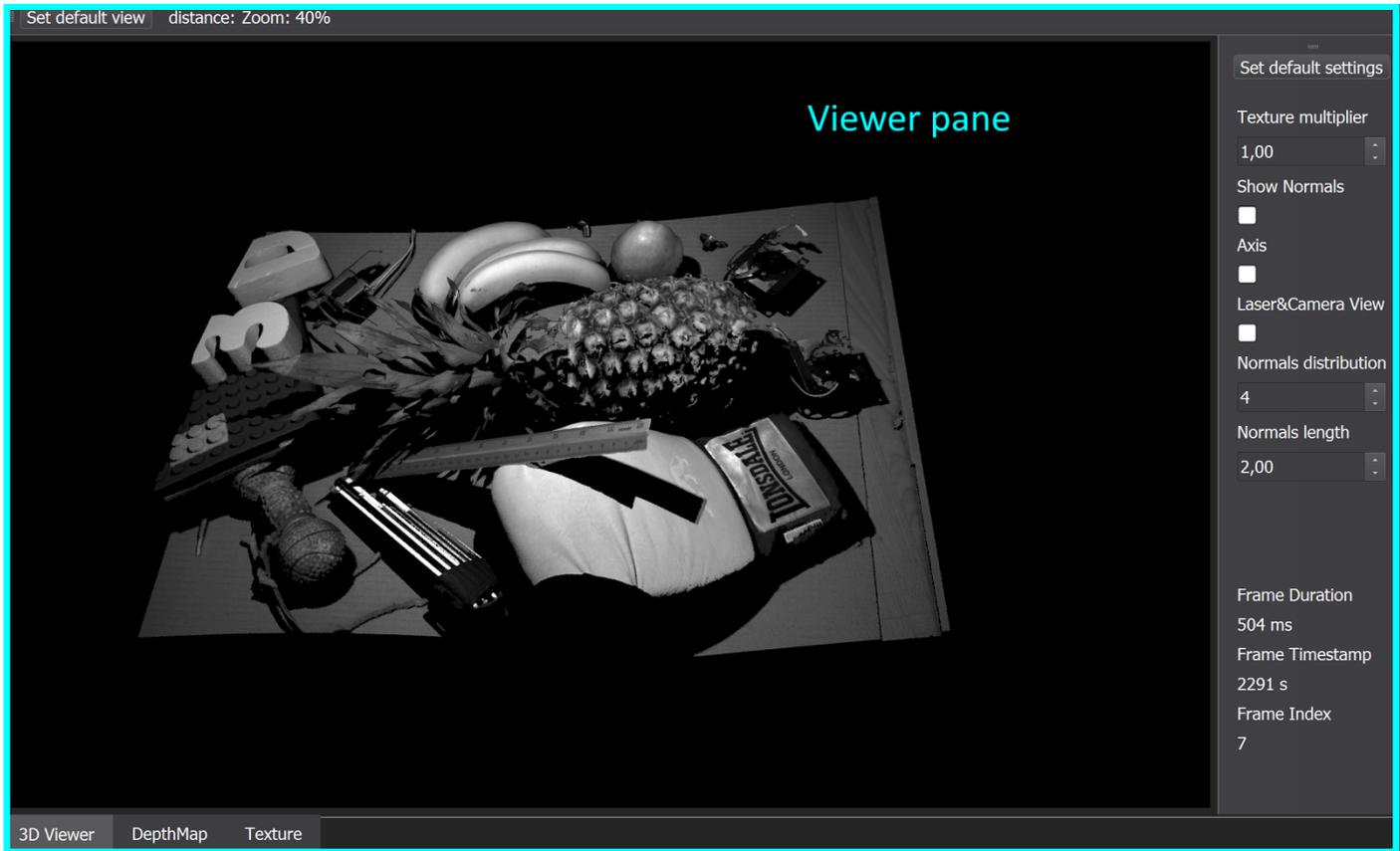
The screenshot shows the PhoXi Control App interface. The 'Output structure' section is visible on the left, with a red arrow pointing to it. The 'Coordinates' section is expanded, showing 'CoordinateSpace' set to 'CameraSpace' and 'RecognizeMarkers' as an unchecked checkbox. Another red arrow points to the 'RecognizeMarkers' checkbox. The 'SaveOnSet' checkbox is also visible at the bottom of the interface.

Output structure

Use the checkboxes to select which kind of data will be retrieved from the scanner. You can speed up the retrieval time by selecting only the data needed for your application.

Viewer pane

This pane displays the output from the scanner. After the start of the application, hit F5 or the button **SoftTrig** in main controls to trigger the scan. The output is provided in different formats that can be switched by the tabs at the bottom. Each view has its own settings on the right.



Tab 3D Viewer

Use this tab to get general overview about the scanned scene. It shows the output in a point cloud with grayscaled texture.

Settings

Show Normals	Renders normal vectors of planes given by central point and neighbouring points. The number of neighbouring points in is given by Normals distribution setting.
Normals distribution	Determine how many points will be used to compute normal vectors in central points. Distribution 1 means every point has own normal vector.
Normals length	The size of rendered normals.
Axis	Renders axis of the coordinate system.
Laser&Camera View	Renders the position and field of view of camera and laser
Texture Multiplier	Multiplies the point color intensity by given number.

Controls

Left mouse button drag	Rotate the point cloud around the selected point of focus. By default, selected point of focus is the camera position
Mouse wheel <i>or</i> vertical right mouse button drag	Zoom in/out
Mouse wheel drag <i>or</i> Hold SHIFT + left mouse drag	Move the point cloud
Hold CTRL + left mouse drag	Tilt the point cloud
F	Set the point of focus to the point under the mouse cursor. This is the point the scene is rotated around.
R	Changes the view so that the cloud point is visible.
+	Increase the size of point
-	Decrease the size of point

Tab Confidence Map

This tab displays the expected deviation of the measured distance. This means, the darker parts are scanned with lower error. The light areas indicate where the error might be higher. These areas might indicate problematic parts of the scene.

Tab Depth Map

This view shows the scene as a grayscale image, where the color intensity of every pixel represents the distance of the measured point from the camera. The depth value of the pixel under the cursor is shown in the bottom of the window. To improve the visual readability of the image, adjust the settings on the right side of the window as explained below. This view can be used also for measuring the distance from one pixel to the other by drawing a line between them with the right mouse button.

Settings

Min value	Minimal depth of the point. Points with lower depth are depicted black.
Max value	Maximal depth of the point. Points with higher depth are depicted white.
Multiplier	The depth value of the point is multiplied with this constant.

The default setting for Min and Max value is 0 - 255 (the standard range for color intensity). However, many points may be much further than 255 mm, making the image look mostly white. In this case you may want to increase the Max value above the depth value of the furthest point.

Controls

Left mouse button drag	Move the scene
Mouse wheel	Zoom in/out
Right mouse button drag	Draw a line and compute distance. The distance is shown on the

	top of the viewer pane.
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Tab Texture

Shows the same view as the Depth Map tab, but with the applied grayscale texture.

API

Introduction

The PhoXi API provides all the building blocks for developing your custom application for PhoXi 3D Scanner. The API is provided directly by PhoXi Control Application, so make sure the application is running before using the API.

This manual will demonstrate how to use the API on two examples. You may start the development based on one of the examples and modify it to suit your specific needs. We will use Microsoft Visual Studio 2013 and [CMake](#) to depict how to run the examples.

The technical documentation is located in the file **API/API_Manual.html** inside the application installation directory. On Windows OS, the path to the API directory is usually "Program Files/PhotoneoPhoXiControl/API".

Getting started example - "Connect and Grab"

This example will test that everything is working correctly and that you are able to use the API. It will also demonstrate that the GUI is a powerful debugging tool as it displays the responses of API calls in real time.

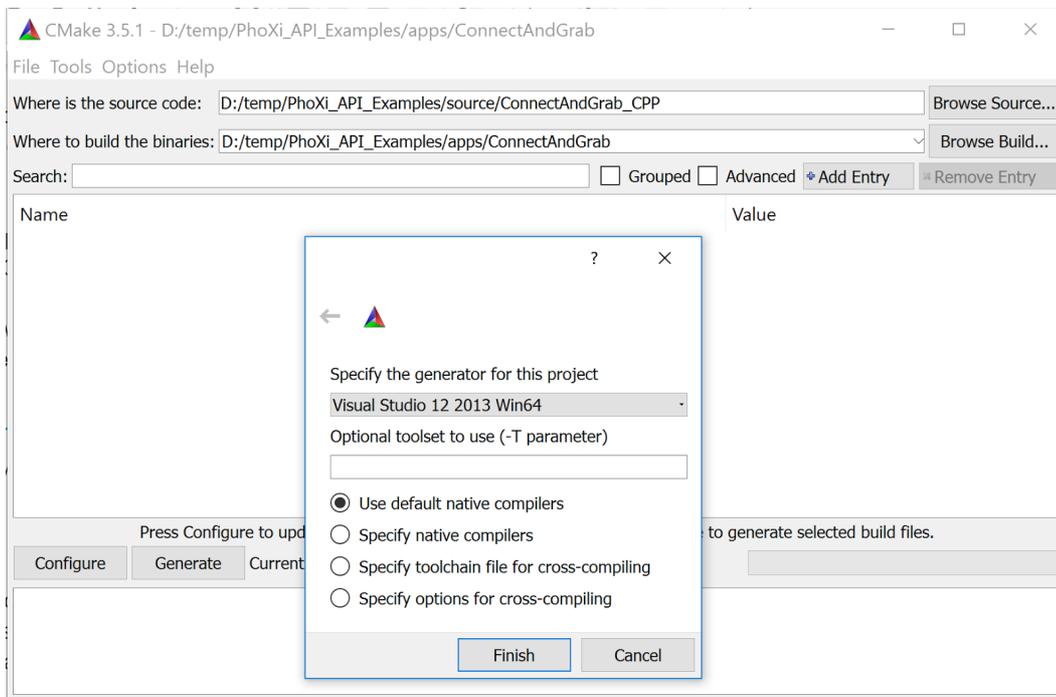
The flow of the program is as follows:

- Firstly, it tests that the PhoXi Control Application is running
- Then it will get the list of all devices available on the network
- If you have already opened some device in PhoXi Control Application, it will connect to that device. Otherwise it will connect to the last scanner in the list.
- It will execute 5 single scans by manual trigger and 5 scans in the free run mode.

For the details, please see the source code and consult the technical documentation. Also note that this example only illustrates the basic usage without any extensive checks for unexpected conditions.

Instructions to run the example

- Copy the content of the directory **API/examples/cpp/ConnectAndGrab_CPP** to your custom directory. (This is only necessary when you want to edit the source code. Originally, the source code is located inside the Program Files directory, so you will need admin rights to change the file.)
- Launch CMake
 - Choose the source and destination directory
 - Click Configure button, specify Visual Studio 2013 as the generator for the project and confirm by Finish button



- Wait while the configuration is done, then click Generate button
- In the destination directory, open the file **ConnectAndGrab.sln**
- Rebuild the solution in Visual Studio (menu > Build > Rebuild Solution).
- Set the project **ConnectAndGrab** as a StartUp Project in the right context menu.
- Make sure that PhoXi Control Application is running
- In Visual Studio, hit F5 to run the example (menu > Debug > Start Debugging)
- While the example is running, switch back to the PhoXi Control Application - every frame that the camera captures is displayed in the Viewer pane.

Full API example

This example illustrates the use of the API in a production environment where every possible error condition should be handled carefully. To run the example, please follow the instructions from the previous example. The source code is located in **API/examples/cpp/FullAPIExample_CPP** .

This example shows how to:

- find available scanners on the network
- connect to the scanner using hardware identification number, index in the list or to the first active device
- get the details about current device state and capabilities
- capture the scene in freerun or manual mode and get the output in all provided formats
- change the scanning settings and specify the desired output formats
- handle and store received data
- correctly disconnect the device

Please consult the source code and technical documentation for more details.

Quick scanning guide

How to configure the scanner to provide the best quality

The quality of the scan depends on multiple factors. The scanner provides a variety of settings to enable an optimal scan; however, even by rearranging the positions of the scene and scanner you can get better results. Always arrange the scene to have the best conditions for scan first and only then manipulate the settings of the scanner.

Distance: Closer objects have a better spatial resolution and generally less noise.

Material albedo (reflectivity): A material with higher albedo provides a better signal-to-noise ratio.

Strong ambient light: Indoor ambient light generally does not influence the scan. However, very strong light such as direct sun might be a problem. This occurs especially when scanning outdoors. Try to remove all sun illumination e.g. by shadowing the window, or by moving into a different place.

Reflections: Generally, non-glossy, matte materials are scanned without problem. Even soft-gloss objects have a nearly optimal scan. However, any specular reflections might influence the scan quality since the projected light is reflected out of the sight of the camera (in which case that part has a poor quality), or when reflected into other parts of the scene, reflected light interferes with scanning (in which case the part illuminated by reflection has artifacts). Especially metal with high-gloss finish (mirror-like) is problematic.

As a rule of thumb: Take a flat piece of the material and try to look at it as it is a mirror. If you are able to recognize a shape of your head as reflected by the material, the material is glossy. Depending on the scene, some parts might be not scanned optimally.

When scanning glossy objects, find a position where light coming from the projection unit does not illuminate other objects on the scene.

To further increase change of optimal scan while scanning glossy materials, use the "AmbienLightSuppresion" setting. Using this setting will increase the scanning time.

Transparent objects: It is not possible to scan transparent materials such as glass, ice or water. Remove such materials from the scene to avoid artifacts. A thin layer of plastic wrap would still allow the wrapped object to be scanned with the risk of greater noise. It might also increase the glossiness of the object (see previous paragraph). Scanning through a window is possible as long as the window does not cause reflection -- the angle between projector unit and window should be close to a right angle.

Translucent objects: It is possible to scan translucent objects to some extent. Scattering of the light inside the material might cause the object surface to be scanned with a lower precision. For materials of a high degree of translucency the same applies as for the transparent objects.

Assessing the quality of the scan

First, do a quick visual check of the scan in Control Application. Switch to the Point Cloud tab. Do you see all parts of the object? Use the mouse drag to rotate the scene or mouse wheel to zoom in or out.

For more advanced assesment, switch to the ConfidenceMap. This tab displays the expected deviation of the measured distance. This means, the darker parts are scanned with lower error. The light areas indicate where the error might be higher. These areas might indicate problematic parts of the scene.

Problems and Troubleshooting

Problem: I don't see PhoXi Scanner listed in PhoXi Control Application

- Double check all cable connections
- The Firewall blocks Bonjour Discovery Service (process mDNSResponder.exe) - Turn off the firewall

Problem: I am not able to rotate Point cloud in PhoXi app.

You should try to do mouse click and press 'R' and then do mouse click and press 'F'.

In case of other problems:

Please report the problem to support@photoneo.com.

Please describe what have you been trying to achieve, what was the result, and what you expected. Depending on the character of the problem, please also report Windows version, PC configuration, and other additional information which would be helpful to replicate the problem and the root cause of it.