# TIDA-00361: Portable Point Cloud Generation for 3D Scanning Using DLP® Technology

# **User's Guide**



Literature Number: TIDU985A May 2015-Revised May 2016



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### **About This Guide**

The 3D Scanner Reference Design enables faster development of machine vision applications utilizing DLP<sup>®</sup> platforms. This guide walks the user through the installation, calibration, and operation of the 3D Scanner Reference Design, as well as building the program from source code.

### **Related Documentation from Texas Instruments**

DLPC300 Datasheet: DLPC300 DLP® Digital Controller for the DLP3000 DMD, DLPS023

DLP3000 Datasheet: DLP3000 DLP® 0.3 WVGA Series 220 DMD, DLPS022

User's Guide: DLP® Lightcrafter™ Evaluation Module (EVM), DLPU006E

User's Guide: DLP® Advanced Light Control SDK for Lightcrafter™ Evaluation Modules, DLPU042

Assembly Guide: TIDA-00361 Camera Trigger Cable Assembly, TIDRIA2

#### If You Need Assistance

Refer to the DLP and MEMS TI E2E Community support forums: http://e2e.ti.com/support/dlp\_\_mems\_micro-electro-mechanical\_systems/default.aspx

#### **Minimum System Requirements**

- PC with 1GHz, or faster, 32-bit (x86) processor
- 2GB RAM
- 10GB of free hard-disk space
- Microsoft® Windows® 7 SP 1
- Microsoft Visual C++ 2010 Redistributable
- Microsoft Visual C++ 2012 Redistributable
- Microsoft .NET Framework 4.5.1
- USB 3.0 port
- USB 2.0 port
- Qt Creator 5.3.2 Integrated Design Environment (IDE)
- OpenCV v2.4.10 Libraries
- Point Grey FlyCapture® v 2.9 SDK
- MeshLab v1.3.3
- DLP® LightCrafter 3000™ Evaluation Module
- Point Grey Flea®3 USB 3.0 Camera

*Note:* The 3D Scanner Reference Design installation and setup is written for users that are familiar with navigating through Windows command line prompts.

*Note:* The 3D Scanner Reference Design was created with the above listed versions of each software tool. Using newer versions of the software tools may render the code inoperable.

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# Introduction to the 3D Scanner Reference Design

The 3D Scanner Reference Design is an active 3-dimensional photography system that generates a digital representation of a physical object. The data generated by the 3D Scanner Reference Design can be analyzed, or otherwise manipulated, to provide information to automated systems about their environment. The information created by the 3D Scanner Reference Design allows machines to make intelligent decisions in a dynamic environment. Applications include industrial automation, robotics, and digital storage of physical objects.

### 1.1 Structured Light

Structured light is a method to achieve 3-dimensional photography of objects by manipulating lighting conditions of a scene under study. The 3D Scanner Reference Design projects a series of timemultiplexed and three phase patterns to extract spatial data from a scene. The 3D Scanner Reference Design leverages the highly-programmable DLP digital micromirror device to rapidly display patterns reducing data acquisition times. DLP is also light source agnostic, making it well suited for structured light applications using solid-state – near infrared, visible, or ultraviolet light – or laser-based illumination.

### 1.2 How the 3D Scanner Reference Design Works

The 3D Scanner Reference Design consists of a LightCrafter 3000 evaluation module and a camera interfacing with a host PC. The 3D Scanner Reference Design utilizes multiple DLP Advanced Light Control SDK for Lightcrafter EVMs (hereto referred to as DLP ALC SDK) modules to perform necessary calculations on the host PC.

### 1.2.1 Projector and Camera Modules

The host PC must send and receive data from both a projector and camera. In this reference design, a Point Grey Flea3 camera is used with a LightCrafter 3000 module that enables easy, feature-rich use of the projector.

### 1.2.2 Calibration

The DLP ALC SDK contains a calibration module to estimate intrinsic and extrinsic parameters of both the camera and projector. An example of the estimated parameters include focal point, lens distortion, and spatial orientation of the camera to the projector. The calibration routine must be performed any time the projector and camera change orientation with each other, or the devices are replaced.

### 1.2.3 Pattern Projection

Pattern projection is handled by a structured light module in the DLP ALC SDK. The module generates vertical and horizontal Gray coded patterns or phase shifted patterns that are sent to a LightCrafter 3000 projector. The firmware file is prepared and uploaded to the projector using the LightCrafter 3000 module.

### 1.2.4 Image Capture

Each projected pattern is captured by the Point Grey Flea3 global or rolling shutter camera or a compatible OpenCV camera (such as a webcam). The images are stored in an image class and the information in the series of images is decoded by the structured light class.



#### 1.2.5 Information Decoding

The structured light class performs decoding of the captured images to determine which projector ray the camera ray detects.

## 1.2.6 Point Cloud Reconstruction

Objects in view of both the camera and projector will cause different rays from the camera and projector to intersect each other. This intersection can be calculated by using the Gray coded and/or phase-shifted ray information from the projector along with the detected ray information from the captured images. This intersection of rays determines an object's real point in space. The geometrical ray intersection calculations are performed by a geometry module in the DLP ALC SDK for each intersecting point.

The points generated by the geometry module are stored in a collection called a point cloud. The point cloud is all of the known points from a captured scene. Software tools and algorithms can be produced to use point clouds to create solid surfaces. MeshLab is the software tool used to view point clouds during the 3D Scanner Reference Design development.

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# Installing the 3D Scanner Reference Design

Before using the 3D Scanner Reference Design application, a few software dependencies and the reference design software itself must be installed. The Point Grey FlyCapture 2+ SDK supplies the drivers required for operating the Point Grey Flea3 USB camera, and MeshLab acts as a 3D viewer for the generated point cloud files. Please read the following sections for more detailed instructions.

### 2.1 Installing the Point Grey FlyCapture® 2+ Full SDK

The Point Grey software development kit (SDK) supplies the required drivers for image capture when using the Point Grey cameras. This section walks the user through set up of the FlyCapture2 Full SDK.

*Warning:* Ensure that Microsoft .NET Framework is installed along with the Visual C++ redistributables listed in the *Minimum System Requirements*.

1. Go to the Point Grey download site, located at <a href="http://www.ptgrey.com/support/downloads">http://www.ptgrey.com/support/downloads</a> and download the FlyCapture2 Full SDK for the appropriate operating system, as shown in Figure 2-1.

*Note:* When developing with the DLP ALC SDK, install the 32-bit version of the FlyCapture SDK to ensure compatibility with the MinGW compiler used in later steps.

	ttps://www.ptgrey.com/support/downloads	F 😭 😳 🖸 🗄
Apps 💠 E2E	🗅 DLP 🦃 DLP® Mercurial F 👋 Support Analyzer	🗀 Other bookmar
	Software (16)	
	Latest FlyCapture 2 Full SDK The FlyCapture Full SDK package can be used to work with Point Grey Firewire, GigE, USB2, and USB3 cameras. The of SDK contains all documentation, example source code, precompiled examples, and libraries required to develop you using our FlyCapture 2 SDK. For a minimal installation which only contains our FlyCap2 camera viewer and minimal d runtimes/libraries, please download the FlyCapture 2 Viewer download.	r application
	Latest FlyCapture2 Viewer The FlyCapture Viewer package can be used to view images from our single lens Firewire, GigE, USB2, and USB3 cam Viewer package is a minimal installer which will only install our FlyCap2 demo application as well as the minimum ne binaries and drivers. For access to the full SDK, documentation, older dlls, and example source code, please downloa SDK.	ecessary
	Latest FlyCapture2 Cognex AIK This software package should be installed only if using Cognex software with Point Grey USB2 or USB3 cameras. For information on using USB cameras in Cognex, please visit http://www.ptgrey.com/KB/10788. For using other interfa Cognex, please visit our knowledge base at http://www.ptgrey.com/http://www.ptgrey.com/support/knowledge-bas	ces in

Figure 2-1. Point Grey Software Downloads Page

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Run the downloaded installation file and click the Install button, as shown in Figure 2-2.
 Note: If the Microsoft .NET Framework has not already been installed, the FlyCapture installer will attempt to install it.

🕻 FlyCapture 2.9 Rel	ease 11 Installer
	The following components will be installed as part of the FlyCapture 2.9 Release 11 installation:
	FlyCapture2_x86.msi
Windows 7 SP1 (x64)	Install

# Figure 2-2. Setting Up the FlyCapture2 Install

3. After extraction of the installation components, the installer will begin with a welcome page as shown in Figure 2-3. Click the "Next" button to continue.

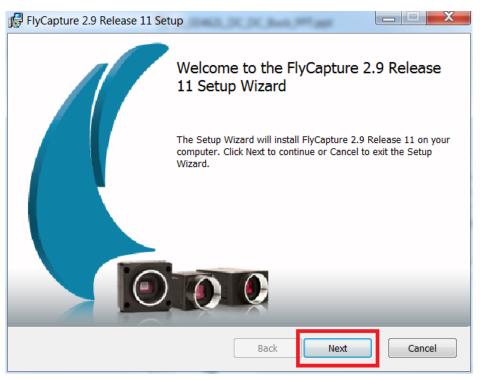


Figure 2-3. FlyCapture2 Installation



 Read and accept or decline the end-user license agreement for the FlyCapture2 SDK as shown in Figure 2-4. If the license agreement is declined, the SDK will not be installed. Click the "Next" button to continue.

🔂 FlyCapture 2.9 Release 11 Setup	X
End-User License Agreement Please read the following license agreement carefully	¢
PGR FlyCapture® SDK License Agreement READ CAREFULLY: This is a legal agreement between you (an individual or a single entity) ("you") and Point Grey Research, Inc. ("PGR"). Before installing and using the FlyCapture® Software Development Kit and any updates to it that we may at our discretion provide to you (collectively, the "SDK"), you should read this agreement. If you do not agree with all of the terms of this agreement, do not install or use the SDK. PGR may change this agreement at any time and it is your responsibility to review the most updated version of it on PGR's website at	
✓ I accept the terms in the License Agreement	
Print Back Next Cancel	

Figure 2-4. FlyCapture2 SDK Licensing Agreement

5. Read the online release notes and click the "Next" button, shown in Figure 2-5, to proceed with the installation.

FlyCapture 2.9 Release 11 Setup	
Release Notes The following information describes this installation.	K
View The Online Release Notes The release notes will open in a web browser. (A network connection is req	uired)
Back Next	Cancel

Figure 2-5. FlyCapture2 SDK Release Notes



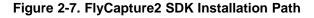
6. Fill out the required Name and Organization fields and click the "Next" button, shown in Figure 2-6, to proceed with the installation.

de	FlyCapture 2.9 Release 1	1 Setup	x
	User Information Enter the following to per	rsonalize your installation.	(
	Full Name: Organization: Email address (optional):	TI User Texas Instruments, Inc example@example.com	
	this computer. You must have this application for:	tion can be installed for the current user or for all users that share ve administrator rights to install the settings for all users. Install Anyone who uses this computer Only for me	
	Automatically register wi	ith PGR via the internet	
		Back Next Cancel	

Figure 2-6. FlyCapture2 SDK User Information

7. Choose the installation directory where the FlyCapture2 SDK will be installed. Click the "Next" button, highlighted in Figure 2-7.

🕞 FlyCapture 2.9 Release 11 Setup	
<b>Destination Folder</b> Click Next to install to the default folder or click Change to choose another.	K
Install FlyCapture 2.9 Release 11 to:	
C:\Program Files (x86)\Point Grey Research\FlyCapture2\ Change	
Back Next	Cancel





8. Click the button labeled "Complete" to install the entire FlyCapture2 SDK, shown in Figure 2-8.

🔂 FlyCapture 2.9 Release	11 Setup
Choose Setup Type Choose the setup type	that best suits your needs
Minimal	Installs only those files required for a FlyCapture2-based program to run (drivers and DLLs only). This option is recommended for OEMs who create custom applications.
Complete	Installs all SDK components except cross-development files. This includes drivers and DLLs, executables, documentation, and example source code. This is the recommended option for most users.
Custom	Use this option to choose which SDK components to install and where they will be installed. Choose this option to install the cross-development files. This option is recommended for advanced users only.
	Back Next Cancel

Figure 2-8. FlyCapture2 SDK Installation Options

 Pick the camera interface that will be used. For the 3D Scanner Reference Design, the USB interface is utilized. Select "I will use USB cameras," uncheck the box "Install USBPro", and then click the "Next" button. The "Next" button and USB selection is shown in Figure 2-9.

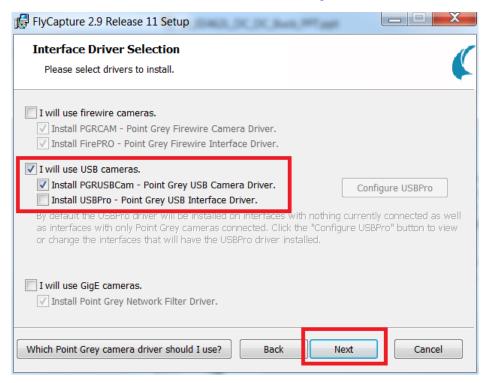


Figure 2-9. Camera Interface Selection for FlyCapture2 SDK



Installing the Point Grey FlyCapture® 2+ Full SDK

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10. Once your options have been selected, the FlyCapture2 installer will confirm the settings. Check the box labeled "Click to confirm," then click the "Next" button, shown in Figure 2-10.

🕼 FlyCapture 2.9 Release 11 Setup	
Confirm Interface Selection Please verify your interface driver selection.	K
You have selected the following interface drivers to be installed. Greyed out drivers wi installed. Please confirm the selection or go back to change the selected interfaces.	ll not be
PGR Camera Driver	
PGR FirePro Driver	
PGR USB Camera Driver	
PGR USBPro Driver	
PGR Network Filter Driver	
Click to confirm	
Back	Cancel

Figure 2-10. Confirm Camera Interface Selection for FlyCapture2 SDK



11. Allow FlyCapture2 to manage processor idle states while the SDK is in use. Accept the default selection and click the "Next" button, shown in Figure 2-11.

**Note:** This option keeps the CPU running as long as the application executable or the Point Grey GUI is active. This can significantly increase the computer's power consumption. After any experiment being run, restore the power option to their previous default. On a Windows machine, search for and select "power options" in the Start Menu. Click "More Power Options" then "Change Plan Settings" and finally select "Restore Default Settings."

FlyCapture 2.9 Release 11 Setup	x
Additional Installer Options Select additional functions for the installer to perform.	¢
If you would like the FlyCapture2 DirectShow dlls to be registered during installation select the checkbox below. The FlyCapture2 DirectShow dlls can be registered/unregistered after installation using the FlyCapture2->Utilities shortcut.	
The installer will register the DirectShow dlls.	
To optimize performance, we recommend that processor idle states be disabled when using FlyCapture2	
Check the box below to allow FlyCapture2 to manage processor idle states. If checked, FlyCapture2 will disable processor idle states while active and restore them after running.	
✓ FlyCapture2 will manage processor idle states.	
Back Next Cancel	

Figure 2-11. Idle State Management Selection for FlyCapture2 SDK



12. Click the "Install" button, shown in Figure 2-12, to continue the installation.

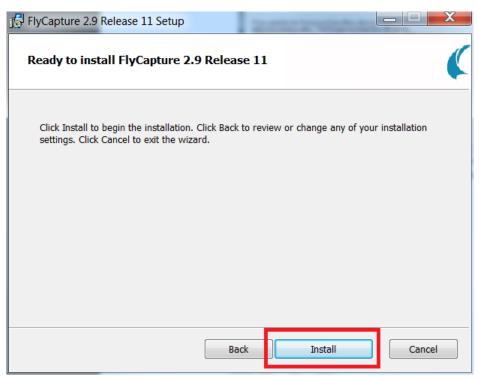


Figure 2-12. Install FlyCapture2 SDK

13. Wait for the FlyCapture2 SDK files to install. The progress bar is shown in Figure 2-13.

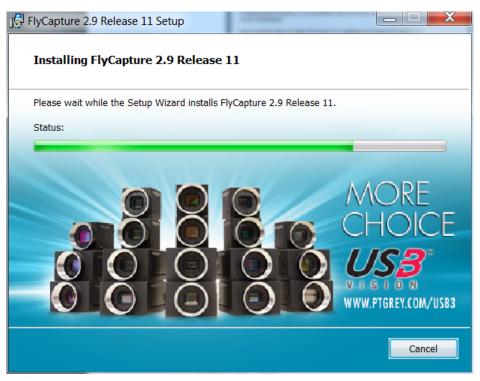


Figure 2-13. FlyCapture2 SDK Installation Progress Bar



14. After the installation is complete, click the "Finish" button shown in Figure 2-14.

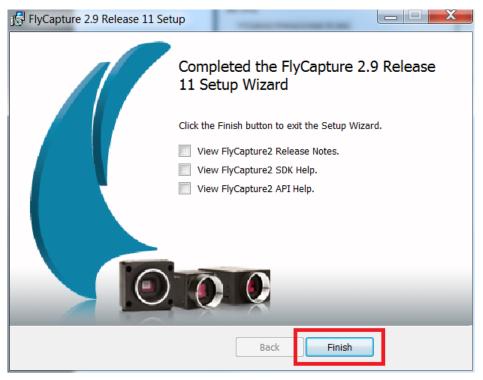


Figure 2-14. FlyCapture2 SDK Finish Installation



#### Installing the LifeCam Cinema Camera Driver and Configuring the Camera

# 2.2 Installing the LifeCam Cinema Camera Driver and Configuring the Camera

If using a Point Grey camera, this section may be skipped. Two important requirements for cameras used in 3D machine vision systems are the ability to set the focus and exposure so that they do not automatically adjust. For this reason, the Microsoft LifeCam Cinema camera was selected as the exposure and focus can be set manually through the Microsoft LifeCam software. The installation and configuration of the Microsoft LifeCam Cinema camera are detailed in this section.

- 1. Go to the Microsoft LifeCam Cinema device downloads website located at <a href="http://www.microsoft.com/hardware/en-us/d/lifecam-cinema">http://www.microsoft.com/hardware/en-us/d/lifecam-cinema</a> and download the software.
- 2. Run the downloaded installation file and click the "Next" button.
- 3. Read and accept the end-user license agreement and the privacy agreement by checking the "I accept this agreement" checkbox and click the "Next" button.
- 4. The installer will download and install the required camera drivers and software.
- 5. After the files have finished installing, connect the camera via the USB port and click "Next."
- 6. If desired, Windows Live Essentials can be installed, but if not desired uncheck the "Install Windows Live Essentials" checkbox and click "Next."
- 7. To complete the installation, click "Finish."

After the camera software has been installed, the camera should be configured so that the auto-exposure and auto-focus are both turned off.

- 1. Open the LifeCam software with the camera connected and a live view should open. Click the arrow on the right side of the window.
- 2. A new window will open to adjust effects of settings of the camera. Click the gear button at the top of the window to show the settings.
- 3. Uncheck the "truecolor" checkbox.
- 4. Click the "Properties" button.
- 5. From the "Camera Control" tab, uncheck the auto-focus checkbox and click "Apply."
- 6. Change to the "Video Settings" tab, and set the "Brightness" and "Saturation" settings to their absolute minimum values.
- 7. Uncheck both the auto-white balance and auto-exposure checkboxes and click "Apply."
- 8. With the LightCrafter projecting a white test pattern, adjust the Exposure settings until the image is well exposed but not over-exposed.



### 2.3 Installing MeshLab

MeshLab is the software utility recommended to view pointclouds generated by the reference design. Installation of MeshLab is detailed in this section.

- 1. Go to the MeshLab website located at <a href="http://meshlab.sourceforge.net/">http://meshlab.sourceforge.net/</a> and download MeshLab V1.3.3 (or higher) executable.
- 2. As a system administrator, run the downloaded installation file and click the "Next" button as shown in Figure 2-15.

*Note:* If the files fail to install, make sure the installation program is run with administrator privileges. Running without administrator privileges will cause the installation to fail.



Figure 2-15. MeshLab Installer Initial Screen

3. Read and accept the end-user license agreement and the privacy agreement by clicking the "I Agree" button once for each agreement, as shown in Figure 2-16.

License Agreemen	E	( NINIT
Please review the lic	ense terms before installing MeshLab_64b 1.3.3.	
Press Page Down to	see the rest of the agreement.	
	GNU GENERAL PUBLIC LICENSE	
	Version 2, June 1991	
	, 1991 Free Software Foundation, Inc.	
	ifth Floor, Boston, MA 02110-1301 USA ted to copy and distribute verbatim copies	
	ment, but changing it is not allowed.	
	Preamble	
The licenses for m	ost software are designed to take away your	-
	rms of the agreement, click I Agree to continue. You mu	ist accept the
agreement to install	MeshLab_64b 1.3.3.	
ullsoft Install System v	/2.46	

Figure 2-16. MeshLab End User License Agreement

Installing MeshLab

4. Choose the installation directory for the MeshLab program, shown in Figure 2-17.

🗇 MeshLab_64b 1.3.3 Setup		
Choose Install Location		Auto
Choose the folder in which to install M	leshLab_64b 1.3.3.	
Setup will install MeshLab_64b 1.3.3 in Browse and select another folder. Clic		
Destination Folder		
C:\Program Files\VCG\MeshLab		Browse
Space required: 78.5MB		
Space available: 89.1GB		
Nullsoft Install System v2.46		
	< Back	nstall Cancel

Figure 2-17. MeshLab Installation Path

5. Allow the files to be installed and, once completed, click the "Finish" button, highlighted in Figure 2-18.

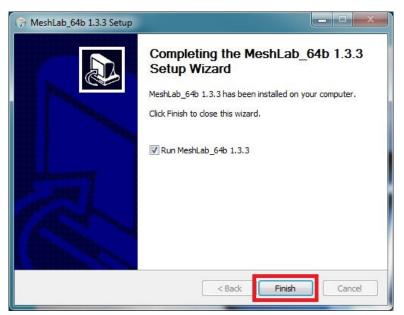


Figure 2-18. MeshLab Installation Completed

# 2.4 Downloading the 3D Scanner Reference Design

Compiled Windows binaries for the 3D Scanner Reference Design are offered for convenience. The binaries can be downloaded from the "Software" section of the reference design tool page at <a href="http://www.ti.com/tool/TIDA-00361">http://www.ti.com/tool/TIDA-00361</a>.

To build the source code for the reference design as well as the DLP Advanced Light Control SDK, please refer to <u>DLPU042</u>.



Installing the 3D Scanner Reference Design

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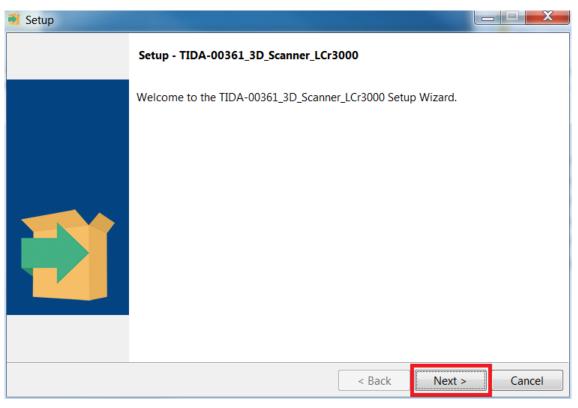
## 2.5 Installing the 3D Scanner Reference Design

- 1. Decompress the "tidcb92.zip" file in a convenient location.
- Install the 3D Scanner Reference Design by executing the file "TIDA00361-\*\*\*-windows-installer.exe," as shown in Figure 2-19.

	nloads\tidcb92			→ Search t 🔎
Organize   Include in library	Share with 🔻 New folder		: : : : :	• 🗌 🔞
☆ Favorites	Name	Date modified	Туре	Size
📃 Desktop	TIMP NOTICE FOR REF DESIGNS.pdf	6/9/2015 12:26 PM	Adobe Acrobat D	15 KB
) Downloads	STIDA00361-2.0-windows-installer.exe	3/29/2016 8:28 PM	Application	13,264 KB
<ul> <li>Recent Places</li> <li>Music</li> <li>Libraries</li> <li>Documents</li> </ul>				
2 items				

### Figure 2-19. 3D Scanner Reference Design Installation Executable

3. Click the "Next" button on the install wizard setup screen, as shown in Figure 2-20.



#### Figure 2-20. 3D Scanner Reference Design Setup Wizard Screen



#### Installing the 3D Scanner Reference Design

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 Read and review the license agreement for the 3D Scanner Reference Design, as shown in Figure 2-21. Click the "I accept the agreement" radio button and then click the "Next" button to continue installing the software.

Setup			
License Agreement	èxas Ii	NSTRUN	MENTS
Please read the following License Agreement. You must accept with the installation.	the terms of this	agreement befo	re continuing
DLP® TIDA-00361 3D Scanner Object Code Software Licen	se Agreement		•
IMPORTANT - PLEASE READ THE FOLLOWING LICENSE AGREEMENT CAREFULLY. THIS IS A LEGALLY BINDING AGREEMENT. AFTER YOU READ THIS LICENSE AGREEMENT, YOU WILL BE ASKED WHETHER YOU ACCEPT AND AGREE TO THE TERMS OF THIS LICENSE AGREEMENT. DO NOT CLICK "I HAVE READ AND AGREE" UNLESS: (1) YOU ARE AUTHORIZED TO ACCEPT AND AGREE TO THE TERMS OF THIS LICENSE AGREEMENT ON BEHALF OF YOURSELF OR YOUR COMPANY; AND (2) YOU INTEND TO ENTER INTO AND TO BE BOUND BY THE TERMS OF THIS LEGALLY BINDING AGREEMENT ON BEHALF OF YOURSELF OR YOUR COMPANY.			
Do you accept this license? I do not accept the agreement			
InstallBuilder	< Back	Next >	Cancel

Figure 2-21. 3D Scanner Design License Agreement Screen

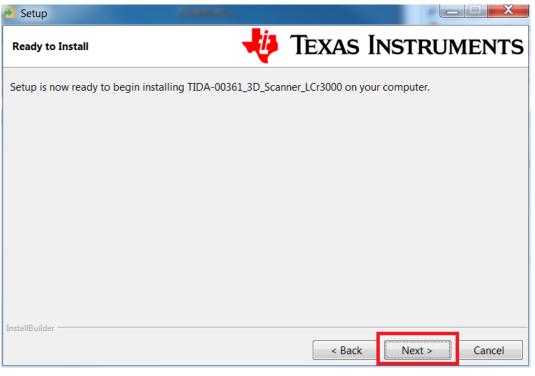
5. Select an installation path where the reference design software will be located. Click the "Next" button, as shown in Figure 2-22. Click the "Next" button to continue installing the software.

Setup	
Installation Directory	Texas Instruments
Please specify the directory where TIDA-00361_3D_Scanne	er_LCr3000 will be installed.
Installation Directory C:\TexasInstruments-DLP\TIDA-003	361_3D_Scann
InstallBuilder	
	< Back Next > Cancel

Figure 2-22. 3D Scanner Reference Design Installation Path Selection



6. The installer is ready to install, click the "Next" button to start the process, as shown in Figure 2-23.



#### Figure 2-23. 3D Scanner Reference Design Installation Confirmation

7. Wait for the files to install in the location specified, as shown in Figure 2-24.

🔁 Setup	
Installing	Texas Instruments
Please wait while Setup installs TIDA-00361_3D_Scanne	er_LCr3000 on your computer.
Insta	Illing
Creating uni	nstaller 25%
InstallBuilder	
	< Back Next > Cancel

Figure 2-24. 3D Scanner Reference Design File Installation Progress



#### Installing the 3D Scanner Reference Design

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8. Once the files have been extracted and installed, click the "Finish" button to close the installer, as shown in Figure 2-25.

🔁 Setup	
	Completing the TIDA-00361_3D_Scanner_LCr3000 Setup Wizard
	Setup has finished installing TIDA-00361_3D_Scanner_LCr3000 on your computer.
	< Back Finish Cancel

Figure 2-25. 3D Scanner Reference Design Installation Completion



# Using the 3D Scanner Reference Design

The 3D Scanner Reference Design application allows users to quickly create a 3D scanner; complete with calibration, setup, and scanning routines. The application generates the calibration board required to calibrate the 3D scanner, as well as preparing the LightCrafter 3000 EVM with its own calibration and structured light patterns. After preparing the calibration board and the LightCrafter 3000 EVM, the user may calibrate the camera and projector. After the calibration procedures are complete, the application is ready to perform 3D scans. Please follow all instructions to properly setup and use the 3D scanner.

# 3.1 Connecting the Hardware When Using a Point Grey Flea3 Camera

When using the 3D Scanner reference design with a Point Grey Flea3 camera the following hardware is needed:

- LightCrafter 3000 EVM & power supply
- Point Grey Flea3 USB 3.0 camera and lens
- USB 2.0 A to mini-B Cable
- USB 3.0 A to micro-B Cable
- TIDA-00254 Camera Trigger Cable
  - Assemble the required cable using the instructions from the TIDA-00361 Camera Trigger Cable Assembly Guide: <u>http://www.ti.com/lit/df/tidria2/tidria2.pdf</u>

Connect the hardware as follows:

- 1. Power the LightCrafter 3000
- 2. Connect the LightCrafter 3000 to the PC's USB 2.0 port using the USB 2.0 cable
- 3. Connect the Point Grey camera to the PC's USB 3.0 port using the USB 3.0 cable
- 4. Connect the camera trigger cable to the Point Grey camera's GPIO port and the LightCrafter 3000 input trigger connector J7

### 3.2 Connecting the Hardware When Using the Microsoft LifeCam Cinema Camera

When using the 3D Scanner reference design with a Microsoft LifeCam Cinema camera the following hardware is needed:

- LightCrafter 3000 EVM & power supply
- Microsoft LifeCam Cinema camera
- USB 2.0 A to mini-B Cable

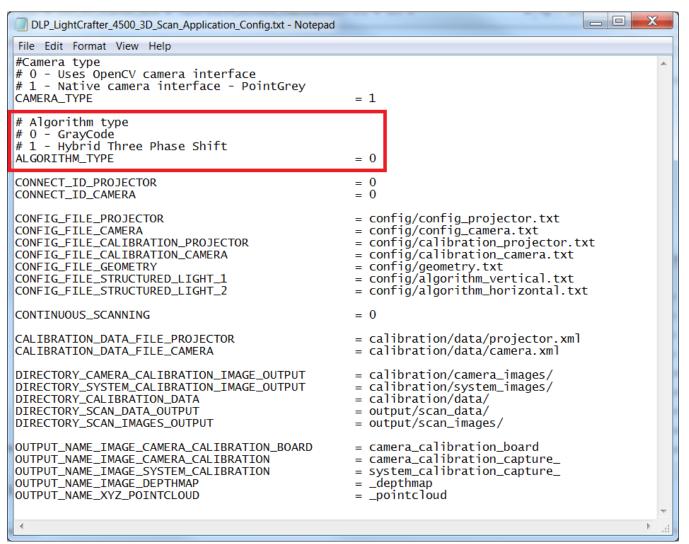
Connect the hardware as follows:

- 1. Power the LightCrafter 3000
- 2. Connect the LightCrafter 3000 to the PC's USB 2.0 port using the USB 2.0 cable
- 3. Connect the Microsoft LifeCam Cinema camera with its attached USB cable

### 3.3 Configuring the Camera and Scan Type

This design features two methods of scanning: binary Gray code scanning and hybrid three-phase scanning. It also allows the user to use the native Point Grey interface or the OpenCV camera interface. To change the scan type, do the following:

- 1. After installing or building the design, find *DLP\_Lightcrafter\_3D\_Scan\_Application\_Config.txt* in the build or install folder for the reference design.
- 2. Open the text file.



### Figure 3-1. Application Config File - ALGORITHM\_TYPE

- To perform a Gray code scan, ALGORITHM\_TYPE should be set to "0". To perform a hybrid three phase shift scan, ALGORITHM\_TYPE should be "1." Figure 3-1 shows where the value should be changed.
- 4. Once a selection has been made, save the file. Close and reopen the reference design executable (if it was running) for the changes to take effect.

**Note:** For untriggered cameras such as a webcam, three-phase hybrid scanning will not work due to the precise timing required. In general, any unsynchronized camera will not work with three-phase hybrid scanning.

To change the camera interface type, do the following:

- 1. Follow steps 1 and 2 above.
- 2. To change the camera type, CAMERA\_TYPE, as shown in Figure 3-2, will have to be edited. Enter "0" to use the OpenCV interface and "1" to use the native camera interface.

DLP_LightCrafter_4500_3D_Scan_Application_Config.txt - Notepad	
File Edit Format View Help	
#Camera type # 0 - Uses OpenCV camera interface # 1 - Native camera interface - PointGrey CAMERA_TYPE	= 1
# Algorithm type # 0 - GrayCode # 1 - Hybrid Three Phase Shift ALGORITHM_TYPE	= 0
CONNECT_ID_PROJECTOR CONNECT_ID_CAMERA	$     = 0 \\     = 0 $
CONFIG_FILE_PROJECTOR CONFIG_FILE_CAMERA CONFIG_FILE_CALIBRATION_PROJECTOR CONFIG_FILE_CALIBRATION_CAMERA CONFIG_FILE_GEOMETRY CONFIG_FILE_STRUCTURED_LIGHT_1 CONFIG_FILE_STRUCTURED_LIGHT_2	<pre>= config/config_projector.txt = config/config_camera.txt = config/calibration_projector.txt = config/calibration_camera.txt = config/geometry.txt = config/algorithm_vertical.txt = config/algorithm_horizontal.txt</pre>
CONTINUOUS_SCANNING	= 0
CALIBRATION_DATA_FILE_PROJECTOR CALIBRATION_DATA_FILE_CAMERA	<pre>= calibration/data/projector.xml = calibration/data/camera.xml</pre>
DIRECTORY_CAMERA_CALIBRATION_IMAGE_OUTPUT DIRECTORY_SYSTEM_CALIBRATION_IMAGE_OUTPUT DIRECTORY_CALIBRATION_DATA DIRECTORY_SCAN_DATA_OUTPUT DIRECTORY_SCAN_IMAGES_OUTPUT	<pre>= calibration/camera_images/ = calibration/system_images/ = calibration/data/ = output/scan_data/ = output/scan_images/</pre>
OUTPUT_NAME_IMAGE_CAMERA_CALIBRATION_BOARD OUTPUT_NAME_IMAGE_CAMERA_CALIBRATION OUTPUT_NAME_IMAGE_SYSTEM_CALIBRATION OUTPUT_NAME_IMAGE_DEPTHMAP OUTPUT_NAME_IMAGE_DEPTHMAP	<pre>= camera_calibration_board = camera_calibration_capture_ = system_calibration_capture_ = _depthmap = _pointcloud</pre>
4	b. ◀

Figure 3-2. Application Config File - CAMERA\_TYPE

To change between using a global shutter monochrome camera and a rolling shutter color camera, edit the following:

- 1. Open config\_camera.txt.
- Figure 3-3 highlights the parameters that must be changed depending on the type of camera used. For a rolling shutter color camera, make sure PG\_FLYCAP\_PARAMETERS\_PIXEL\_FORMAT is set to "MONO8." If the camera is global shutter monochrome camera, set to "RAW8." Similarly, edit the PG\_FLYCAP\_PARAMETERS\_STROBE\_DELAY to "5.0" for rolling shutter color cameras and "0.0" for global shutter mono-chrome cameras.

config_camera.txt - Notepad		
File Edit Format View Help		
CAMERA_PARAMETERS_FRAME_BUFFER_SIZE	= 72	•
######################################	= 0	
######################################	= 18	
<pre># For below parameter set # Rolling shutter color Camera - MONO8 # Global shutter Monochrome camera - RAW8 PG_FLYCAP_PARAMETERS_PIXEL_FORMAT</pre>	= RAW8	=
PG_FLTCAP_PARAMETERS_SHOTTER_EAPOSURE_MS PG_FLYCAP_PARAMETERS_FRAME_RATE_HZ PG_FLYCAP_PARAMETERS_STROBE_SOURCE PG_FLYCAP_PARAMETERS_STROBE_ENABLE PG_FLYCAP_PARAMETERS_STROBE_POLARITY	= 100 = 15 = 2 = 1 = 1	
<pre># For below parameter # Rolling shutter color camera - 5.0 # Glocal shutter Monochrome camera - 0.0 PG_FLYCAP_PARAMETERS_STROBE_DELAY PG_FLYCAP_PARAMETERS_STROBE_DURATION</pre>	= 0.0 = 1.0	
PG_FLYCAP_PARAMETERS_STROBE_DURATION PG_FLYCAP_PARAMETERS_AUTOEXPOSURE PG_FLYCAP_PARAMETERS_EXPOSURE	= 1.0 = 0 = 1.0	-
•		h. ∢

Figure 3-3. Camera Shutter and Color Settings



Creating the Calibration Board

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#### 3.4 Creating the Calibration Board

This section guides the user through the generation and measurement of the camera calibration board.

1. Start the 3D Scanner Reference Design program, installed in Section 2.5, by running the executable file, as shown in Figure 3-4.

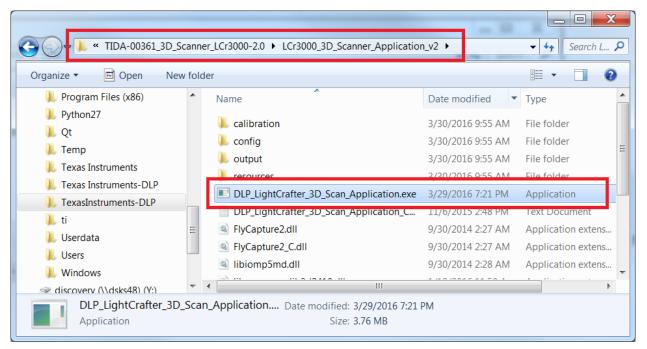


Figure 3-4. Running the 3D Scanning Command Line Program

2. Run the "1: Generate camera calibration board and enter feature measurements" option by entering "1" in the command line menu, as shown in Figure 3-5.

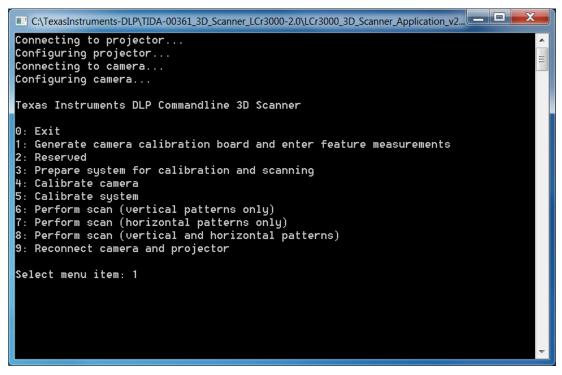


Figure 3-5. Command Line Menu Prompt



#### Creating the Calibration Board

- 3. Once the command has been entered, the program will generate the calibration board. Print the camera calibration board image that is found in the location indicated in the prompt (calibration/camera\_images/camera\_calibration\_board.bmp). The camera calibration board should be approximately half the size of the total projection area.
- 4. Attach the printed calibration board to a flat, white surface that is larger than the projection area, as shown in Figure 3-6. The number of squares on the grid can be changed in the configuration files for the program. The default grid is 7 x 10.

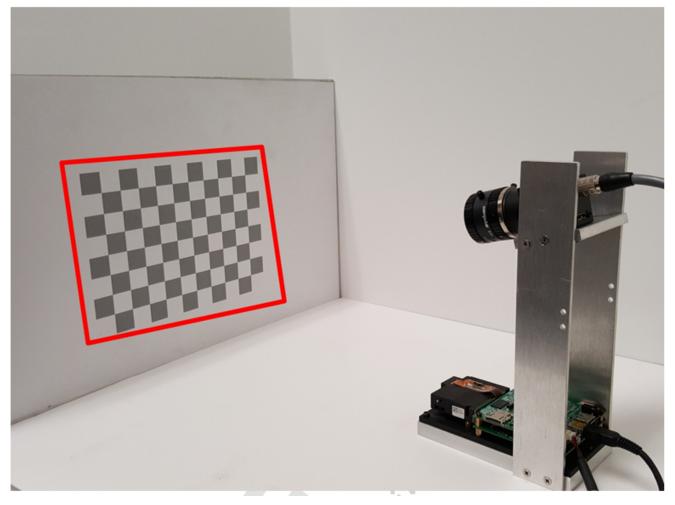


Figure 3-6. Calibration Board Attached to Flat Calibration Surface

5. After attaching the camera calibration board to the calibration surface, measure the length of one side of one of the squares on the grid and type the number into the command prompt as shown in Figure 3-6. Do not enter any units in the command line. Hit enter to continue.

*Note:* The generated point clouds will show unit-less distances. The actual units depend on how you measured your calibration board. For example, if each square is 2 cm wide, enter "2" into the prompt. The generated point clouds will show distances which appear unitless but are actually in centimeters.



# 3.5 Preparing the Projector

The LightCrafter 3000 system must be prepared with the calibration images and structured light patterns for calibration and object scanning, respectively. The 3D Scanner Command Line program will prepare the projector with the necessary images by selecting menu option "3: Prepare system for calibration and scanning" by entering "3" in the command line, as shown in Figure 3-7. The system will need to be prepared every time it is initialized.

C:\TexasInstruments-DLP\TIDA-00361_3D_Scanner_LCr3000-2.0\LCr3000_3D_Scanner_Application_v2	
Connecting to projector Configuring projector Connecting to camera	• III
Configuring camera Texas Instruments DLP Commandline 3D Scanner	
0: Exit 1: Generate camera calibration board and enter feature measurements 2: Recorved	
3: Prepare system for calibration and scanning 5: Calibrate camera 5: Calibrate system 6: Perform scan (vertical patterns only) 7: Perform scan (horizontal patterns only) 8: Perform scan (vertical and horizontal patterns) 9: Reconnect camera and projector	
Select menu item:	

Figure 3-7. Prepare Projector Step



#### 3.6 Calibrating the Camera

This section guides the user through the process of creating the physical connections between the LightCrafter 3000, the host PC, and the Point Grey Flea3 camera and calibrating the camera.

Warning: Section 3.4 must be completed before the camera can be calibrated.

 Connect the GPIO output trigger from the camera to the projector's input trigger, using the cable detailed in the file "TIDA-00361-CAMERA\_TRIGGER\_CABLE\_ASSEMBLY.pdf", as shown in Figure 3-8.

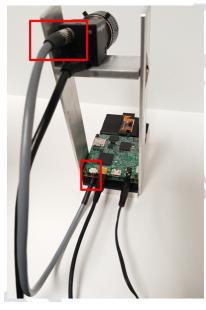


Figure 3-8. Connecting the Camera to the Host PC

- 2. Connect the Point Grey Flea3 camera to the host PC's USB 3.0 port.
- 3. Connect the LightCrafter 3000 to the host PC's USB 2.0 port.



4. Make sure there is sufficient distance between the camera and the projector. The camera and projector should be separated by a 20 to 45 degree angle as formed by the object being scanned, shown in Figure 3-9.



Figure 3-9. Projector, Camera, Object Spatial Orientation

5. Enter menu option "4" to start the camera calibration. Follow the prompts and directions on the screen during the entire process.



#### Calibrating the Camera

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6. A live camera view window will appear on the host PC. Position the camera calibration board entirely in the frame, as shown in Figure 3-10.

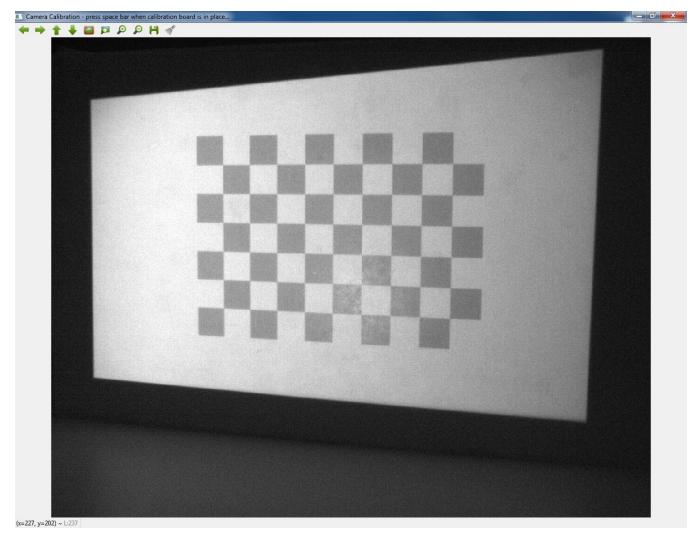


Figure 3-10. Camera Calibration Board Live View



7. Stop down the aperture as low as possible while still being able to discern the gray and white squares on the calibration board and minimize all sources of glare. Make sure the projection area is in focus, and lock the aperture and focus. An example of an overexposed image is shown in Figure 3-11, and an example of an underexposed image is shown in Figure 3-12.

**Note:** If the camera's aperture size or focus is changed after this step, the resulting point cloud data will be impacted. Perform camera calibration routine again if the results are undesired.

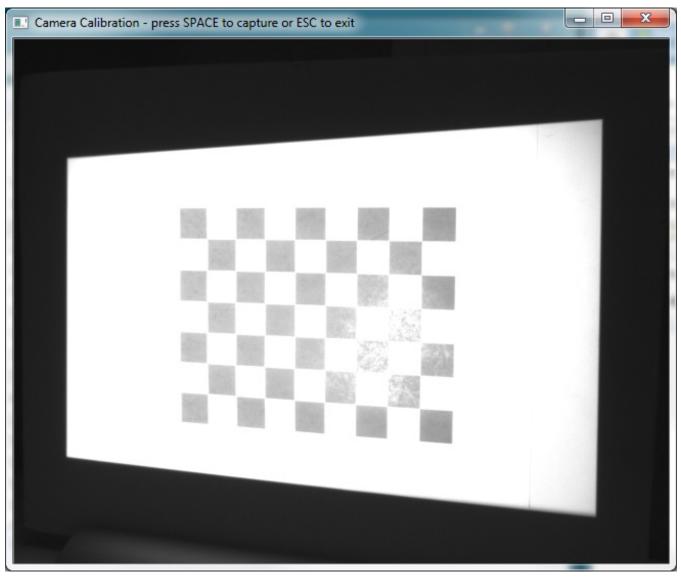
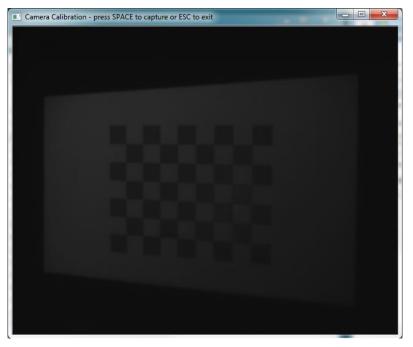


Figure 3-11. Overexposed Camera Capture



#### Figure 3-12. Underexposed Camera Capture

- 8. Click on the live camera view window on the host PC and verify the calibration board is in focus.
- 9. From the live camera view window, position the camera at varying angles and distances from the projection surface. Place the grid in different areas of the camera's view and press the SPACEBAR to capture images. Default settings require twenty calibration images although this parameter can be adjusted. In \config, find calibration\_camera.txt. Figure 3-13 highlights the parameter which specifies the number of calibration images. Some recommended calibration images are shown in Figure 3-14 to Figure 3-23. It is okay to move the camera at this point in the calibration procedure.

Calibration_camera.txt - Notepad			X
File Edit Format View Help			
CALIBRATION_PARAMETERS_BOARD_COUNT = 20 CALIBRATION_PARAMETERS_BOARD_FOREGROUND = 255, 255, 255 CALIBRATION_PARAMETERS_BOARD_FOREGROUND = 150, 150, 150 CALIBRATION_PARAMETERS_BOARD_FEATURE_ROWS = 7 CALIBRATION_PARAMETERS_BOARD_FEATURE_ROW_DISTANCE = CALIBRATION_PARAMETERS_BOARD_FEATURE_ROW_DISTANCE_PIXELS CALIBRATION_PARAMETERS_BOARD_FEATURE_ROW_OFFSET_PIXELS = CALIBRATION_PARAMETERS_BOARD_FEATURE_COLUMNS = 10 CALIBRATION_PARAMETERS_BOARD_FEATURE_COLUMNS = 10 CALIBRATION_PARAMETERS_BOARD_FEATURE_COLUMN_DISTANCE = CALIBRATION_PARAMETERS_BOARD_FEATURE_COLUMN_DISTANCE = 0 CALIBRATION_PARAMETERS_BOARD_FEATURE_COLUMN_OFFSET_PIXELS CALIBRATION_PARAMETERS_BOARD_FEATURE_COLUMN_OFFSET_PIXELS CALIBRATION_PARAMETERS_BOARD_FEATURE_COLUMN_OFFSET_PIXELS CALIBRATION_PARAMETERS_BOARD_FEATURE_COLUMN_OFFSET_PIXELS CALIBRATION_PARAMETERS_BOARD_FEATURE_COLUMN_OFFSET_PIXELS CALIBRATION_PARAMETERS_SET_TANGENT_DIST_TO_ZERO = 0 CALIBRATION_PARAMETERS_FIX_SIXTH_ORDER_DIST = 0	2 = 700 2 =	100 100 700	•
			-
4			•

Figure 3-13. Camera Calibration Configuration File



Calibrating the Camera

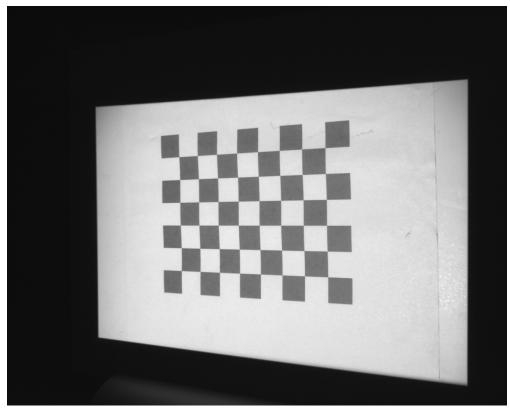


Figure 3-14. Calibration Board Image Capture Position 1

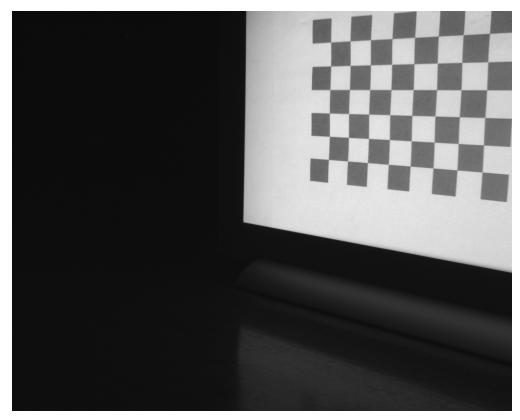


Figure 3-15. Calibration Board Image Capture Position 2



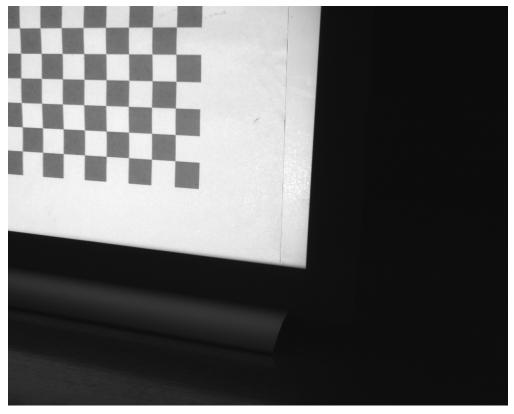


Figure 3-16. Calibration Board Image Capture Position 3

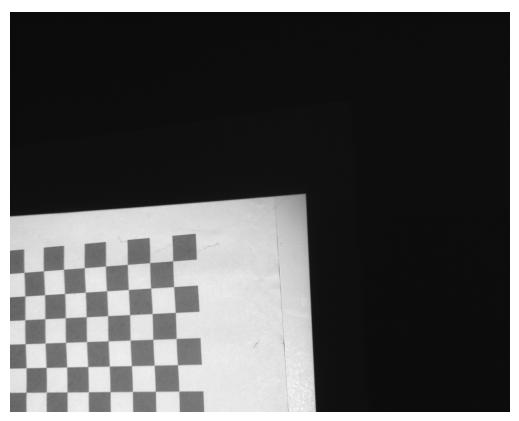


Figure 3-17. Calibration Board Image Capture Position 4



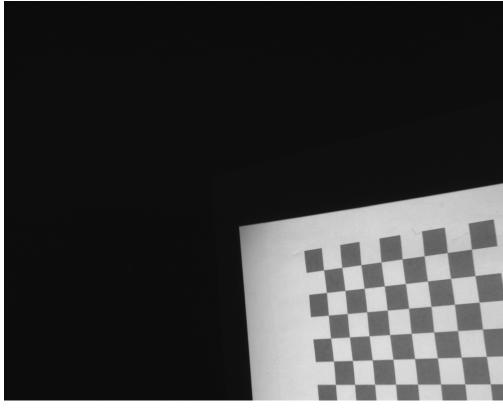


Figure 3-18. Calibration Board Image Capture Position 5

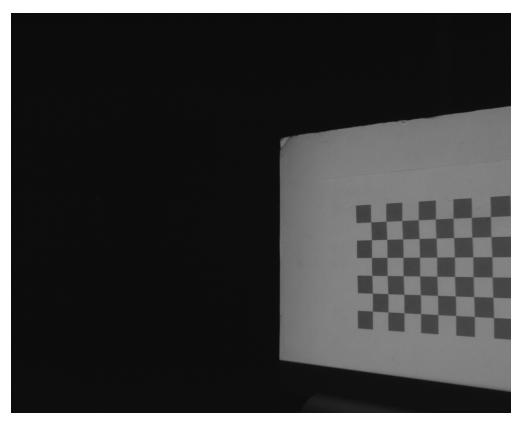


Figure 3-19. Calibration Board Image Capture Position 6



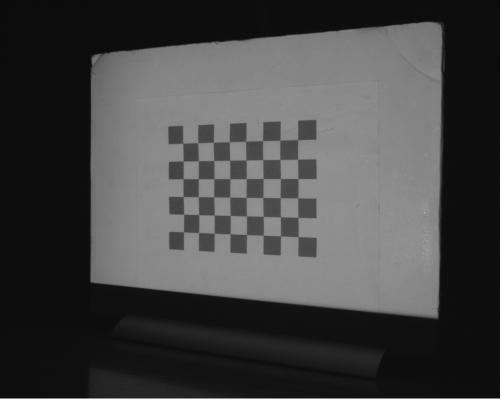


Figure 3-20. Calibration Board Image Capture Position 7

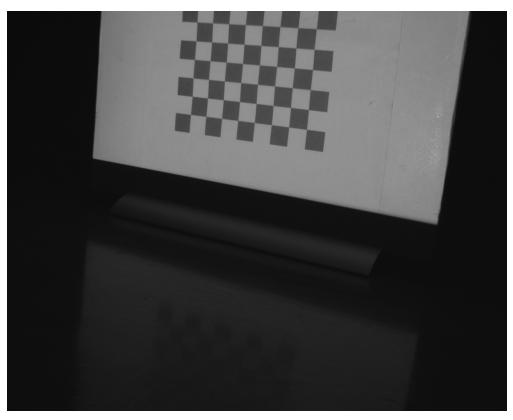


Figure 3-21. Calibration Board Image Capture Position 8



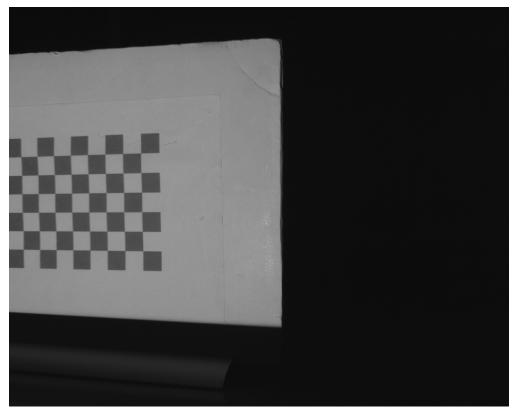


Figure 3-22. Calibration Board Image Capture Position 9

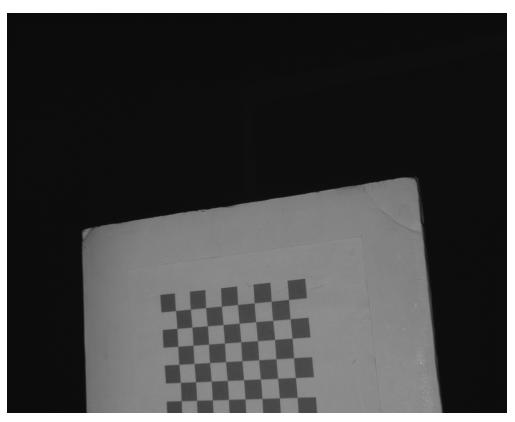


Figure 3-23. Calibration Board Image Capture Position 10



#### Calibrating the Camera

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10. The calibration process estimates the lens focal length, focal point, lens distortion, and the translation and rotation of the camera relative to the calibration board. The calibration procedure will generate a reprojection error. Zero reprojection error is ideal, however an error below 2 should be adequate for typical usage. If the reprojection error is not satisfactory or if initial scans are not providing good results, run the camera calibration routine again.



# 3.7 Calibrating the Projector

This procedure calibrates the projector and projector/camera system. Only perform this procedure with a valid camera calibration already completed.

 Once the camera calibration is complete and the projector has been prepared, the system calibration can be performed. Start the system calibration process by entering "5" in the command line prompt. Read the directions in the prompt in detail. Default calibration will require 5 images. To change this, open *calibration\_projector.txt* in \config. Figure 3-24 shows the parameter to change.

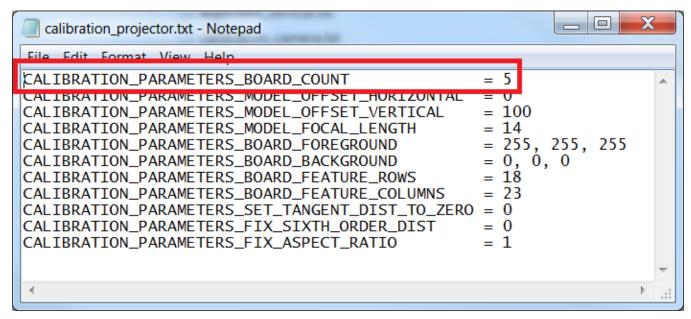


Figure 3-24. Number of Projector Calibration Shots

- 2. The projector will display a calibration board. The projected calibration board should be larger than the camera calibration board but still fall entirely on the calibration surface. Adjust the camera's position to center the projected calibration board in the live view.
- 3. Select the live camera view window and press the spacebar to capture the centered calibration board. Avoid glare from the projected board or the captured image is discarded by the software. Rotate the angle of the backstop on all 3 axes in the captured images. Figure 3-25 to Figure 3-35 show some recommended projector calibration capture orientations. The camera captures three patterns after the spacebar is clicked: solid white, black and white chessboard, and solid black.



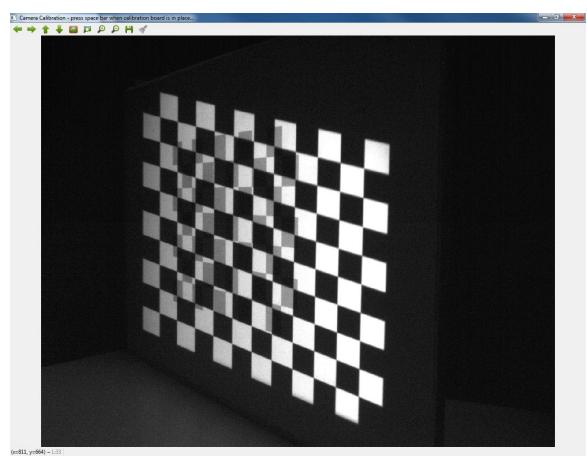


Figure 3-25. Projector Calibration Chessboard Capture



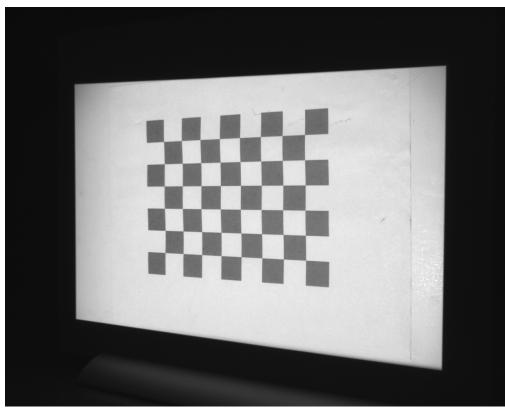


Figure 3-26. Projector Calibration Board Capture Position 1

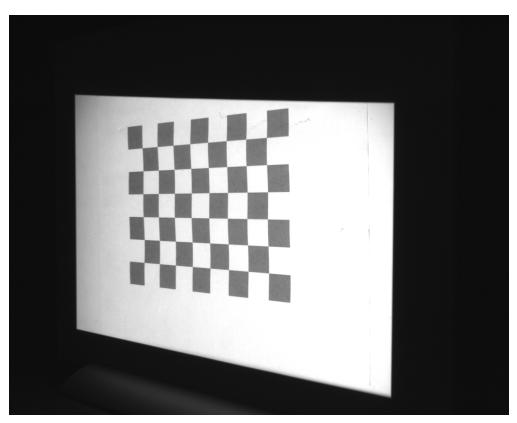


Figure 3-27. Projector Calibration Board Capture Position 2



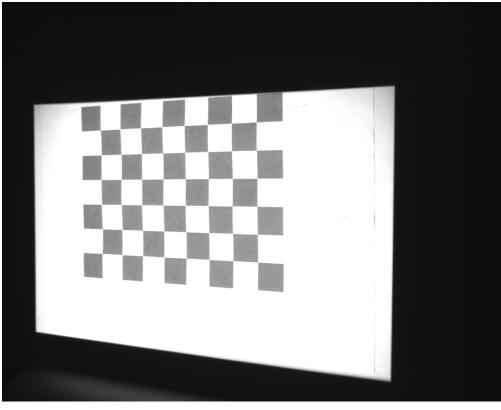


Figure 3-28. Projector Calibration Board Capture Position 3

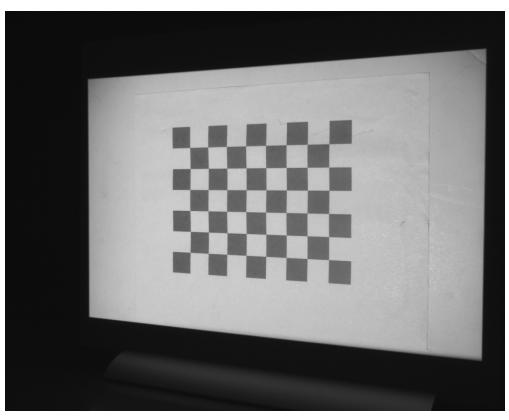


Figure 3-29. Projector Calibration Board Capture Position 4



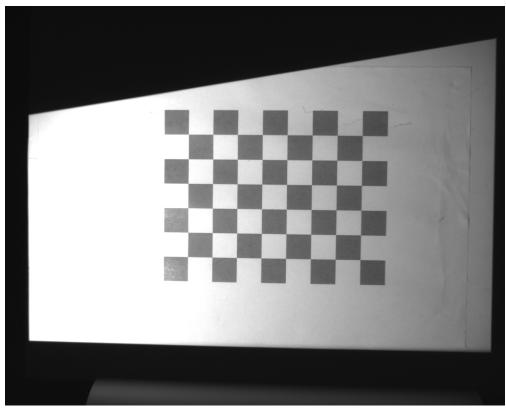


Figure 3-30. Projector Calibration Board Capture Position 5

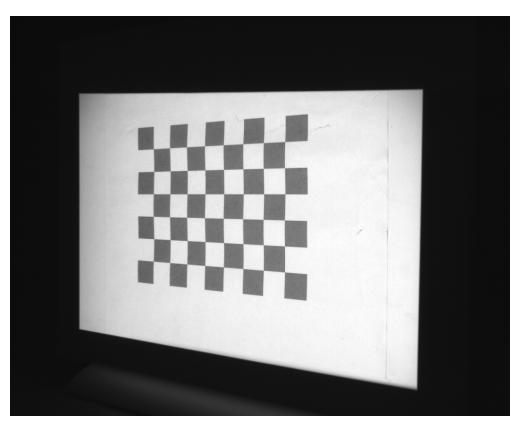


Figure 3-31. Projector Calibration Board Capture Position 6



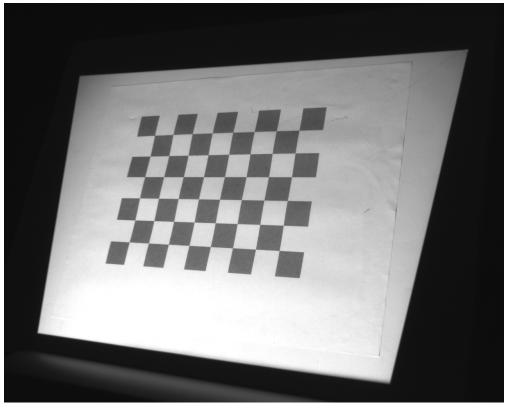


Figure 3-32. Projector Calibration Board Capture Position 7

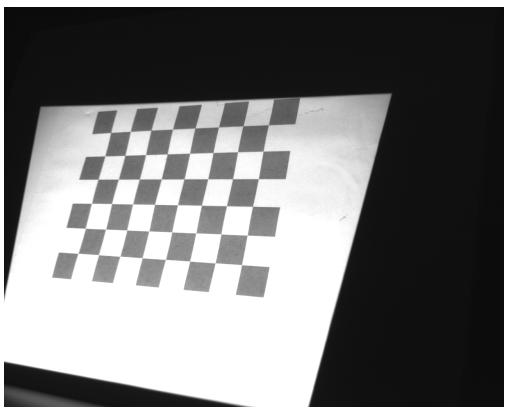


Figure 3-33. Projector Calibration Board Capture Position 8



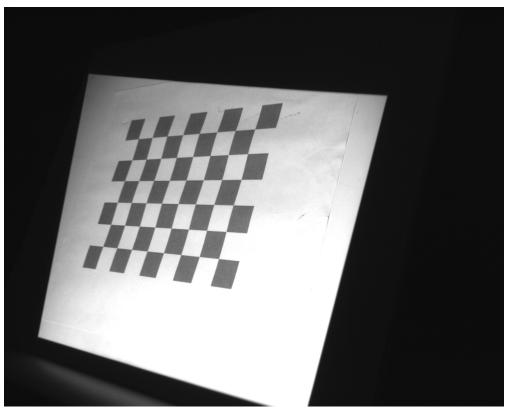


Figure 3-34. Projector Calibration Board Capture Position 9

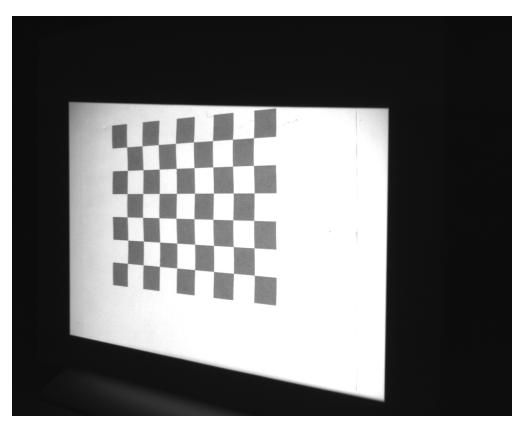


Figure 3-35. Projector Calibration Board Capture Position 10



### Calibrating the Projector

- 4. Repeat step 3 a total of five times, capturing various angles and positions of the calibration board by rotating and moving the calibration surface. Ensure the projected calibration board falls entirely on the calibration surface in each capture.
- 5. The system calibration process estimates extrinsic and intrinsic parameters, and lens distortion parameters, for the projector. The system calibration also estimates the camera-projector orientation. The calibration procedure will generate a reprojection error similar to the camera calibration. Zero reprojection error is ideal, however an error below 2 should be adequate for typical usage. If the reprojection error is not satisfactory, verify the calibration as detailed in Section 3.8 before performing the calibration again.



### 3.8 Calibration Verification

Once system calibration is complete, the calibration should be verified. Scan a flat, white surface, like the backdrop for the printed calibration image, by entering the perform scan command "8" in the command line menu. The output depth map should look similar to Figure 3-36. Performing a scan with both vertical and horizontal patterns only works with the Lightcrafter set to use binary patterns only as discussed in Section 3.3

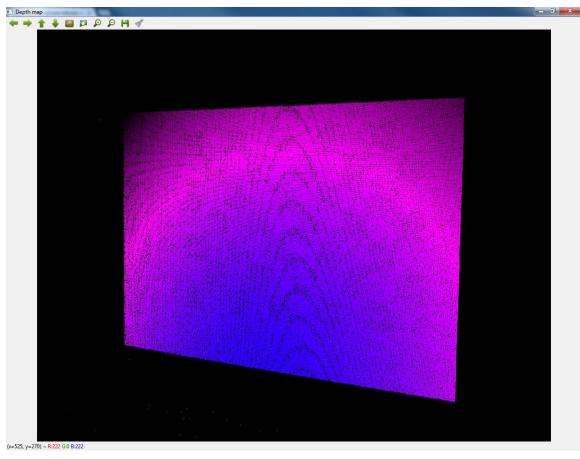


Figure 3-36. Typical Depth Map of a Flat Surface



Calibration Verification

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If the depth map is missing a significant amount of points, as shown in Figure 3-37, check the camera/projector synchronization by looking at the captured images and verifying the gray coding is displayed correctly. It is also possible that the scene was not static. Please ensure that the objects being scanned are not moving.

Depth map	
2017년 2월 18일 - 18일 18일 <b>2월 28일 28일 28일 2</b> 일 2017년 201 1921년 2월 1921년	
승규가 물건을 물건을 물건을 가지 않는 것을 가지 않는 것을 했다.	
2019년 - 1997년 - 1997년 - 2019년 - 1987년 - 1997년 - 1997년 - 2019년 - 1987년 - 2019년 -	· 동안 문항
승규는 그는 것이 같은 사람이 많은 것을 가지 않는 것을 하는 것이 없다.	
· 영상 · · · · · · · · · · · · · · · · · ·	
	He Carlos
(x=493, y=442) ~ R:0 G:0 B:0	

Figure 3-37. Deficient Depth Map of a Flat Surface



When the depth map is acceptably dense, open the output point cloud file using MeshLab. Inspect the point cloud for accurate reproduction of the scanned board. An example of an acceptable point cloud displayed in MeshLab is shown in Figure 3-38.

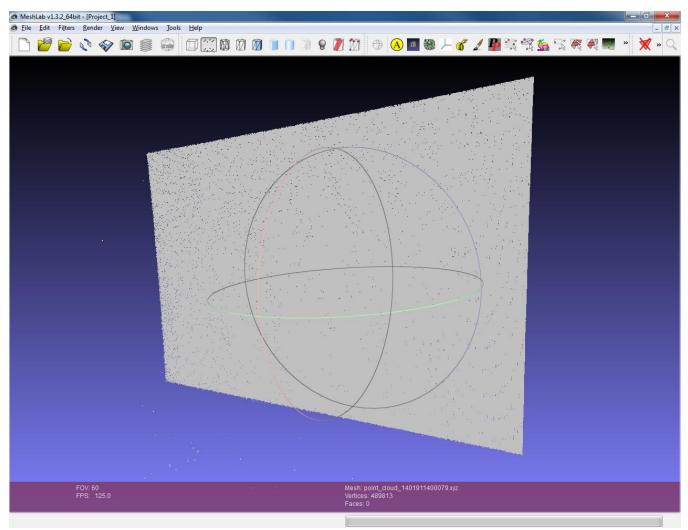


Figure 3-38. Point Cloud of a Flat Surface



Calibration Verification

If the depth map is twisted or distorted around the edges, the calibration should be performed again with special attention paid to placing the printed calibration board close to the edges of the camera frame. An example of an unacceptable point cloud displayed in MeshLab is shown in Figure 3-39.

*Note:* The 3D Scanner Reference Design is capable of very accurate measurements. If the flat surface being scanned has a perceivable twist in it, verify that the surface is not twisted as well before performing the calibration routine again.

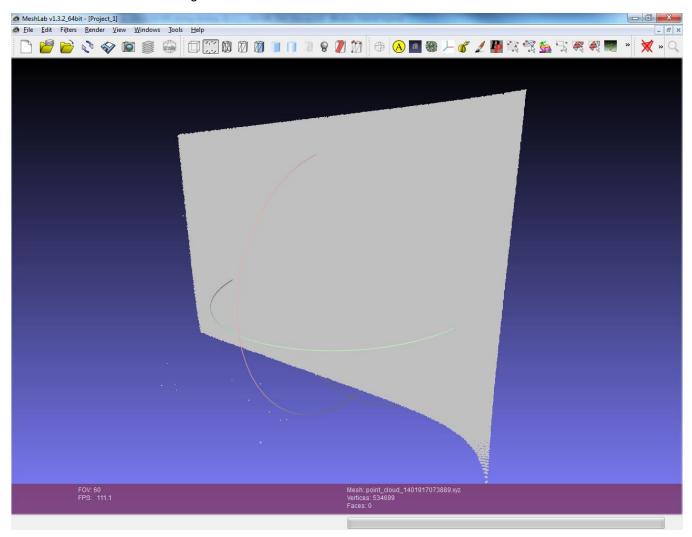


Figure 3-39. Point Cloud of a Flat Surface Generated With Poor Calibration Data



## 3.9 Scanning Objects

With the system calibration complete and verified, scanning of an object is done by placing the object of interest in the field of view of the camera and projector. Run the 3D Scanner executable file and enter the perform scan command "8." The object is scanned and a depth map image will open up. The output point cloud is saved as an XYZ file in the ../output/scan/ directory, viewable in MeshLab, as shown in Figure 3-40.

The system offers three types of scans. Option "6" uses only the horizontal patterns, options "7" uses only the vertical patterns, and option "8" uses both types of patterns. Best results will be obtained by using both types of patterns, being aware that option "8" cannot be used with three-phase hybrid scans.

CONTINUES AND DESCRIPTION	· cettale	of in projector.		
C C P . « TIDA-00361_3D_Sc	anner_LCr3000-2.0  LCr3000_3D_Scanner_Application	n_v2 ▶ output ▶	<b>▼ 4</b>	earch 🔎
Organize   Include in library	Share with   New folder			0
🧆 OSDisk (C:)	Name	Date modified	Туре	Size
L Cisco	👢 scan data	3/30/2016 9:55 AM	File folder	
NSCUtils	🗼 scan_images	3/30/2016 9:55 AM	File folder	
👢 OpenCV				
👢 Packages	Ξ			
PerfLogs				
Program Files Program Files (x86)				
Python27				
👢 Qt	▼ <			•
2 items				

Figure 3-40. Point Cloud File Location for Use With MeshLab



# Troubleshooting

### 4.1 General Troubleshooting Steps

This chapter details the troubleshooting steps for common problems encountered by users.

• **Problem:** The LightCrafter 3000 projector will not connect to the 3D Scanner program.

**Solution:** Make sure the LightCrafter 3000 GUI is not running on the PC. Reset the LightCrafter 3000, and reconnect using menu option "9."

• Problem: The projected images do not appear in the camera's live view on the PC.

**Solution:** It is likely that the LightCrafter 3000 and camera are not synchronized. Try reducing the frame rate of the camera, reducing the shutter speed, and increasing the exposure time and pattern period of the projector. These settings can be changed in the "config\_camera.txt" and the "config\_projector.txt" files in the ../config/ folder, respectively. The camera settings file is shown in Figure 4-1, and the projector settings are shown in Figure 4-2. In the example shown below, the camera frame rate is set to 15 frames per second. The projector exposure and period are set to 60,000 microseconds. The formula for the conversion to and from frame rate to exposure is:

 $10^6$  = Camera Frame Rate × Projector Exposure Time

(1)

config_camera.txt - Notepad		
File Edit Format View Help		
CAMERA_PARAMETERS_FRAME_BUFFER_SIZE	= 72	
#######################################		
##OpenCV Camera #		
#######################################		
#OPENCV_CAM_PARAMETERS_EXPOSURE	= 0	
#######################################		
##PointGrey Camera #		
######################################	= 18	
# For below parameter set	- 10	
# Rolling shutter color Camera - MONO8		=
# Global shutter Monochrome camera - RAW8	D ALVR	
PG_FLYCAP_PARAMETERS_PIXEL_FORMAT PG_FLYCAP_PARAMETERS_SHUTTER_EXPOSURE_MS	= RAW8 = 66	
PG_FLYCAP_PARAMETERS_FRAME_RATE_HZ	= 15	
PG_FLYCAP_PARAMETERS_STROBE_SOURCE	$= \frac{2}{1}$	
PG_FLYCAP_PARAMETERS_STROBE_ENABLE PG_FLYCAP_PARAMETERS_STROBE_POLARITY	= 1 = 1	
# For below parameter	- 1	
# Rolling shutter color camera - 5.0		
# Glocal shutter Monochrome camera - 0.0	0.0	
PG_FLYCAP_PARAMETERS_STROBE_DELAY PG_FLYCAP_PARAMETERS_STROBE_DURATION	= 0.0 = 1.0	
PG_FLYCAP_PARAMETERS_AUTOEXPOSURE	= 0	
PG_FLYCAP_PARAMETERS_EXPOSURE	= 1.0	-
4		
	- C. Channel, Ton Longerster, J	





config_projector.txt - Notepad	
File Edit Format View Help	
DLP_PLATFORM_PARAMETERS_SEQUENCE_PREPARED= 1DLP_PLATFORM_PARAMETERS_SEQUENCE_EXPOSURE_US= 60000DLP_PLATFORM_PARAMETERS_SEQUENCE_PERIOD_US= 60000	<u>۸</u>
LCR4500_PARAMETERS_USE_DEFAULT = 1 ##For below parameter ## 1 - External Positive Trigger ## 0 - Internal Trigger	
LCR4500_PARAMETERS_TRIGGER_SOURCE = 1 LCR4500_PARAMETERS_DLPC350_IMAGE_COMPRESSION = RLE LCR4500_PARAMETERS_VERIFY_IMAGE_LOAD_COUNT = 0	.P\DLPR350PROM-3.0.0\DLPR350PROM_v3.0.0.bin
LCR4500_PARAMETERS_LED_CURRENT_BLUE = 200	

Figure 4-2. Projector Configuration File

• **Problem:** The camera appears to be running at a very low frame rate causing slow scan rates. **Solution:** Close the 3D Scanner program by entering "0" at the main menu. Click the Windows Start button and search for "flycap2." Open the Point Grey FlyCap2 software, as shown in Figure 4-3.

Programs (12)
<u>     Point Grey FlyCap2         </u>
Location: Point Grey FlyCap2 (C:\FlyCapture)
Documents (171)
<pre> pg_flycap2_settings_c.o pg_flycap2_c.o pg_flycap2_c.o pg_flycap2</pre>
Microsoft Outlook (9)
<ul> <li>Makefiles</li> <li>Mexist Revision SDK EXE File</li> <li>Mexist Revision SDK EXE File</li> </ul>
Files (10)
<pre>     pg_flycap2_c.o     pg_flycap2_settings_c.o     pg_flycap2 </pre>
₽ See more results
flycap2 × Lock +
📀 🧭 🔚 🖸 💽 🕓 🥂

Figure 4-3. FlyCap2 Software Utility Shortcut



General Troubleshooting Steps

Select the camera in use, in the case of a single camera, it will already be selected. Click the Configure Selected button, as shown in Figure 4-4.

🕻 FlyCaptu	re2 Camera Selection 2.6.3.4				
Camera List (1 cameras detected)			Camera Information		
Serial #	Model	Interface	IP Address	Serial Number:	13480292
13480292	Flea3 FL3-U3-13Y3M	USB 2.0	N/A	Model:	Flea3 FL3-U3-13Y3M
				Vendor:	Point Grey Research
				Sensor:	Cypress VITA1300 (1/2" 1280x1024 CMOS)
				Resolution:	1280x1024
				Interface:	USB 2.0
				Bus Speed:	S480
				PCIe Bus Speed	Unknown PCIe bus speed
				IIDC Version:	1.32
				Firmware Version:	2.7.3.0
				Firmware Build Time:	Tue Sep 10 16:40:50 2013
				Driver:	USB Camera Driver (PGRUsbCam.sys) - 2.6.3.0
For	ce IP Refresh			OK Config Selec	ure ted Cancel

Figure 4-4. Configure Selected Camera in FlyCap2 Software



Enter the Advanced Camera Settings tab on the left of the screen, make sure the memory channel is set to default. Click the Save button, as shown in Figure 4-5.

FlyCapture2 2.6.3.4 Poin	t Grey Research Flea3 FL3-U3-13S2C (130212	33)		_ <b>x</b>
Camera Settings	Advanced Camera Settings			
Standard Video Modes	Raw Bayer output (Only for Y8 and Y16)	Select the frame-s	ge Information pecific information to be	
Custom Video Modes	Mirror image (horizontal flip)	embedded in the i	mage.	
Camera Information	V16 Endianness Big endian (IIDC 1394 DCAM Y16 mode)	Gain	Frame counter	
Camera Registers Trigger / Strobe	<ul> <li>Little endian (PGR-specific Y16 mode)</li> </ul>	Shutter	Strobe pattern	
Advanced Camera Settings	Display Test Pattern	Brightness	GPIO pin state	
High Dynamic Range	Pattern 1	Exposure	ROI position	
Look Up Table	Pattern 2	Select All	Unselect All	
Frame Buffer	None	Auto Range Cor	ntrol	
Data Flash	Memory Channels	Property: Expo	osure 🔻	
System Information	Channel: Default 🔹	Min: N/A	Max: N/A	
BusTopology	Note: Saving to the default memory channel restores the camera to factory defaults.	Get Range	Set Range	
Help / Support	Save	Buchalow		
		Bus Speed Cont Async Speed:	S480 -	
		Async Opeeu.	5400	
		Isoch Speed:	S480 🔻	
		_		

Figure 4-5. Restore Factory Camera Settings in FlyCap2 Software

FlyCap2 software will prompt the user that the default setting will load the factory settings. Click the OK button, as shown in Figure 4-6.

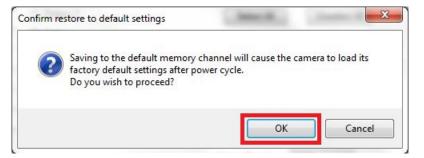


Figure 4-6. Confirm Factory Camera Settings in FlyCap2 Software

After the factory settings have been sent to the camera, disconnect the Flea3 camera from the PC. Wait 3 seconds with the camera depowered before plugging the camera back into the PC. Restart the 3D Scanner program and try to scan an object to verify the solution.



General Troubleshooting Steps

• **Problem:** The host PC does NOT have a USB 3.0 port to connect the Flea3.

**Solution:** The Flea3 camera can be connected to a USB 2.0 port but must be run at a lower frame rate. Open the file named "config\_camera.txt" in the ../config/ folder and change the value for "PG\_FLYCAP\_PARAMETERS\_FRAME\_RATE\_HZ" to "30" or less, as shown in Figure 4-7. Change the projector exposure and period in the "config\_projector.txt" file according to the above frame rate/exposure time equation.

in config_camera.txt - Notepad	_	
File Edit Format View Help		
CAMERA_PARAMETERS_FRAME_BUFFER_SIZE	= 72	A
#######################################		
##OpenCV Camera #		
######################################	0	
#OPENCV_CAM_PARAMETERS_EXPOSURE	= 0	
#######################################		
##PointGrey Camera #		
######################################	= 18	
# For below parameter set	- 10	
# Rolling shutter color Camera - MONO8		=
# Global shutter Monochrome camera - RAW8	= RAW8	
PG_FLYCAP_PARAMETERS_PIXEL_FORMAT PG_FLYCAP_PARAMETERS_SHUTTER_EXPOSURE_MS	= 66	
PG_FLYCAP_PARAMETERS_FRAME_RATE_HZ	= 15	
PG_FLYCAP_PARAMETERS_STROBE_SOURCE	= 2	
PG_FLYCAP_PARAMETERS_STROBE_ENABLE	= 1 = 1	
PG_FLYCAP_PARAMETERS_STROBE_POLARITY # For below parameter	= 1	
# Rolling shutter color camera - 5.0		
# Glocal shutter Monochrome camera - 0.0		
PG_FLYCAP_PARAMETERS_STROBE_DELAY	= 0.0	
PG_FLYCAP_PARAMETERS_STROBE_DURATION PG_FLYCAP_PARAMETERS_AUTOEXPOSURE	= 1.0 = 0	
PG_FLYCAP_PARAMETERS_EXPOSURE	= 1.0	
1	- Contractor Contractor	

### Figure 4-7. Camera Configuration File Settings for USB 2.0

• **Problem:** Attempting to scan an object, or take any captured image, causes a fatal error in the operating system.

**Solution:** The Point Grey software can cause issues if the 3D Scanner program is terminated unexpectedly due to unterminated camera execution threads. If your 3D Scanning program is closed in any way **other** than entering "0" into the command prompt, put the PC into sleep mode – or restart the PC entirely – before attempting to take a picture with the camera.



# **Revision History**

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

C	Changes from Original (May 2015) to A Revision Page			
CI • • • •	hanges from Original (May 2015) to A Revision       P         Restructured document to follow format of other DLP user guides	. 6 . 6 . 6 . 6 . 7 . 7 . 9 18		
• • • •	Updated screenshots and file names for installing 3D scanner design in Section 2.5	25 25 26 51 55		

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