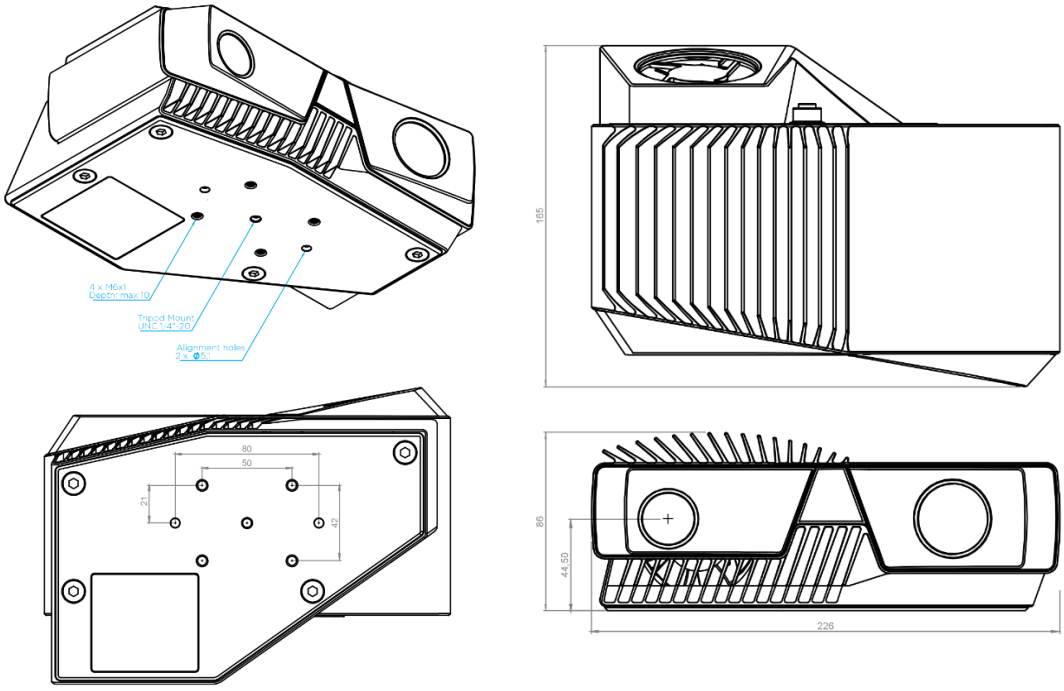
ZIVID STUDIO USER GUIDE

Zivid Studio is a tool designed to help you get easily started with the features of your Zivid 3D camera.

Before you start

1. Read the Quick Start Guide to correctly set up your camera and install Zivid Studio on your PC. This is available on our website under Developer > Quick Start Guide https://www.zivid.com/quick-start-guide

2. Mount the camera using the interface underneath the camera.



3. Ensure that you have set up the camera within the optimal operating distance range.
   Zivid One: 80 cm
   Zivid One+ Small: 40 cm
   Zivid One+ Medium: 80 cm
   Zivid One+ Large: 120 cm

4. Download the latest version of Zivid Studio from the webpage: https://www.zivid.com/downloads

5. Download the technical specification datasheet from the webpage: https://www.zivid.com/downloads

Quick Reference Index

Option	Function
File	
Open	Loads a .ZDF file which is the native Zivid file format. ZDF files include the point cloud, 2D image, basic settings used to capture the point cloud and camera info.
Save	Saves the point cloud in the chosen file format. Saving as .ZDF will also store the 2D image and the depth image.
Export	Allows you to export the .zdf file as PLY file (*.ply as ordered or unordered)/ ASCII points file (*xyz)/ Point cloud data file (*.pcd)
Exit	Exits Zivid Studio.
View	
Reset 3D View	Resets the layout of the 3D point cloud.
Color	Turns the color on or off. When color is turned off, all acquired pixels in the point cloud are represented in green.
Mesh	Creates the appearance of a mesh between all available points in the point cloud.
Reset UI layout	Resets the layout of the Zivid Studio window.
Enter full screen mode	Toggles between full and regular screen (keyboard shortcut- F11).
Help	
View help online	Redirects you to the Zivid knowledge base.
Legal Notice	Gives you detailed legal information and third-party software notices.
System Info	Gives you information on the systems used by the Zivid software.
Capture dialogue	
Capture (Single/HDR)	Takes an image with all the settings specified in the iris frames that are checked. Unchecked frames are ignored in capture.
Live	Enables live mode so you can view the scene in real time.
Exposure time	Increases the amount of light that enter the camera. Use in combination with iris setting to determine how much light enters the camera.
Iris /Aperture Step	The electronic iris setting adjusts how much light enters the camera. Use in combination with exposure time to determine how much light enters the camera. For sharp images, it is recommended to set the iris below 40 and increase exposure time beyond this instead.

Brightness	The brightness function is set according to the ambient light in operating conditions. Set the brightness < 1.0 in dark conditions and > 1.0 in strong ambient lighting. Setting brightness > 1.0 enables the Boost light mode. Boost light mode is helpful when the object is far away. If the scene is close it might be a good idea to reduce brightness to avoid oversaturation from the projector. Note that live mode will not work when boost light mode is enabled. Enabling boost light mode also reduces the amount of capture time during a certain time interval. The camera will be limited to a maximum of 50% duty cycle over a 10 second period. This is to prevent the camera from overheating.
Gain	The gain setting allows you to set the analog gain of the camera for each frame. Having a low gain setting reduces noise and is recommended. However, in some cases with dark scenes it might be necessary to increase the gain to get data.
Red color balance	The red color balance values affect the white balance of the camera. The minimum value is 1.0 and the maximum value is 8.0. Strong ambient lighting may affect the appearance of the color image, and it may require these settings to be altered.
Blue color balance	The blue color balance values affect the white balance of the camera. The minimum value is 1.0 and the maximum value is 8.0. Strong ambient lighting may affect the appearance of the color image, and it may require these settings to be altered.
Bidirectional setting	The bidirectional mode projects light patterns horizontally and vertically. Enable if reflection filter cannot get rid of certain noise points. Note that bidirectional mode takes more time and requires that exposure time be set to at least 33000 µs.
Contrast	Enabling the contrast function allows you to specify a minimum contrast for a point to be considered valid. Typically, the contrast will be low in areas of the image that lie in the shadow of the projector light. The contrast will also be low if the iris or the exposure time is set too low, resulting in a dark image. The contrast is defined as the standard deviation for the intensity observed in each pixel as different bright and dark patterns are projected onto it. The default value for the minimum contrast is 5.0 gray levels. Increasing the threshold of the contrast filter can help improve the accuracy of the point cloud by removing noisy pixels. *The contrast is directly related to the signal-to-noise ratio.* Try to set the iris and exposure time to get a color image that is as bright as possible.
Outlier	Enabling the outlier function allows you to eliminate points based on the distance between the point and its neighbors. The threshold specifies the maximum distance in millimeters between points to be considered a valid point. If the distance between the point and its neighbors is larger than threshold, it is considered an outlier and is eliminated. The default value

	for contrast is set to 5.0 mm. The threshold can be increased to e.g. 20 mm if the scene to be imaged is around 2 m away.
Reflection filter	The reflection filter attempts to identify and remove erroneous pixels caused by reflections. Such pixels typically look like they are being pulled towards or away from the camera relative to the surface.
Saturation	The saturated function allows you to eliminate all saturated points from your point cloud.
Window options	
Scan for connected cameras	Creates a list of all cameras that are connected to the PC in use, lists them by model and serial number. Zivid Studio can control one camera at a time.
Expand all	Expands the settings on all available frames.
Collapse all	Collapses the settings on all available frames.
Reset to default	Resets the layout of the 3D point cloud.
Add frame	Adds a frame resembling all the settings of the last specified iris frame.
Clone frame	Adds a frame resembling all the settings of the chosen frame.
Delete frame	Deletes the chosen frame.

I. An Introduction to Zivid Studio

What is Zivid Studio?

Zivid Studio is an application that provides you simple graphical user interface (GUI) to explore the functionality of Zivid, our advanced and exceptionally accurate 3D camera.

What to expect with Zivid Studio?

With Zivid Studio you can explore all the available functions of the Zivid camera to correctly develop your application. You can:

- Visualize the 3D point cloud, 2D image and depth data
- Save the point cloud to disk
- Determine the correct settings for your sample object
- Enable live mode to view the 3D point cloud in real time
- Evaluate data quality in high quality 3D images

A point cloud is a 3D representation of an image. A good point cloud is characterized by dense points and no missing data, yielding a life-like 3D model of the captured scene

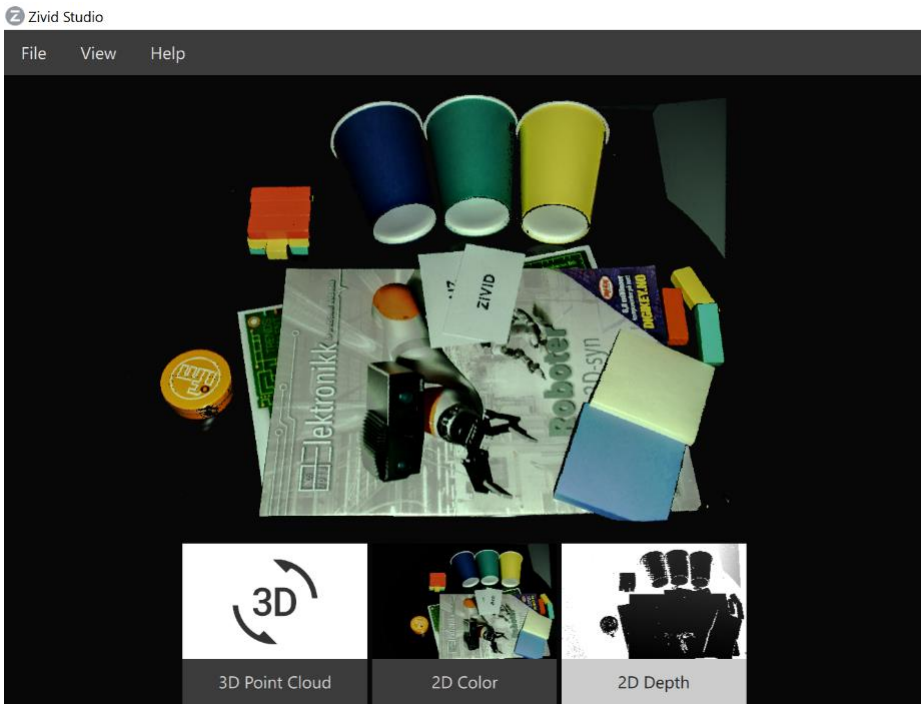


Fig 1 Zivid Studio displaying 3D point cloud, camera image and depth image

1. Overview of user interface elements in Zivid Studio

1.1 Toolbar

The Zivid Studio toolbar on the top of the interface comprises of some options to allow you to save your image, control the interface, and get information about the Zivid Studio interface being used.

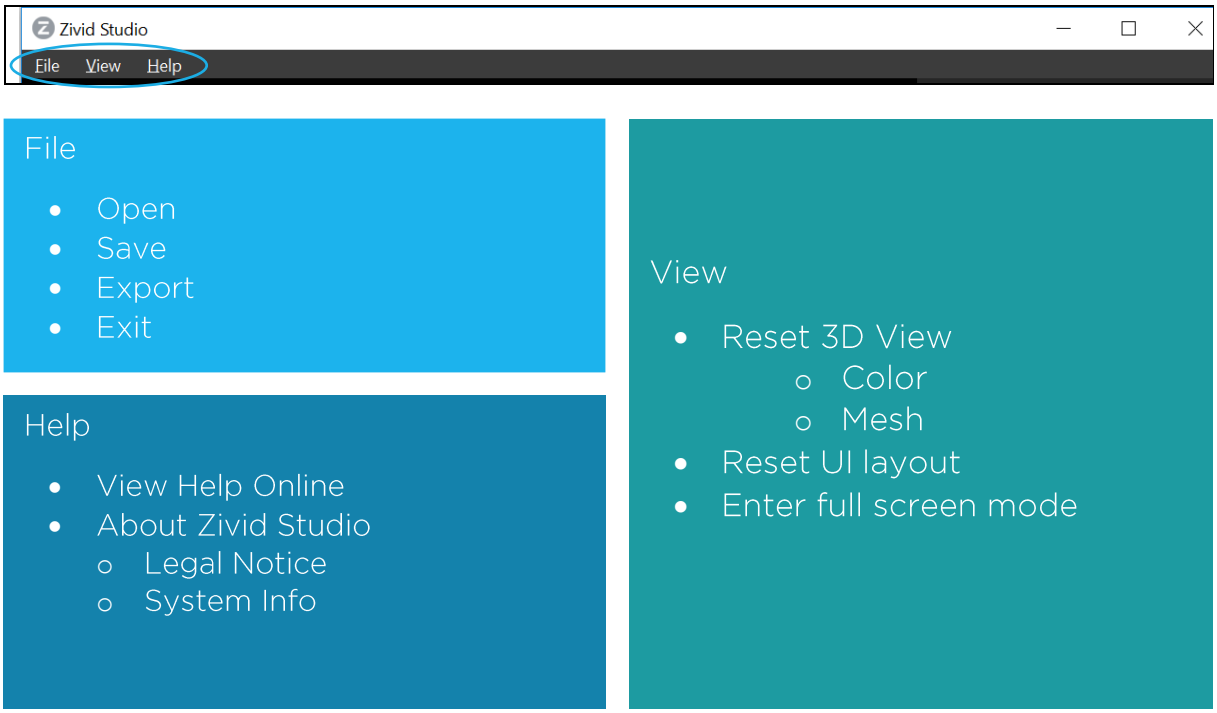


Fig 1.1 Toolbar options with Zivid Studio

Option	Function
File	
Open	Loads a .ZDF file which is the native Zivid file format. ZDF files include the point cloud, 2D image, basic settings used to capture the point cloud and camera info
Save	Saves the point cloud in the chosen file format. Saving as .ZDF will also store the 2D image and the depth image.
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View help online	Redirects you to the Zivid knowledge base
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System Info	Gives you information on the systems used by the Zivid software

Table 1 Zivid Studio toolbar features in detail

1.2 Available Views

There are three available views to choose from at the bottom of the Zivid Studio interface as shown in **Fig 1.2**

Fig 1.2 Available views

3D Point Cloud

This view displays the 3D point cloud of the scene after capture, or in real time when using the live mode. This is a flexible view with zoom, pan, and rotate functionality. Use the left mouse button to rotate the point cloud and the right mouse button to pan the view. You can zoom in or out by rolling the mouse wheel, or by the middle mouse button (if available) followed by dragging the mouse.

2D Color

You can view the 2D image by choosing the 2D color tab at the bottom. Zoom and pan functionality is available, however rotate function is not available with this view.

2D Depth

This view displays the depth image of the imaged objects. The color scale shows the variation in distance along the z-axis from the camera to the surfaces of the imaged objects.

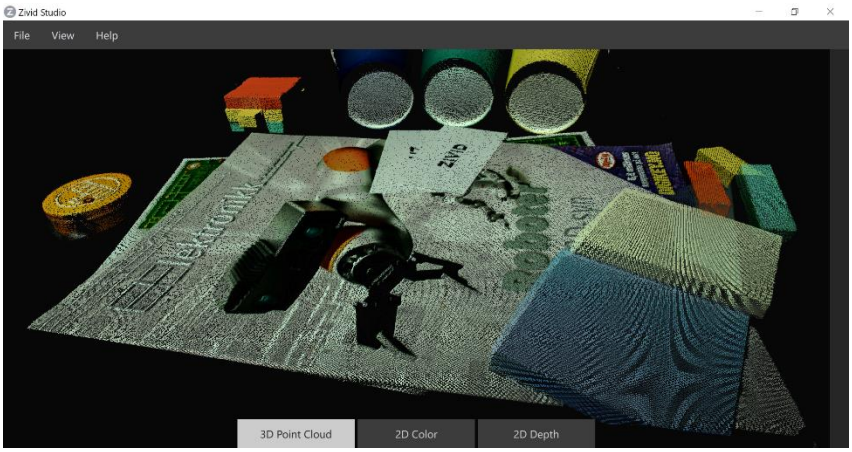


Fig 1.3 3D point cloud in color

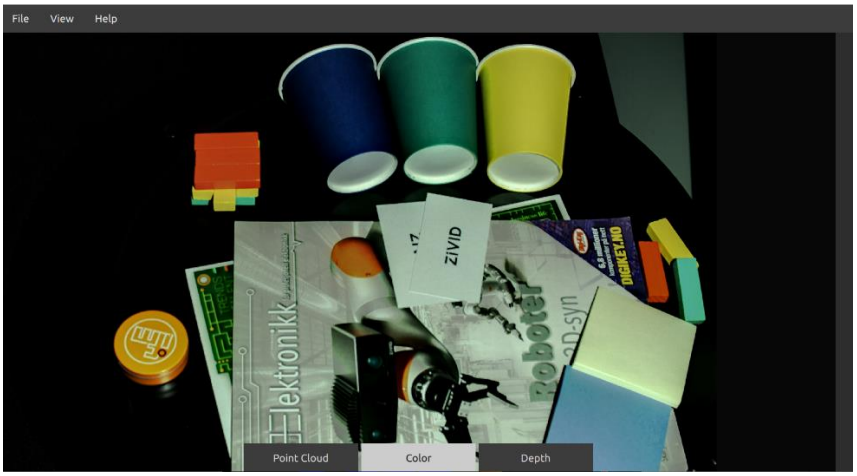


Fig 1.4 2D image in color

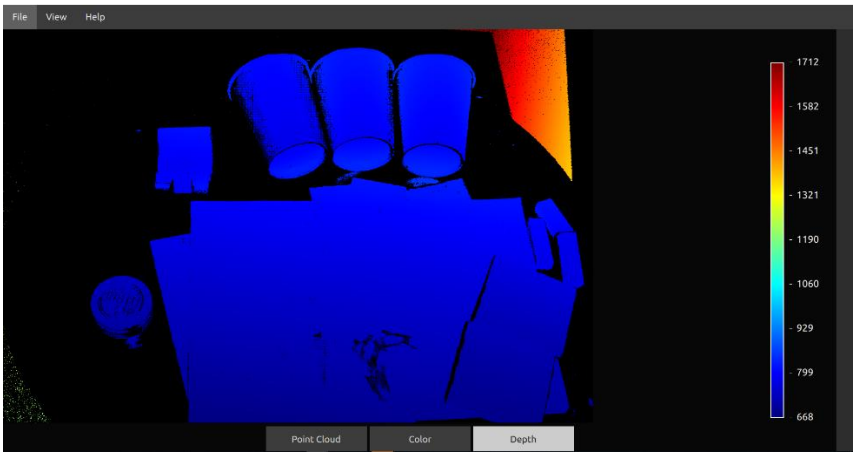


Fig 1.5 2D depth image in color

1.3 Basic settings

There are several unique filters and settings available in Zivid Studio to ensure that you get a high-quality point cloud. The basic settings to adjust in order to capture a good 3D image are iris, exposure time and brightness.

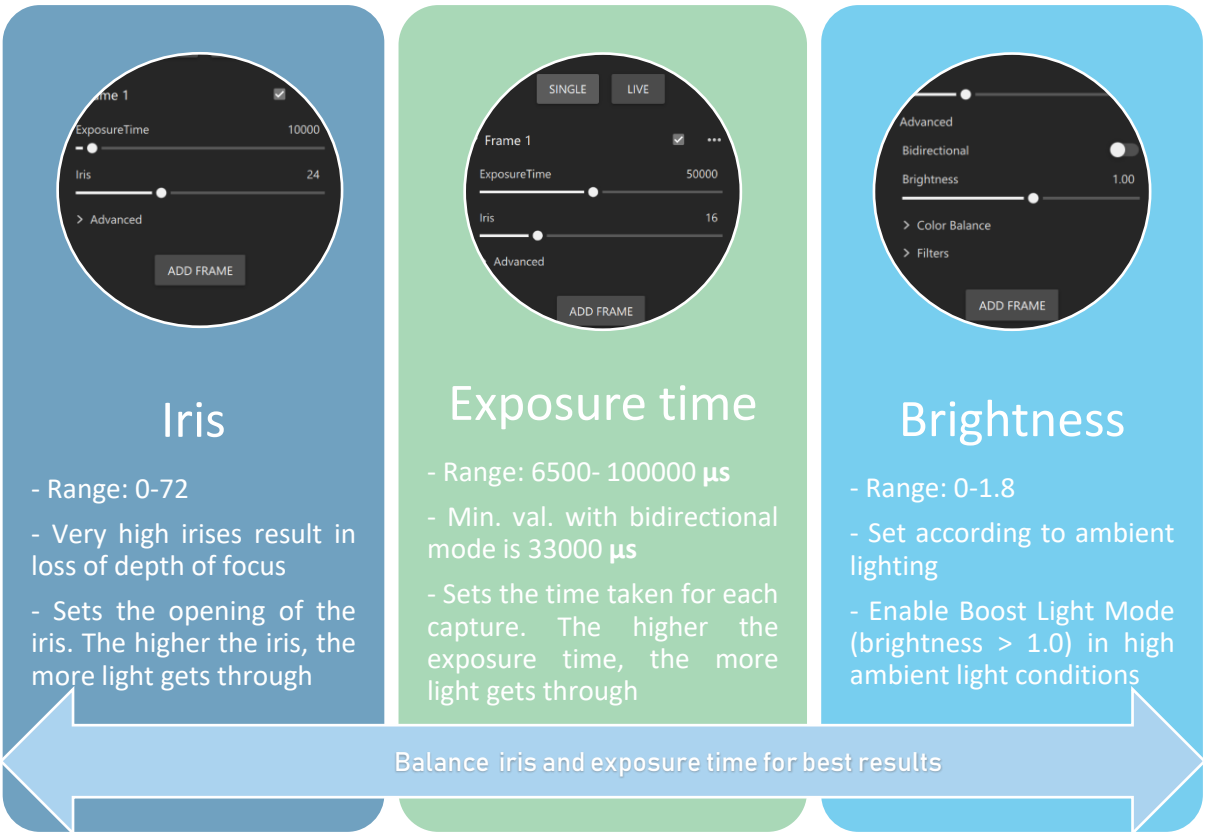


Fig 1.6 Basic settings in Zivid Studio

Expert Tip: To ensure that images retain depth of field, set the iris values below 40 and increase the exposure time instead to compensate for loss of light.

2. Capture your first image in 3 steps

2.1 Single Frame Capture

Step 1. Enter live mode

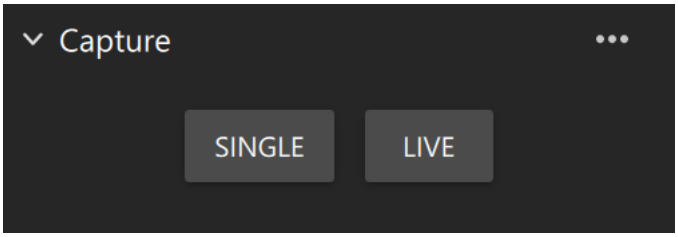


Fig. 1.7 Mode buttons - single and live

Step 2. Determine optimal settings to acquire dense points over the entire scene.

The camera has an electronic iris that controls the amount of light that gets into the camera. The iris can have values from 0 to 72 where higher values let more light in. The iris is open enough to capture objects from a scene at around iris value range of 8-10. As you keep on increasing the iris you will continue to acquire more and more points on your object until a certain iris value. Beyond this iris value, you will start losing points on your object. A sample graph for a white object is shown below.

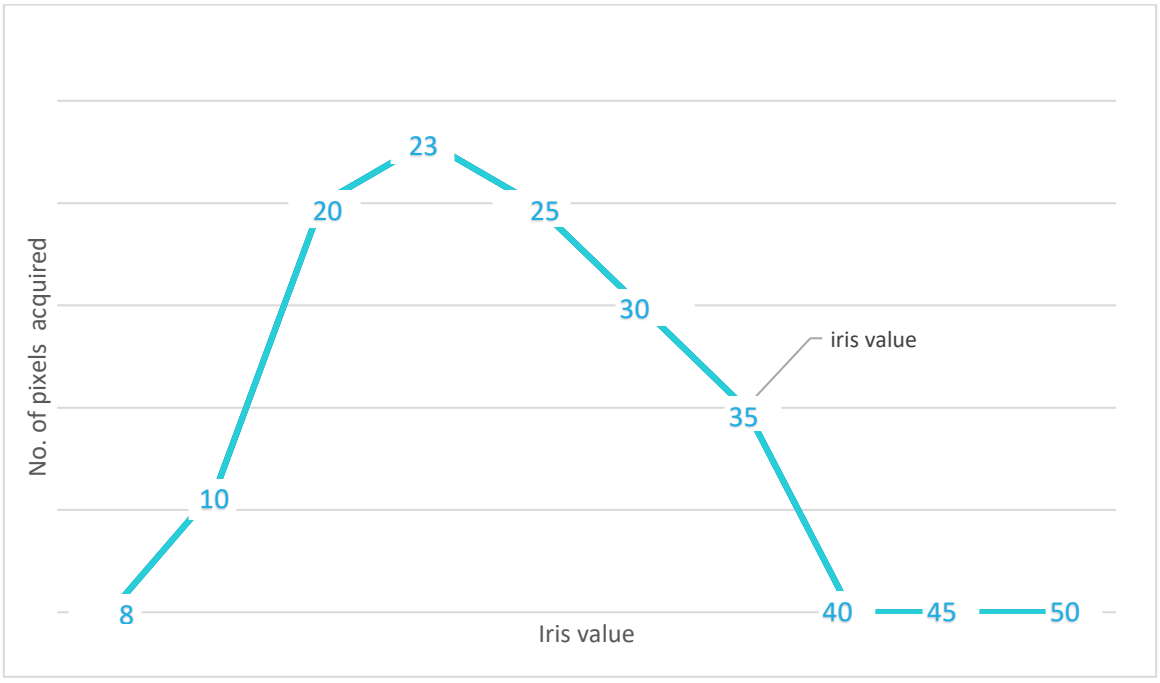


Fig. 1.8 Number of pixels acquired and iris value for a white sample object

The Zivid camera can capture high quality images for many objects with a single iris. However, depending on the objects being imaged, you may need more than one iris value to get points on the whole scene.

- Find the iris value that gives you max points on the scene.
- Address any areas with missing points. Click add frame to add more iris values.

- For dark objects in your scene, if you have to increase the iris beyond 40 to get points, increase the exposure time in increments until you can get points with an iris value 40 or below. This will help you retain depth of field for the images.
- Use the available parameters like the reflection filter.

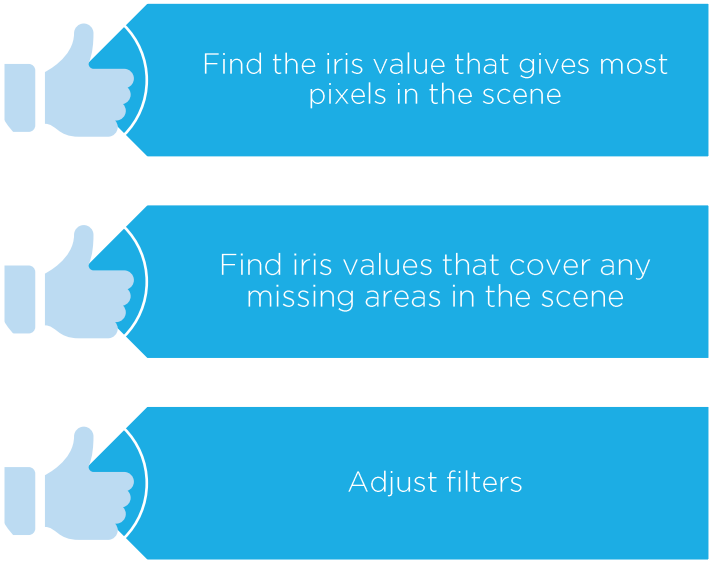


Fig. 1.9 Choosing optimal settings

Turning the color off (View > Colors OR keyboard shortcut 'c') shows you all the acquired points in green. This can be helpful when determining the optimal iris values.

Do not choose iris values randomly or in increments. This reduces data quality. Ensure that you adjust the iris slider in live mode to find the iris(es) that render points over the whole scene.

If multiple irises are required, click add frame

Step 3. Click capture to view the resulting point cloud

2.2 Multi frame HDR

All the settings available within Zivid Studio are clustered into frames. For each frame specified, the camera captures an image with all the associated settings (iris, exposure time, brightness etc.) for that frame. The images corresponding to each frame are finally combined to display a single high-quality HDR output image.

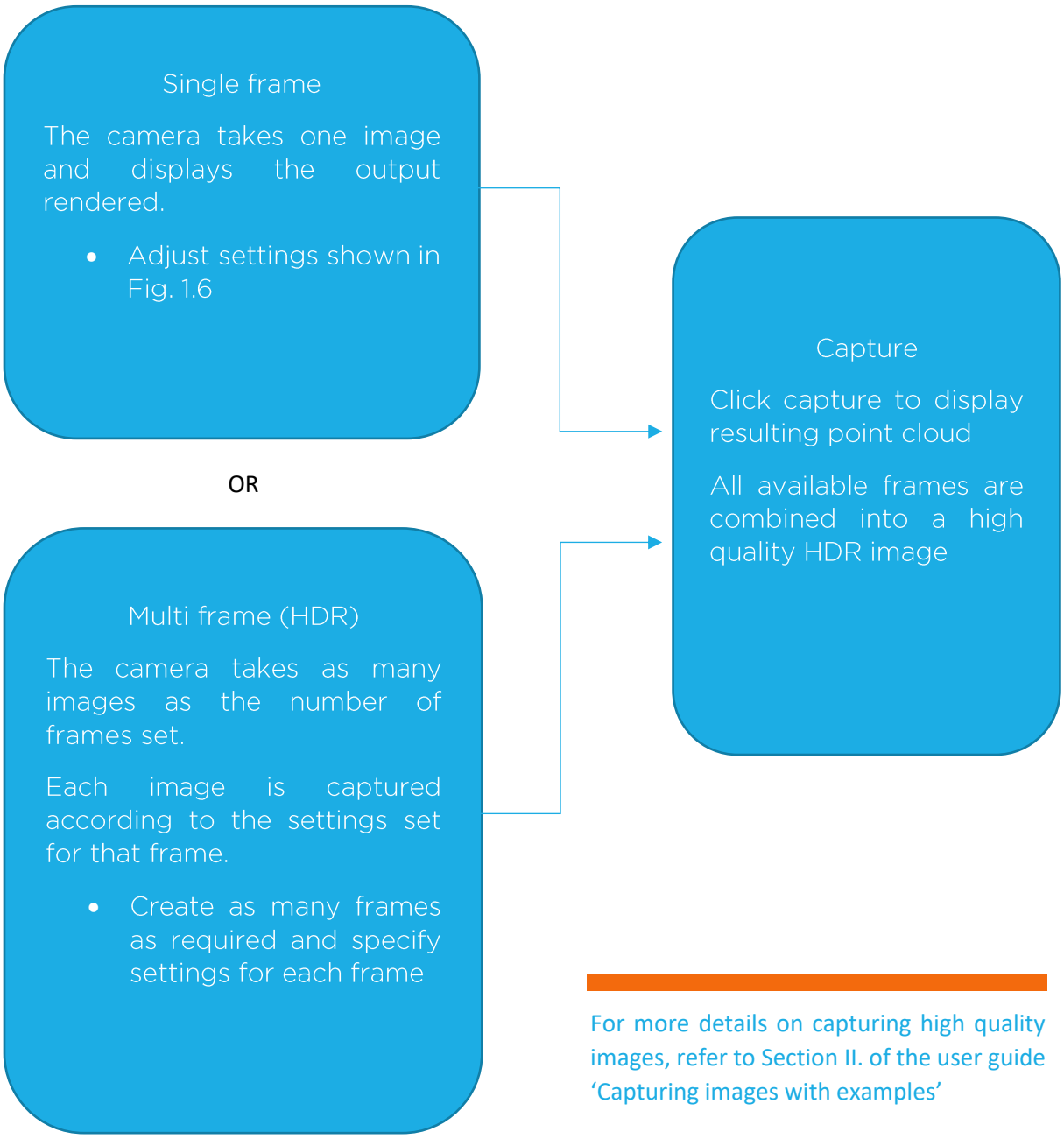


Fig 1.10 Capture Dialog

3. Zivid Studio features in detail

Capture dialogue options

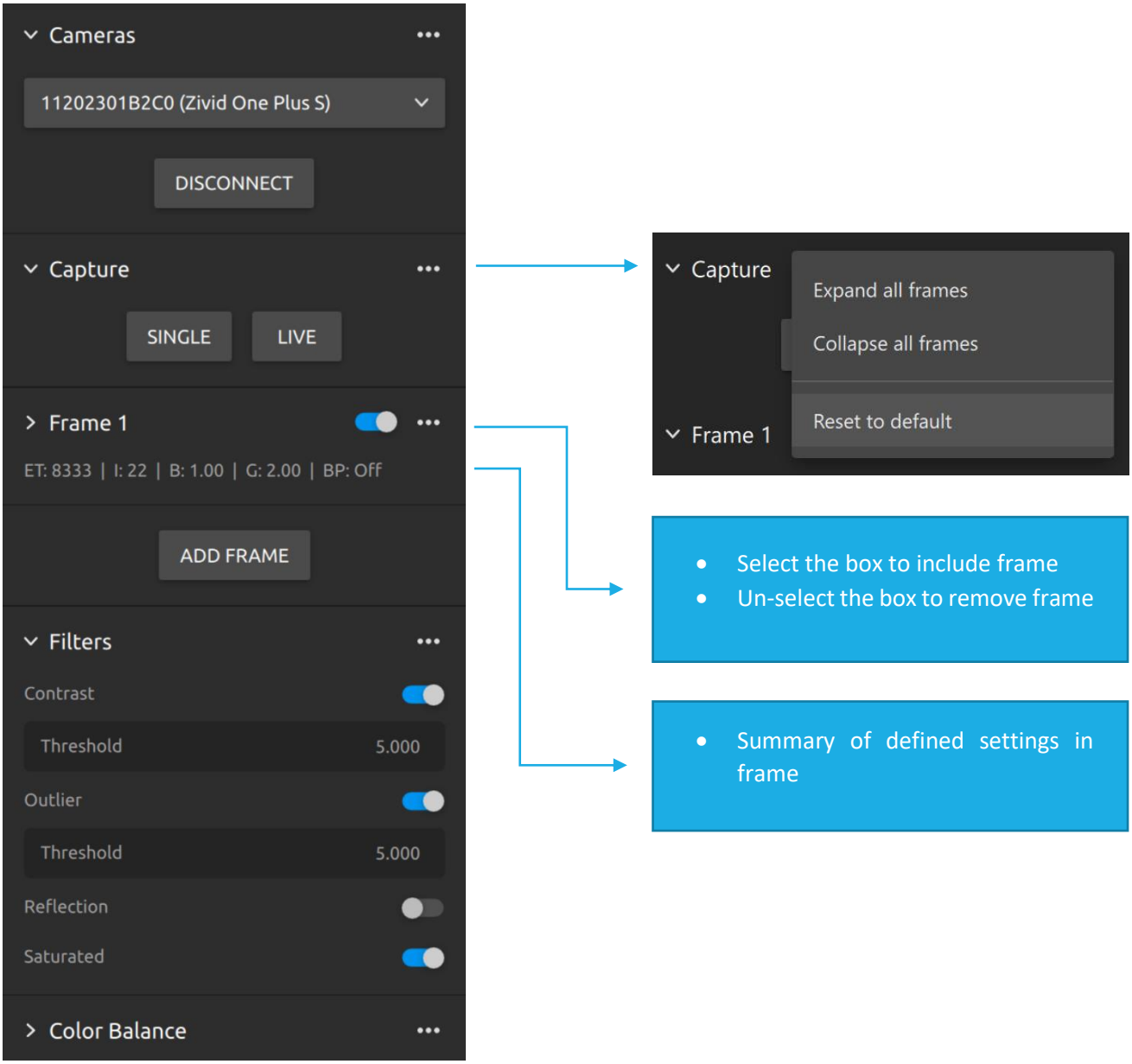


Fig. 1.11 Capture dialogue and frames

Zivid Studio functions in detail

The exposure time value increases the amount of light into the camera. Use exposure time in combination with the iris value to determine how much light enters the iris.

The iris value increases the amount of light into the camera. Increasing the iris above 40 makes the image blurred. Keep the iris values less than 40 and rather increase exposure time instead to retain depth of focus. Use in combination with the exposure time setting to determine how much light enters the iris.

It is recommended to use Brightness > 1 if the ambient lighting conditions are strong or if the scene is far away (≳ 1.5 m). Enabling boost light mode (Brightness > 1) reduces the amount of capture time during a certain time interval. The camera will be limited to a maximum of 50% duty cycle over a 10 second period. This is to prevent the camera from overheating.

The gain control allows you to set the analog gain of the camera for each frame. Having a low gain setting reduces noise and is recommended. However, in some cases with dark scenes it might be necessary to increase the gain to get data.

The bidirectional mode projects light patterns horizontally and vertically. Enable if reflection filter cannot get rid of certain noise points. Note that bidirectional mode takes more time and requires that exposure time be set to at least 33000 µs.

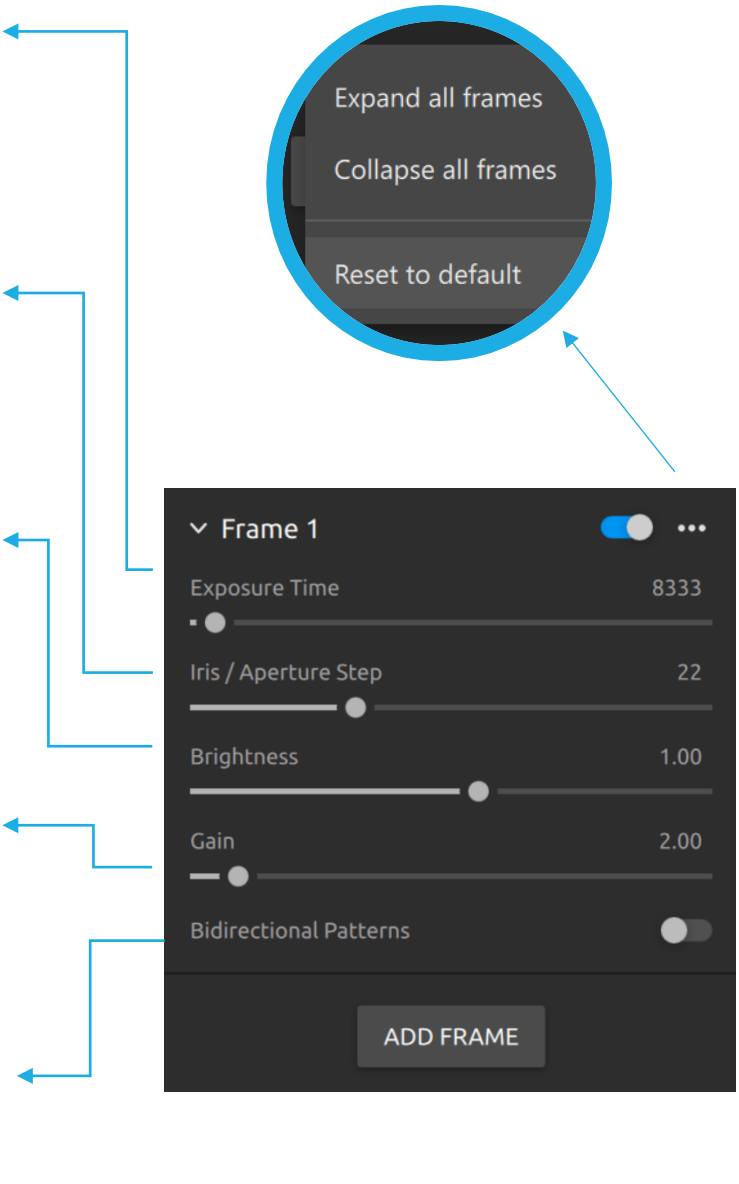


Fig. 1.12 Capture dialogue and frames

Enabling the contrast function allows you to specify a minimum contrast for a point to be considered valid. Typically, the contrast will be low in areas of the image that lie in the shadow of the projector light. The contrast will also be low if the iris or the exposure time is set too low, resulting in a dark image.
The contrast is defined as the standard deviation for the intensity observed in each pixel as different bright and dark patterns are projected onto it. The default value for the minimum contrast is 5.0 gray levels. Increasing the threshold of the contrast filter can help improve the accuracy of the point cloud by removing noisy pixels.
Note: The contrast is directly related to the signal-to-noise ratio. Try to set the iris and exposure time to get a color image that is as bright as possible.

Enabling the outlier function allows you to eliminate points based on the distance between the point and its neighbors. The threshold specifies the maximum distance in millimeters between points to be considered a valid point. If the distance between the point and its neighbors is larger than threshold, it is considered an outlier and is eliminated. The default value for contrast is set to 5.0 mm. The threshold can be increased to e.g. 20 mm if the scene to be imaged is around 2 m away.

The reflection filter attempts to identify and remove erroneous pixels caused by reflections. Such pixels typically look like they are being pulled towards or away from the camera relative to the surface.

The saturated function allows you to eliminate all saturated points from your point cloud.

Color balance values affects the white balance of the camera. The minimum value is 1.0 and the maximum value is 8.0. Strong ambient lighting may affect the appearance of the color image, and it may require these settings to be altered.

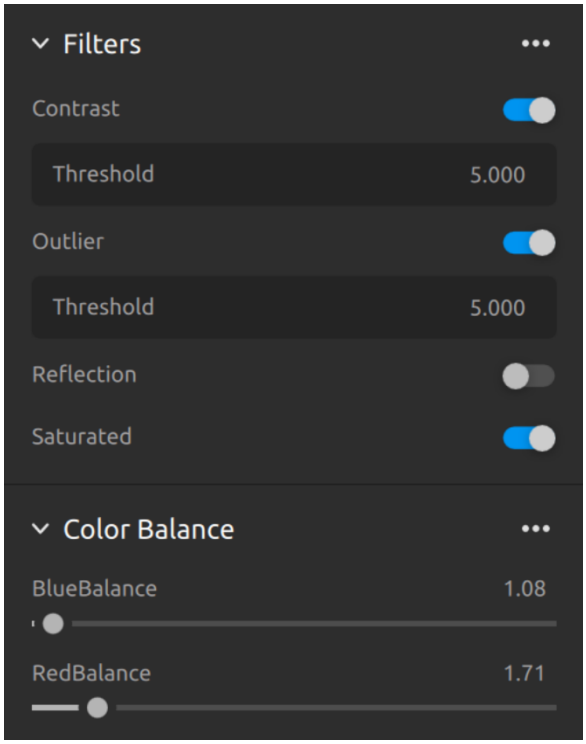


Fig. 1.13 Capture dialogue and frames

	SMALL	MEDIUM	LARGE
Key usage	Tiny and small objects, trays/boxes	Small and medium objects, totes/bins	Medium and Large objects, standard EU/US pallets
Optimal range	0.3 - 0.8 m	0.6 - 1.6 m	1.2 – 2.6 m
Maximum range	1.0 m	2.0 m	3.0 m
Acquisition Rate	13 Hz (full resolution)		
Output	3D (XYZ)+ Color (RGB) + Quality (Q) for each pixel		
Image Size	1920 x 1200 (2.3Mpixel)		

Table 2 Optimal range and output for Zivid One+ models

4. Aperture control, electronic iris and corresponding f-numbers

The electronic iris is an adjustable opening (aperture), which controls the amount of light coming through the lens (i.e. the "exposure"). The more you open the iris, the more light comes in and the picture appears brighter. The iris can have values from 0 to 72 where higher values lets more light in. The iris is open enough to capture objects from a scene at around iris value range of 8-10. As you keep on increasing the iris you will continue to acquire more and more points on your object until a certain iris value. Beyond this iris value, you will start losing points on your object (**Fig . 1.82.2**).

To maintain the same photographic exposure when doubling the *f*-number, the exposure time would need to be four times as long.

Reducing the aperture diameter (increasing the *f*-number) increases the depth of field because only the light travelling at shallower angles passes through the aperture.

Zivid One Plus	f-number	f/1.4	f/2	f/2.8	f/4	f/5.6	f/8	f/11	f/16	f/22	f/32
	Zivid Iris (≈)	72	46	35	27	22	17	14	12	10	8
S	Depth of Field [mm]	40	60	80	115	165	235	320	470	645	940
M		165	235	330	470	655	940	1290	1875	2580	3750
L		535	760	1065	1520	2125	3040	4180	6075	8355	12150

Table 3: F-number, iris and depth of field

You will notice that changing the lower iris values changes the F-stop number considerably. As the iris values increase, the change in *f*-number becomes smaller and the DOF also reduces significantly.

II. Capturing Images: Examples

To help you understand how to take optimal images with your new Zivid One+ 3D camera, we have compiled a few case scenarios with different types of materials.

1. Case 1: Dark objects

SAMPLE	Zivid One+ 3D camera
MATERIAL	Black anodized aluminum and plastic
MODE	Multi frame
ESTIMATED TIME REQUIRED	4 minutes
AMBIENT LIGHTING	Low
STEPS	7

Fig 2.1 Zivid Camera in 2D

Step 1: Enter live mode.

Step 2: Adjust the iris slider to find the settings that gives you maximum number of points in the point cloud.

Step 3. Adjust the exposure time if necessary.

Keeping the irises low to retain depth of focus

With the default exposure time, you need to increase the iris above 40 to get points on the black object. In this case, stop live mode, increase the exposure time (use increments of 20000) and enter live mode again to find the optimal iris values which will now be lower because of the increased exposure time.

Repeat this process if necessary, to find the best combination of exposure time and iris value which yields a sharp image.

Step 4: If multiple irises are required, click add frame to introduce new iris(es). You can adjust the exposure time and other settings for every frame as required.

Review your point cloud

It is recommended to select each defined frame individually and click capture to view the resulting point cloud. This helps to ensure that you have not added any non-valued frames (where the resulting point cloud is already covered in another defined frame). Adding only the required number of frames ensures that the camera runs without any unrequired delays.

Step 5: Click capture to view the resulting point cloud from all the defined frames. Turn color off (keyboard shortcut 'c') to ensure that you have points all over the black object or change settings if required.

For this case with the Zivid camera, the combination of iris values 15 and 36 along with the exposure time of 10000 produces a good point cloud. **Fig 12.2** and **Fig 1 2.3** illustrate the need for multi-frame capture. **Fig 1 2.4** has dense points over most of the object, but some areas, e.g. around the edges and the Zivid logo do not have points unless you include iris 15.

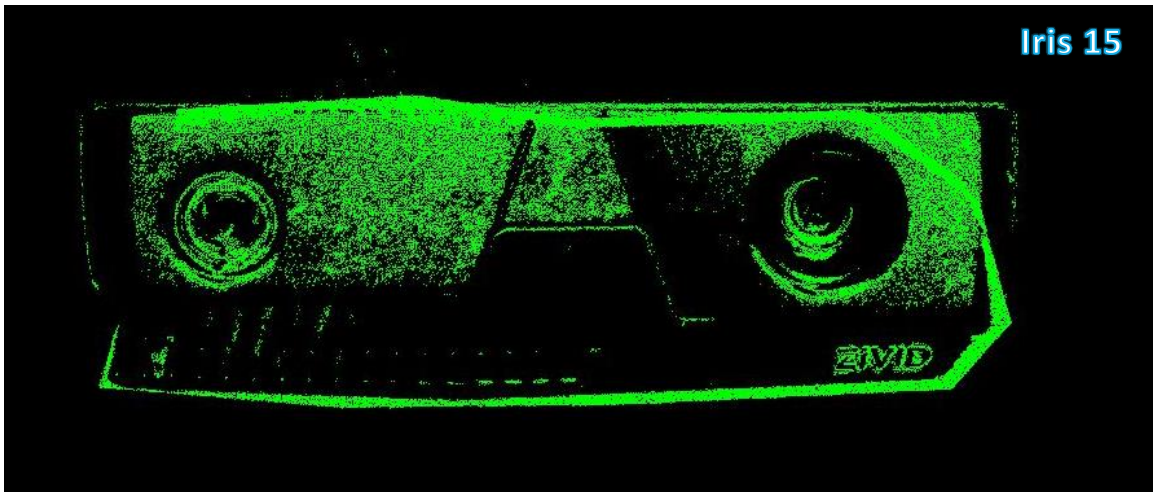


Fig 2.2 Single frame capture with Iris 15

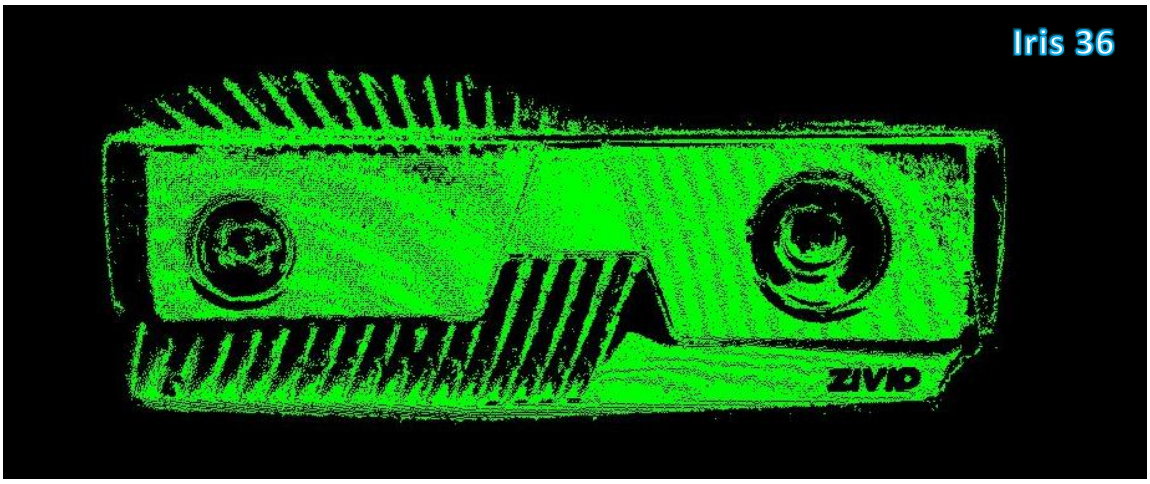


Fig 2.3 Single frame capture with Iris 36

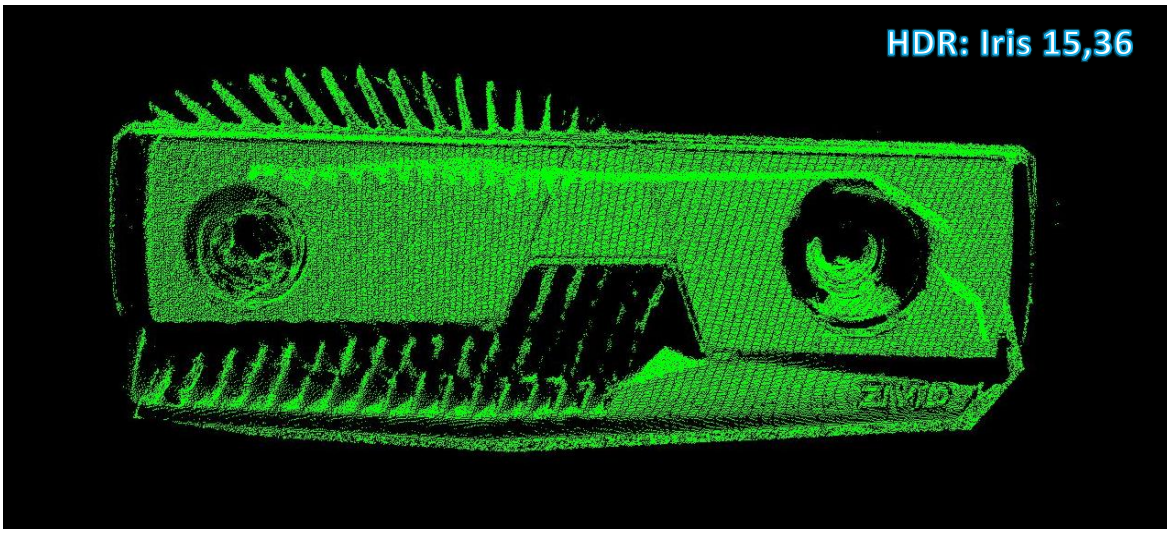


Fig 2.4 High quality point cloud using HDR mode with iris 15 and 36

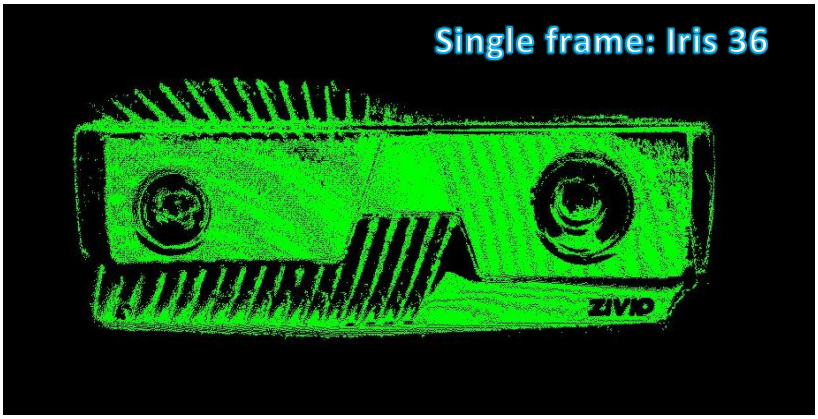
For this case with the Zivid camera, the combination of iris values 15 and 36 along with the exposure time of 10000 produces a good point cloud. **Fig 12.2** and **Fig 1 2.3** illustrate the need for multi-frame capture. **Fig 1 2.4** has dense points over most of the

object, but some areas, e.g. around the edges and the Zivid logo do not have points unless you include iris 15.

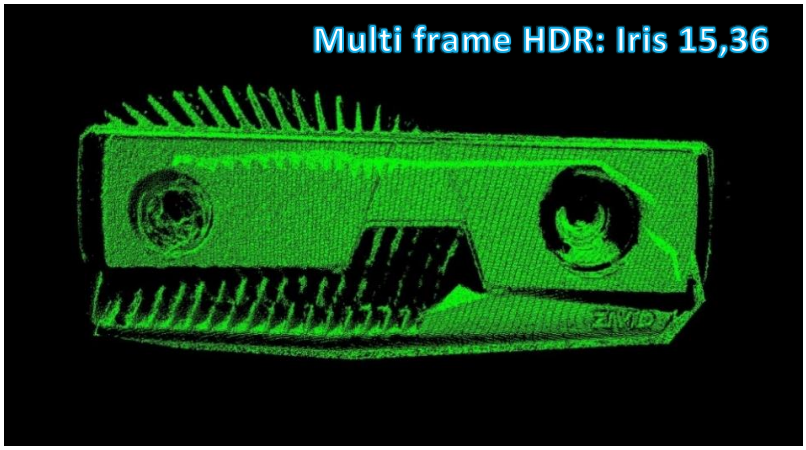
Optimize your settings

When including multi frames, the goal is to use the least number of irises to get a complete point cloud. For case 1, a high-quality point cloud was achieved by using just 2 irises. Increasing the number of irises used or increasing the exposure time, increases the overall acquisition time

The number of iris values used, and the resulting quality of data should be based on the needs of your application.



For **bin-picking applications**, iris 36 renders a point cloud that is satisfactorily dense. Adding iris 15 is not necessary in this case and choosing just 1 frame ensures faster acquisition time and eliminates unnecessary delays.



For **quality inspection applications**, on the other hand, it is important to include all irises that ensure a complete point cloud because of the nature of the application. In this case, ensure that you have chosen best iris and exposure time values to avoid including more frames than necessary.

Fig 2.5 Optimizing settings for your application

2. Case 2: Colored objects

SAMPLE	Meffert's cube
MATERIAL	Colored plastic
MODE	Multi frame
ESTIMATED TIME REQUIRED	2 minutes
AMBIENT LIGHTING	Medium
STEPS	4

Fig 2.6 Image of Meffert's cube in 2D

Step 1: Enter live mode.

Step 2: Adjust the iris slider to find the settings that gives you maximum number of points in the point cloud.

Step 3. Adjust the exposure time if necessary.

For the Mefferts cube, it was not necessary to change the exposure time.

Step 4: If multiple irises are required, click add frame to introduce new iris(es). You can also adjust the exposure time and other settings for every frame as required.

Preview your point cloud

It is recommended to select each defined iris frame individually (use the check box) and click capture to view the resulting point cloud. This helps to ensure that you have not added any non-valued frames (where the resulting point cloud is already covered in another defined iris frames). Adding only the required number of frames ensures that the camera runs without any unnecessary delays

Step 5: Click capture to view the resulting point cloud from all the defined frames. Turn color off (keyboard shortcut ‘c’) to ensure that you have points all over the black object or change settings if required.

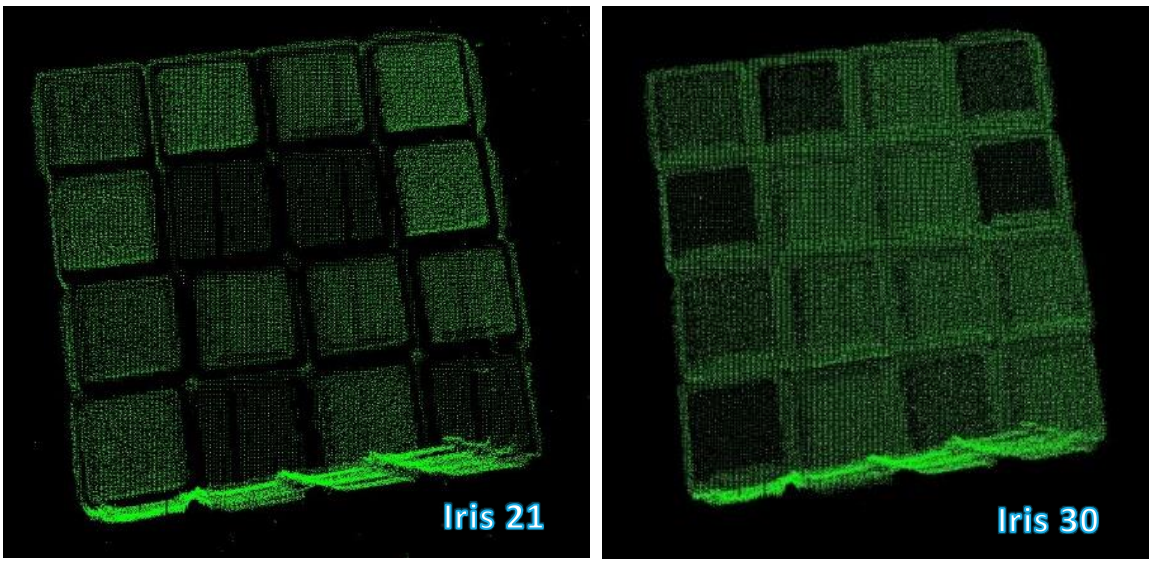


Fig 2.7 Point cloud with iris values 21 and 30

Using 2 frames with irises 21 and 30 renders a high quality HDR image and a dense point cloud with no missing areas as shown in Fig 2.3.

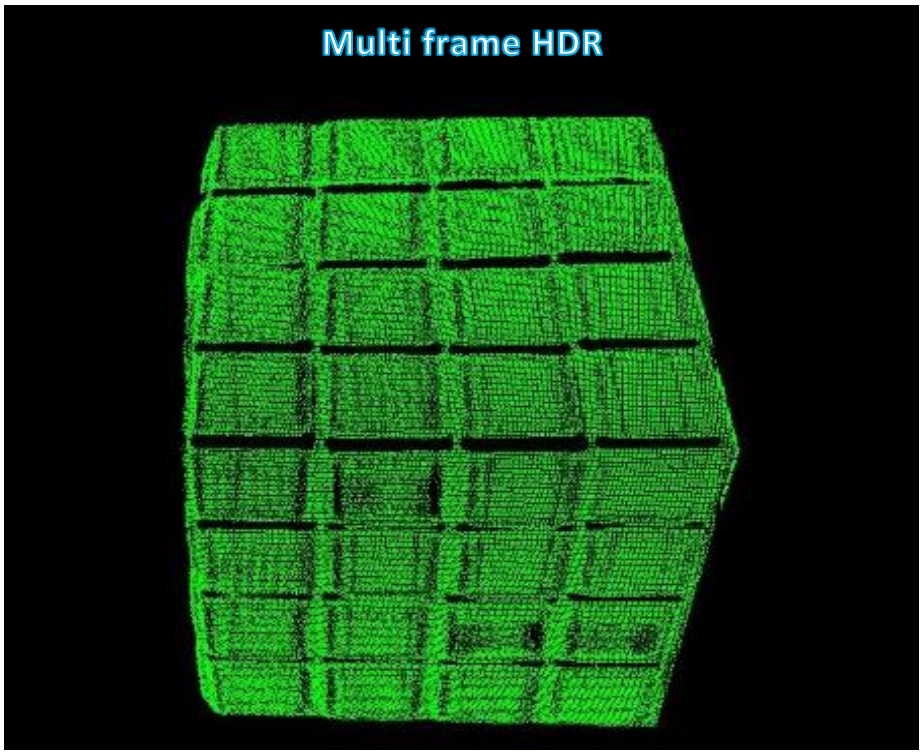


Fig 2.8 High quality point cloud

3. Case 3: Shiny metallic parts

SAMPLE	Metal pipe
MATERIAL	Shiny metal
MODE	Multi frame
ESTIMATED TIME REQUIRED	7 minutes
AMBIENT LIGHTING	Low
STEPS	5

Fig 2.9 Image of the metal pipe in 2D

Step 1: Enter live mode.

Step 2: Adjust the iris slider to find the settings that gives you maximum number of points in the point cloud.

Step 3. Adjust the exposure time if necessary.

Step 4: If multiple irises are required, click add frame to introduce new iris(es). You can adjust the exposure time and other settings for every frame as required.

☛ Preview your point cloud

It is recommended to select each defined iris frame individually (use the check box) and click capture to view the resulting point cloud. This helps to ensure that you have not added any non-valued frames (where the resulting point cloud is already covered in another defined iris frame). Adding only the required number of frames ensures that the camera runs without any unnecessary delays

Step 5: Click Capture to view the resulting point cloud from all the defined frames. Turn color off (keyboard shortcut 'c') to ensure that you have points all over the black object or change settings if required.

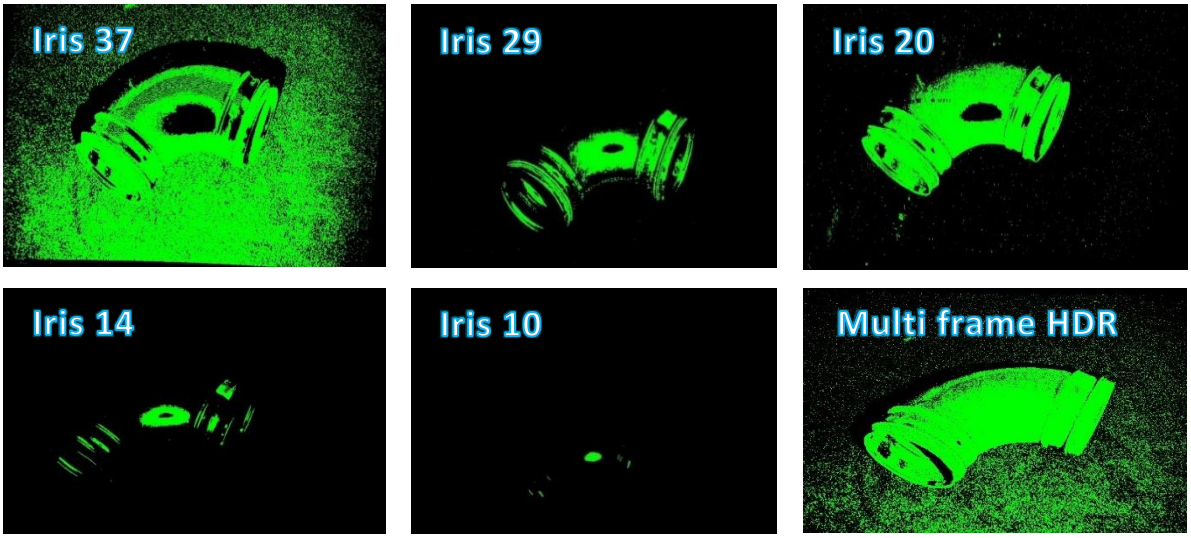


Fig 2.10 Capturing HDR image of the shiny object

For this object, five iris values are required- 10, 14, 20, 29 and 37. Each of these active iris points were tested individually and confirmed to be the best combination of settings required for this object.

Fig 3.112 illustrates the result of these different iris values individually, and the final output with the use of Zivids unique HDR feature.

☛ Optimize your settings

For *bin-picking* applications, you could remove one iris value (e.g. iris 10). This would lower acquisition time without any compromise on the application.

For *quality inspection* applications, on the other hand, it is important to include all irises that ensure a complete point cloud because of the nature of the application. In this case, ensure that you have chosen the best iris values to avoid including more irises than necessary.

Choosing the irises correctly in the live mode will help you get high-quality data with the least number of irises, thereby reducing the acquisition time

III. Tips and Tricks

👍 Always use live mode to determine the best irises for your sample objects. Do not set the irises randomly or in increments. This compromises on speed and/or data quality.

👍 Adding more irises does not necessarily optimize data quality. If the image was already optimized or if other parameters need to be tuned, adding more irises instead will only increase acquisition time.

Example: For the shiny metal pipe, adding iris 11 when iris 10 and 14 are already set do not optimize the image further as the points rendered by iris 11 are already included in the points given by iris 10 and 14.

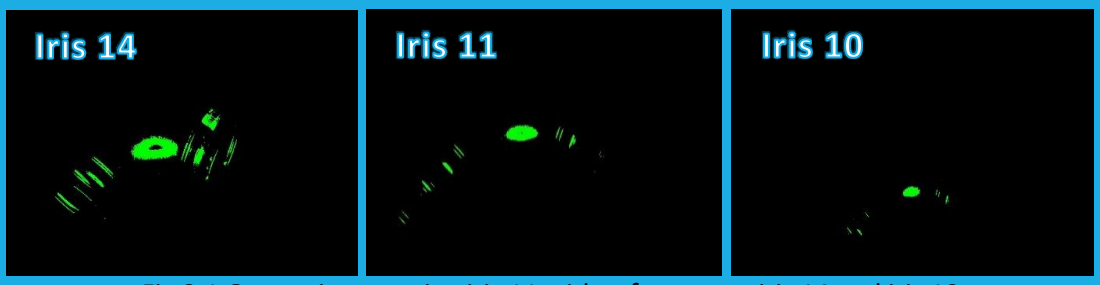


Fig 3.1 Output image using iris 11 with reference to iris 14 and iris 10

👍 Use the Reflection Filter to get rid of noise points.

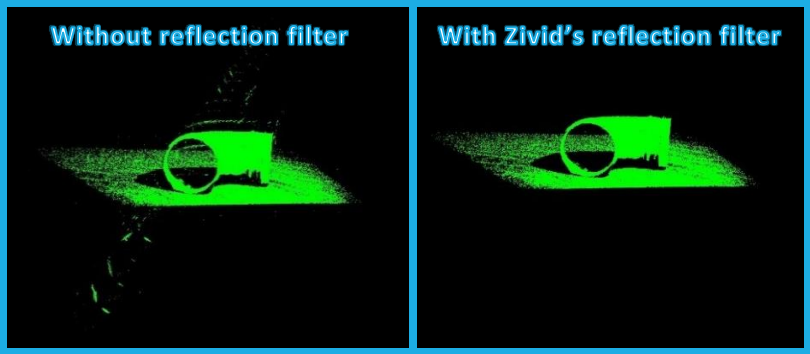


Fig 3.2 Effect of Zivid's unique reflection filter

👍 Use the Bidirectional filter if there are noise points that the reflection filter could not eliminate.

Adjust ambient light if possible. Low ambient lighting works best for acquiring sharp images, this is true for shiny parts in particular. If lighting cannot be adjusted, ensure that the brightness parameter is adjusted for the best results.

E.g. Use brightness less than 1.0 in dark conditions, and higher than 1.0 in bright conditions.

Always set the recommended operational distance.

E.g. 0.5m for the Small, 0.8 m for the Medium, and 1.8 m for the Large cameras.

Use a dark background to capture high-quality point cloud easily, especially with shiny parts. Do not use transparent or reflective bins as they further inter-reflections.

E.g. Black bin/ black background.

To counter highlights in your point cloud, include a lower iris value. Use live mode to determine which iris to include.

E.g. As shown in Fig. 3.3 below, the highlight in the middle of the duct tape is countered by adding a lower iris of 13.

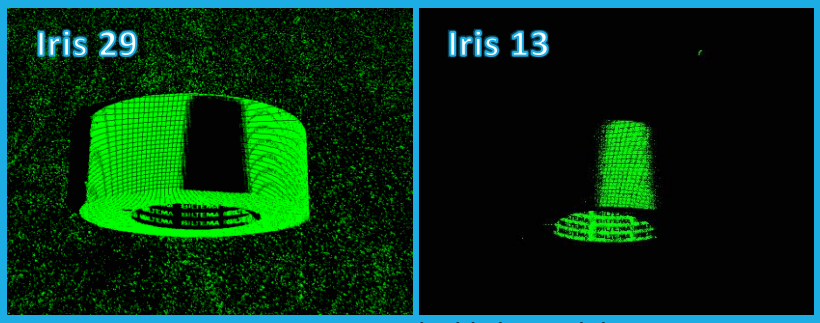


Fig 3.3 Countering highlights with low irises

Hotkeys

Colour | c	Toggle full screen | F11	Reset 3D view | backspace
Capture | F5	Live | Shift+F5	Stop Live | Esc
Save | Ctrl+s	Open | Ctrl+o	Quit | Alt+F4

IV. Troubleshooting

This section is to help you troubleshoot possible problems that may arise while either setting up or using your Zivid camera. Should you encounter any difficulties, email us at customersuccess@zivid.com. Also check out our FAQ page and knowledge base at zivid.atlassian.net.

This section is divided into:

- Zivid Studio setup
- Connecting to a Zivid camera in Zivid Studio
- Error messages in Zivid Studio
- Effects of ambient lighting

1. Zivid Studio setup

If you are unable to launch Zivid Studio after an installation, please try the following steps (please note that the following steps are described for Windows 10, but similar approach should be done in Linux):

- Open “Add or remove programs” (in Windows 10)
- Uninstall “Zivid”
- Uninstall “TeliCamSDK”
- Ensure that the files were properly uninstalled by deleting folders “C:\Program Files\Zivid” and “C\Program Files\TOSHIBA TELI”
- Reinstall Zivid Studio and include all installation steps as shown in Fig. 4.1

If you are still facing problems, please contact the Zivid team at customersuccess@zivid.com.

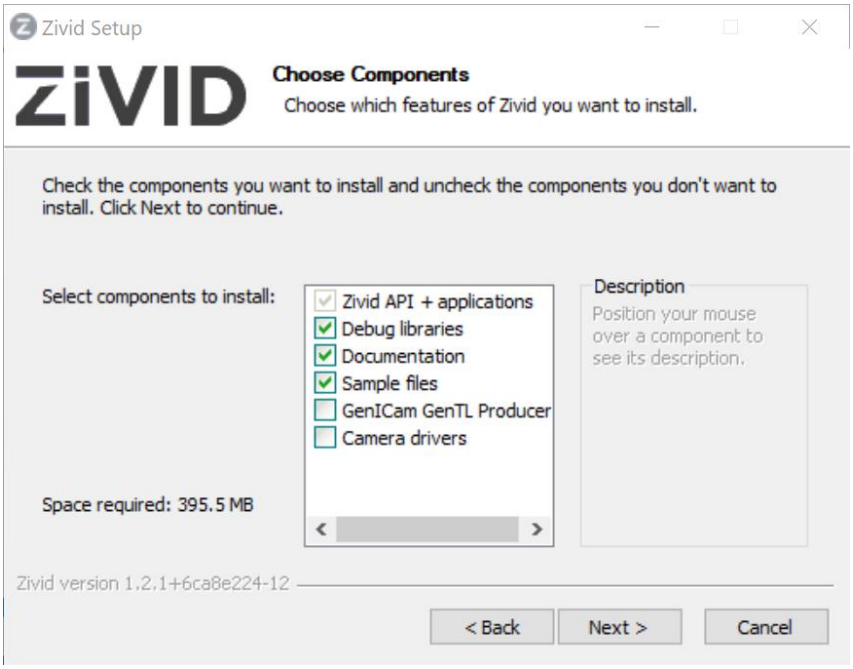


Fig. 4.1 Zivid Set up dialog

2. Connecting to a Zivid camera in Zivid Studio

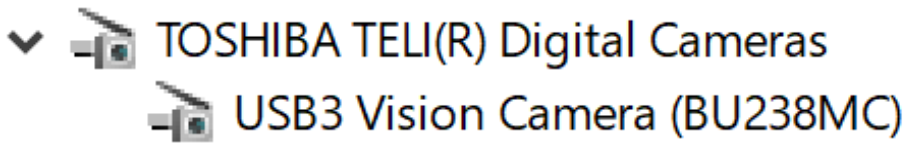
If you are unable to find or connect to the Zivid camera in studio, please try the following steps (please note that the following steps are described for Windows 10, but similar approach should be done in Linux):

- Check that the camera is properly connected to power and USB3. Tighten screws and verify that it is properly connected to PC. On most PCs you can identify that it is an USB3 port if it looks like the following:

Fig. 4.2 USB 3 port

- The camera will display a “Zivid” logo if it has power connected and boots up.
- Make sure that no other program is occupying the Zivid Camera (such as Visual Studio).

- In Zivid Studio on the right pane, click the "…" next to "Cameras" and select "Scan for connected cameras".
- If you still cannot detect a camera please verify that the drivers were correctly installed by going to "Device Manager" and looking for the following:



- In the case that you cannot see the Zivid Camera properly detected in the "Device Manager", please go through the steps in Zivid Studio setup above.
- Contact mailto:custmersuccess@zivid.com.

3. Error messages in Zivid Studio

ERROR	RESOLUTION
No Camera found	• Go to File > Scan for connected cameras • Restart Zivid Studio • Ensure that no other application is running Zivid • Ensure multiple tabs of Zivid Studio are not open
Failed to check if block 0 in the EEPROM master table is occupied OR Inconsistent frame timing detected, which would result in a broken point cloud	Ensure that the Zivid camera is not used by any other applications such as Cloud viewer, Zivid Studio, or Visual Studio. Also ensure that multiple tabs of the same application are not open.
Disconnection or freezing application	Ensure that the power and data cable are screwed in tightly into their slots. Loose cables will result in frequent loss of connection

Table 3 Troubleshooting tips

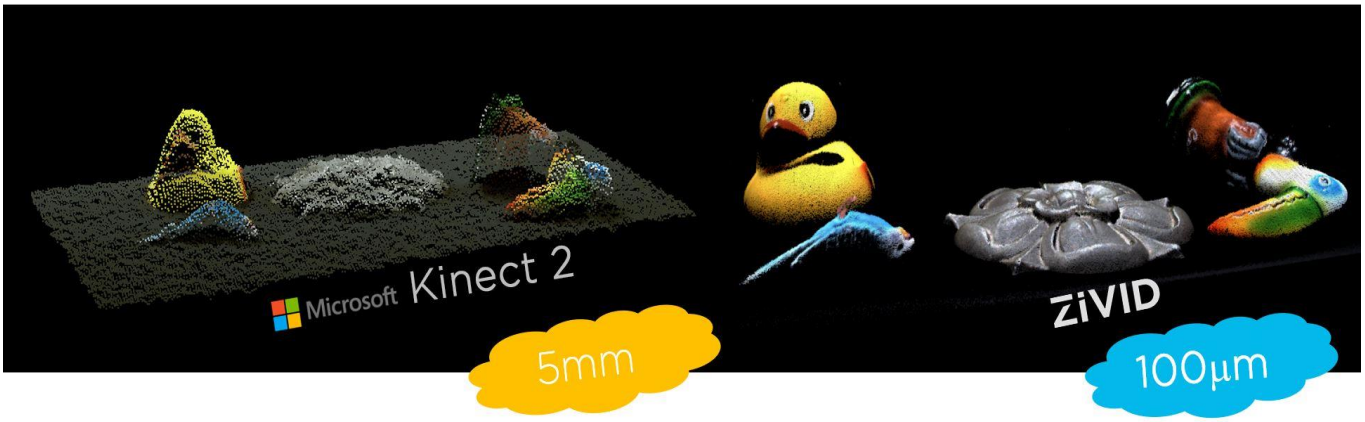
4. Ambient lighting

Zivid cameras use projected light to determine the distance to objects in the scene. Ambient light introduce noise that affect the accuracy of the 3D sensors, and in worst case may cause data loss. The table below explains some effects of ambient light and how to deal with them.

Symptoms	Cause	Possible solution
The 3D point cloud is changing over time with the same scene as if the settings used are no longer giving the same results as they did before.	Changing light conditions such as automatically enabled or dimmed lights or sunlight entering through windows.	• Increase projector brightness to mitigate the effect. • Provide shade from windows by using e.g. blinds. • Disable light automation or take it into account in your software solution by changing settings depending on surrounding brightness.
I'm seeing waves or ripple-like effects on planes in the point cloud.	This could be caused by the power line frequency mixing into the sensor signal.	• Use an Exposure Time equivalent to $t_{exp} = n2 \times f_{line}$, where n is an integer and f_{line} is the power line frequency. In e.g. EU this is 50Hz, and in US this is 60Hz. For Europe, exposure times in multiples of 10'000 µs should be used, and multiples of 8'300 µs in the US.
The 2D color image has very bright spots, or there could be spots of missing data in the 3D point cloud.	Direct reflex from light sources may oversaturate the sensor.	• Cover the projector (e.g. with your hand) and grab an image. • Look at the 2D image in Zivid Studio and see if there are bright spots. • If there are, try to assess where it comes from. It could be from a light bulb, the sun, or some other source. • If possible, eliminate them by facing them away, provide shade or similar.

Table 5. Effects of ambient lighting

V. Zivid's Inner Workings



Your Zivid camera is the world's most accurate, real time 3D color camera because it has been developed and put together with much eye for detail by your friends at Zivid to ensure that you have a fantastic 3D experience! So, what makes Zivid tick?

Here is a little background to help you know your camera better.

The Zivid camera functions on the principle of structured light. Zivid contains a projector and a camera that is placed at a specific angle to and distance from each other. Light patterns are projected by the projector onto the object and the displacement in the light patterns are used to calculate the depth of the object at every point giving you a 3D model of your object.

For every image capture performed by Zivid One+, several images are captured internally by the camera at a remarkable acquisition rate of 13 Hz to ensure that the captured point cloud gives the most accurate data.

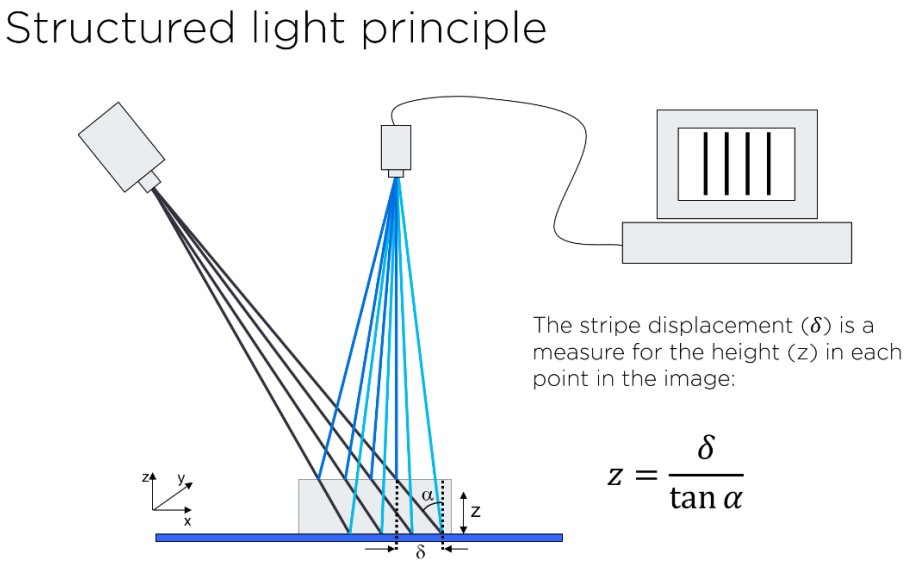


Fig 5.1 Calculating depth with structured light

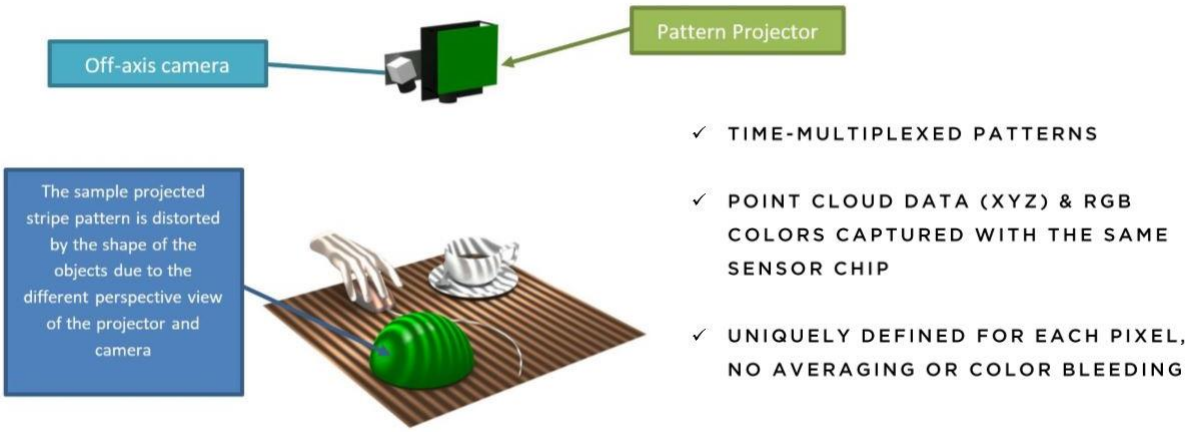


Fig 5.2 Projection of stripe patterns

One of Zivid's most unique features is the HDR capability. 'Difficult' objects are made easy with this feature. The HDR mode allows you to choose different iris values which are best suited for the different colors or areas of your object. The camera captures images internally with each of these specified iris values and these images are then combined to give you the best possible output with overall accuracy.

Some other features that make Zivid special are the filters that give you added functionality. The reflection filter for example ensures that you can take images of shiny objects without false, noise points. Consider a picking scenario where the camera mistook false points (points in the point cloud corresponding to reflections) as part of the object. A robot attempting to perform a pick could aim at these false points instead, resulting in an erroneous and chaotic process!

Zivid One + also functions in the full color spectrum to produce an accurate point cloud.

VI. Support and Assistance

For more information about the Zivid One+ camera please visit www.zivid.com
For software related information and sample codes, visit www.zivid.com/software
For resource articles and the knowledge base, visit zivid.atlassian.net
For assistance, please email customersuccess@zivid.com