2D/3D Dual CygLiDAR

CygLiDAR D2

User Manual

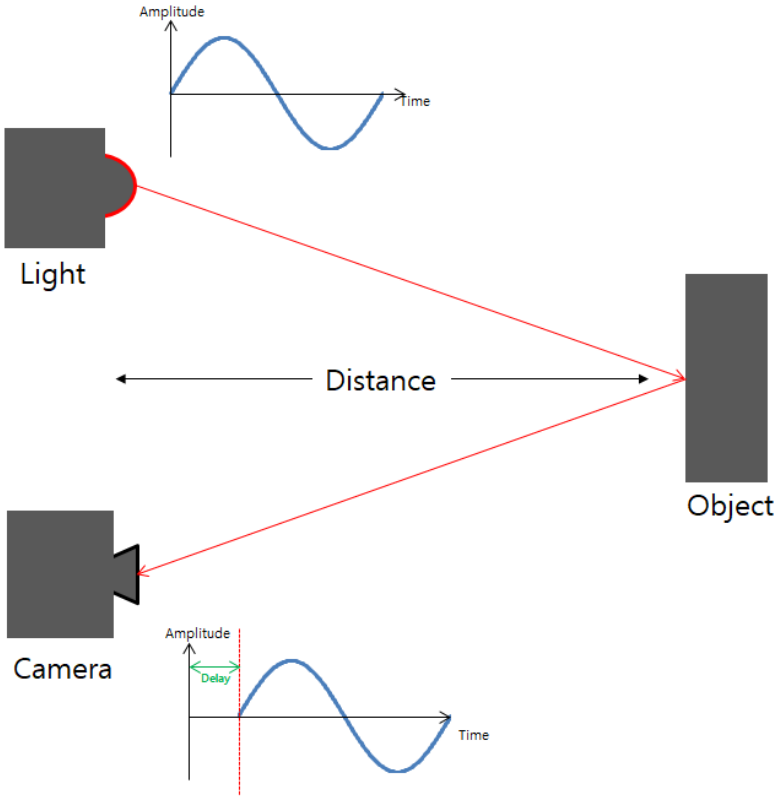
Cygbot

Table of Contents

1. Introduction

ToF (Time of Flight)

CygLiDAR measures distance by light round trip time (ToF). ToF emits a pulse signal at the light emitter and measures the phase change of the signal reflected by the object. The phase shift method can measure time and calculate the distance of object.



Solid State

Solid State CygLiDAR has no vibration, heat or noise that is directly linked to the life of the device.

Unlike the 360 ° Scanning LiDAR, which uses a motor, a wide viewing angle is secured with a wide-angle lens, so the light emitting part (laser, LED) does not have to operate for a long time. This can reduce the heat generated by the light emitting part.

Solid State does not use a motor, so it can set smaller in size. CygLiDAR that use this method are highly compatible.

2D / 3D Dual

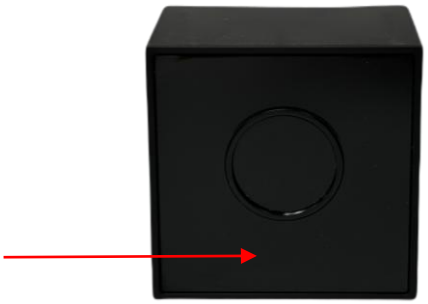
CygLiDAR can measure 2D and 3D distance data at the same time. A delicate external environment is possible with 3D data, enabling long-distance measurements with 2D data. CygLiDAR allows for flexible system configurations.

2. Specification

Detection range	Range affected by reflectivity 2D : 200mm ~ 7,000mm 3D : 50mm ~ 2,000mm (*DRM)
Distance accuracy	±1%
Resolution (Measure in mm)	2D : 0.75° (Angle) 3D : 160 x 60 (Pixel)
FOV : Field of View	2D/3D Horizontal : 120° 3D Vertical : 65°
Wavelength	*Laser Diode : NIR 940nm LED : NIR 940nm
Measuring speed	2D : 15Hz 3D : 15Hz
Size (W * H * D)	37.4 * 37.4 * 24.5 (mm^3)
Weight	31g
Interface	UART TTL 3.3V 3,000,000 bps
Input power source	5V, 500mA
Operating Temperature	-10°C ~ 50°C
Pulse pattern (pulse duration, repetition rate, …)	600 µs, 20 MHz 100 µs, 40 MHz
Maximum power or energy output	Max. 1.2 mW

*DRM : Dynamic Range Mode

*Laser Diode : Be Careful
Do not inject the Laser directly into your eyes.
The act of looking at the laser with an optical measuring instrument (magnifying glass, microscope, telescope, etc.) can cause poor vision.

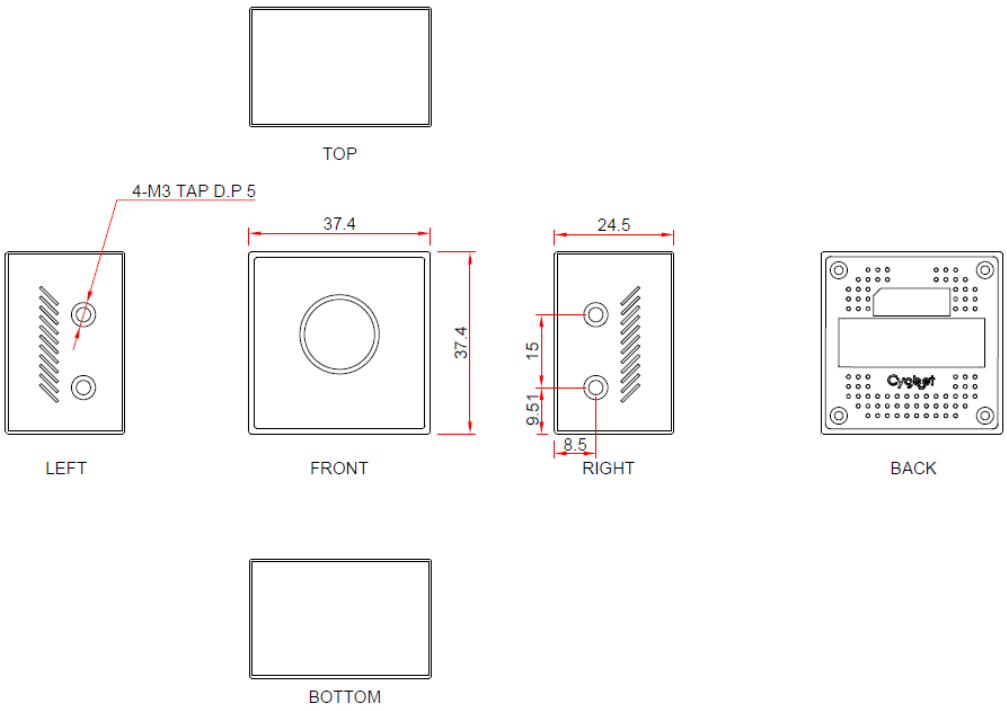


3. Component

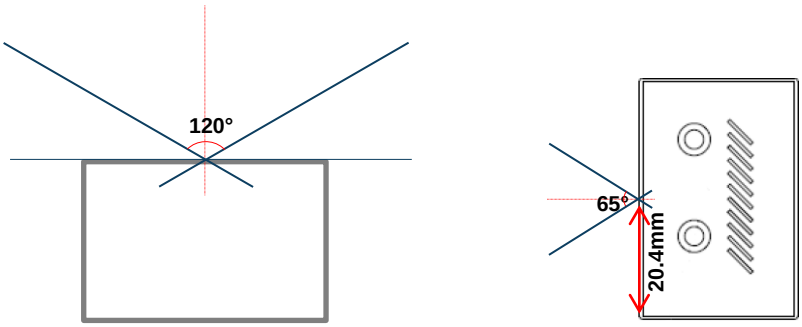
			
CygLiDAR D2	Connector	USB to UART Converter	5pin USB Cable

* Components other than CygLiDAR D2 are provided separately and may differ from the image above.

4. Hardware Design

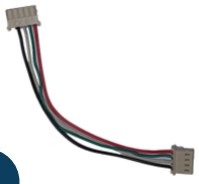


FOV definition

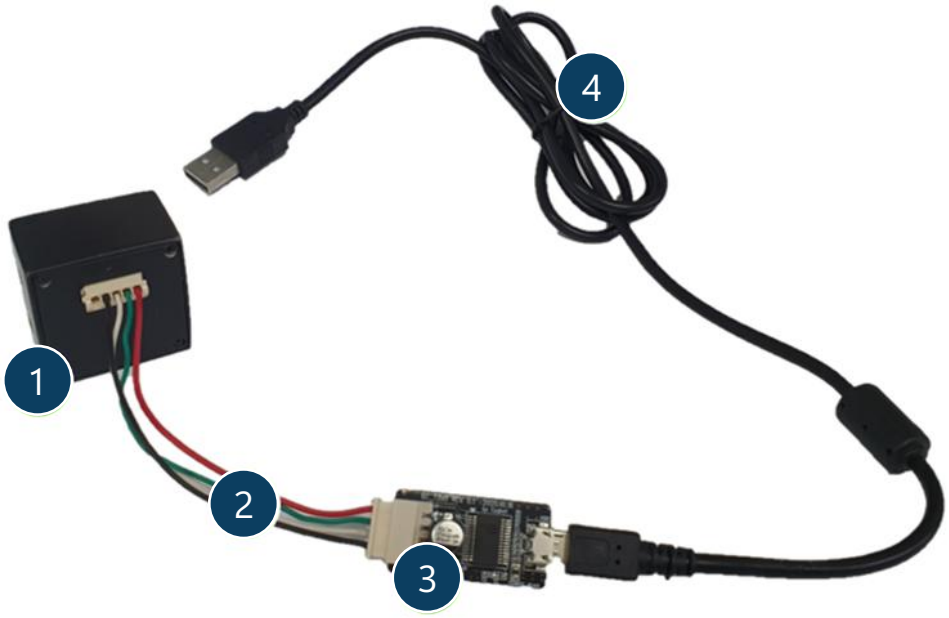


5. How to Use

- This is the tool you need to get your Lidar working.

 1	 2	 3	 4	 5
CygLiDAR D2	Connector	USB to UART Converter	5pin USB Cable	PC or Raspberry Pi

- Connect 1, 2, 3, 4 in order as shown below.



- Finally, connect 4 and 5 (PC or Raspberry Pi).

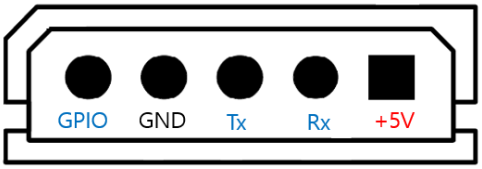
6. Serial Communication

UART

Data Bit	:	8 bit
Parity	:	none
Stop Bit	:	1 bit
Baud Rate	:	3,000,000 bps

PINMAP

VCC	:	+5V
Rx	:	UART TTL Rx
Tx	:	UART TTL Tx
GND	:	GND
GPIO	:	Reserved



Packet structure

Packet					Payload					Packet
Header1	Header2	Header3	Payload Length LSB	Payload Length MSB	Payload Header	Payload Data 0	Payload Data 1	...	Payload Data n	Checksum
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	n byte				1 byte

Header : Three fixed values assigned to every valid dataset, consisting of 0x5A, 0x77 and 0xFF.
Payload Length : Payload size in byte.
Payload Header : A unique value for a clarification of the device version.
Payload Data : A set of the significant bits of the pixel component data.
Checksum : The result of XOR of all values only except Headers from 1 to 3.

Checksum

Checksum is the last byte of a frame that is only used for an integrity check.

```
#define PAYLOAD_LENGTH_LSB_INDEX 3

uint8_t CalcChecksum(uint8_t *buff, int buffSize)
{
	uint8_t CheckSum = 0;
	for(int i = PAYLOAD_LENGTH_LSB_INDEX; i < buffSize – 1; i++)
	{
		CheckSum ^= buff[i];
	}
	return CheckSum;
}
```

6. Serial Communication

Packet

Request Overview

Request Name	Payload Header Value	Payload Length	Response Packet	LiDAR Operation	Supported Firmware Version
Get Device Info	0x10	2	O	Get the release versions of the latest update to F/W and H/W.	0.0.1
Get Device ID	0x21	2	O	Get the ID set for the current sensor.	0.3.5
Set Device ID	0x20	2	X	Sets the ID of the sensor.	0.3.5
Run 2D Mode	0x01	2	O	Start 2D Data measurement.	0.0.1
Run 3D Mode	0x08	2	O	Start 3D Data measurement.	0.0.1
Run Dual Mode	0x07	2	O	Start Dual Data measurement.	0.0.1
Switch Distance 3D	0x15	2	X	Output Distance Data when measuring 3D Data.	
Switch Amplitude 3D	0x15	2	X	Output Distance Data and Amplitude Data when measuring 3D Data.	
Stop	0x02	2	X	Change status to Idle.	0.0.1
Set 3D Light pulse duration	0x0C	3	X	Control 3D Light pulse duration.	0.0.1
Set Frequency Channel	0x0F	2	X	Change frequency channel.	0.0.1
Set Baud Rate	0x12	2	X	Change serial baud rate.	0.2.4
Set New Filtering	0x13	3	X	Change filters in 3D and Dual mode.	0.3.5
Set Edge Filtering	0xD0	2	X	Set the Edge filter.	0.3.5

6. Serial Communication

Get Device Info (0x10)

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x10	0x00	0x12					
Response Packet	0x5A	0x77	0xFF	0x07	0x00	0x10	F/W 1	F/W 2	F/W 3	H/W 1	H/W 2	H/W 3	Check Sum

[Example] F/W version = 0.0.1, H/W Version = 0.2.0 인 경우 Payload Data

0x00	0x00	0x01	0x00	0x02	0x00

Both versions of firmware and hardware are provided.

Get Device ID (0x21)

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x21	0x00	0x23
Response Packet	0x5A	0x77	0xFF	0x07	0x00	0x21	Device ID	Check Sum

Get the ID set for the current sensor.

Set Device ID (0x20)

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x20	Device ID	Check Sum

You can change the sensor's ID settings. Device IDs can be set from +0 to 255.

Device ID

0 (default) → 0x00
1 → 0x01
2 → 0x02
.
.
.
255 → 0xFF

6. Serial Communication

Run 2D Mode Request (0x01)

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x01	0x00	0x03

Response Packet	0x5A	0x77	0xFF	0x43	0x01	0x01	LSB Time	MSB Time	LSB Temp	MSB Temp	LSB -60º	MSB -60º	…	LSB +60º	LSB +60º	Check Sum

Light source : Laser, LED
FOV : 120º
Resolution : 0.75º
Range : 200 ~ 8,000mm
Data Type : 16 bit

Error code list
16000 : Limit for valid data
16001 : Low Amplitude
16002 : ADC Overflow
16003 : Saturation
16004 : Bad Pixel

Switch the state to 2D Mode. When the state is in 2D Mode, it measures and outputs 2D distance data.
The data output sequence is from -60º to +60º with a 0.75º interval.
It outputs sensor's temperature (Temperature, ℃) data and time (TimeStamp, μs) data after the target measurement before sending the 2D data.
The measurement time can be obtained by subtracting the 2D timestamp from the current time, and the temperature is caculated as 'Temperature / 256 = Sensor Temperature' in Celsius(℃)

Run 3D Mode Request (0x08)

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x08	0x00	0x0A

Response Packet	0x5A	0x77	0xFF	0x41	0x38	0x08	LSB Time	MSB Time	LSB Temp	MSB Temp	3D Distance Data	Check Sum
Response Packet	0x5A	0x77	0xFF	0x41	0x38	0x88	LSB Time	MSB Time	LSB Temp	MSB Temp	3D Distance & Amplitude Data	Check Sum

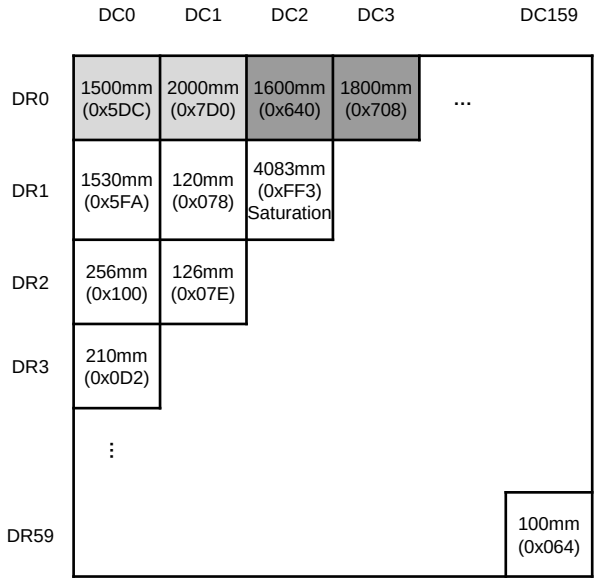
Light source : LED
Resolution : 160 x 60
Horizontal FOV : 120°
Vertical FOV : 65°
Range : 50 ~ 3,000mm
Data Type : 12 bit

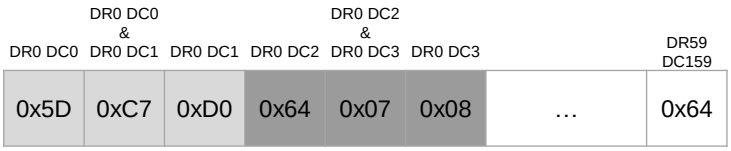
Error code list
4080 : Limit for valid data
4081 : Low amplitude
4082 : ADC Overflow
4083 : Saturation

Switch the state to 3D Mode. When the state is in 3D Mode, it measures and outputs 3D Distance Data or Amplitude Data.
The data output sequence is in pixel coordinates (0, 0), (0, 1), (0, 2), ..., (159, 59).
It outputs sensor's temperature (Temperature, ℃) data and time (TimeStamp, μs) data after the target measurement before sending the 2D data.
The measurement time can be obtained by subtracting the 2D timestamp from the current time, and the temperature is caculated as 'Temperature / 256 = Sensor Temperature' in Celsius(℃)

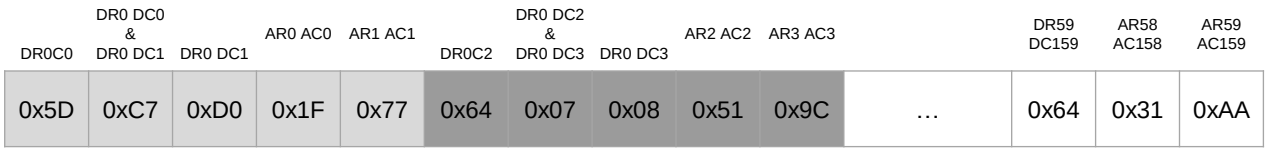
6. Serial Communication

3D Data format

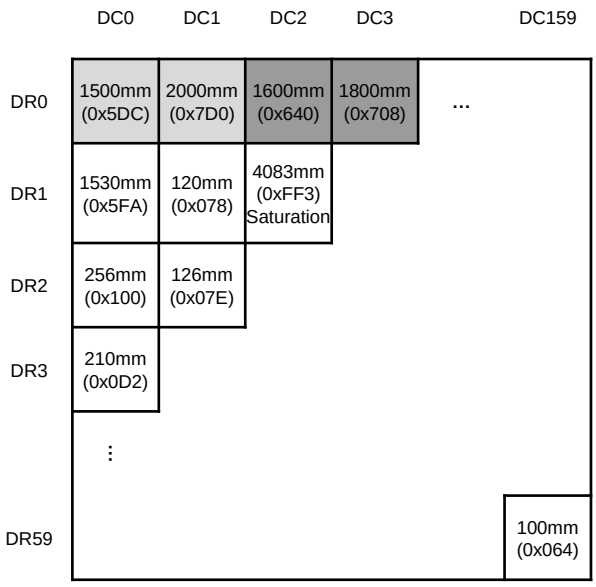




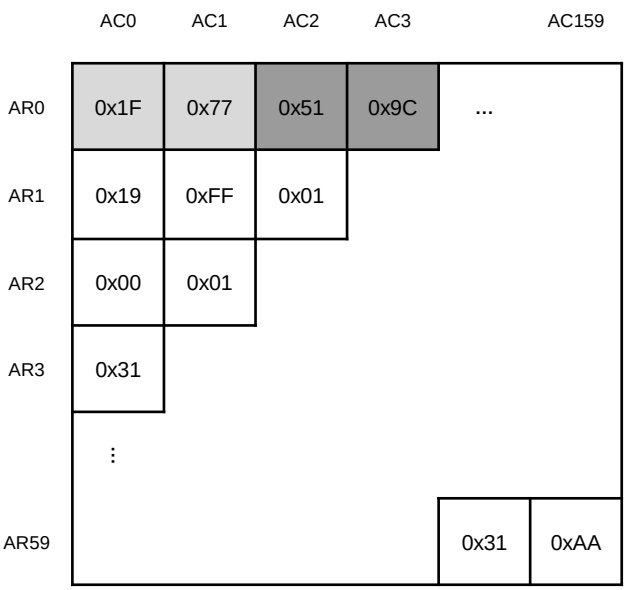
Run Dual Mode Request (0x07)



3D Distance Data



3D Amplitude Data



6. Serial Communication

Run Dual Mode Request (0x07)

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x07	0x00	0x0A

Response Packet	0x5A	0x77	0xFF	0x43	0x01	0x01	LSB Time	MSB Time	LSB Temp	MSB Temp	LSB -60°	MSB -60°	…	LSB +60°	LSB +60°	Check Sum

Response Packet	0x5A	0x77	0xFF	0x41	0x38	0x08	LSB Time	MSB Time	LSB Temp	MSB Temp	3D Distance Data	Check Sum

Response Packet	0x5A	0x77	0xFF	0x41	0x38	0x88	LSB Time	MSB Time	LSB Temp	MSB Temp	3D Distance & Amplitude Data	Check Sum

Switch the state to Dual Mode.
When the state is in Dual Mode, it sequentially measures and outputs 2D and 3D data.
For 3D data, it outputs response data based on the selected Mode Type.

Switch Distance 3D / Amplitude 3D Mode Type

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x15	0x00	0x00	0x16

When outputting 3D data, change the mode to output only Distance data type.

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x15	0x01	0x00	0x17

When outputting 3D data, change the mode to output both Distance and Amplitude data.
Amplitude data can be transformed according to user intent through vision algorithms.

6. Serial Communication

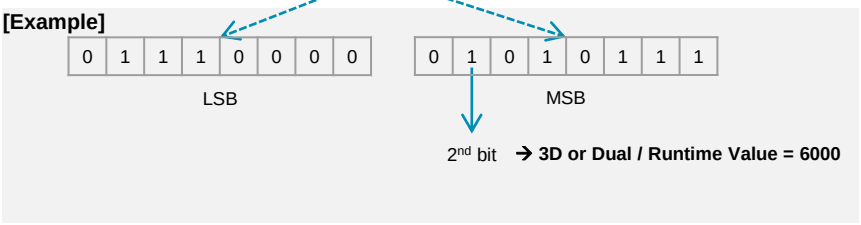
Stop (0x02)

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x02	0x00	0x00

Change the status to Idle.
When the status is in Idle, device does nothing.

Set 3D Pulse Duration Request (0x0C)

Request Packet	0x5A	0x77	0xFF	0x03	0x00	0x0C	LSB	MSB	Check Sum



2nd bit	Result
0	Auto
1	Fixed

3D Data is utilized in both 3D Mode and Dual Mode.
You can adjust the Pulse Duration using the Set 3D Pulse Duration packet.
The adjustable time range is limited to 0 to 10,000 microseconds.
Pulse Duration has two modes:
Auto, where the LiDAR adjusts it automatically, and Fixed, where the user specifies a value.
If Pulse Duration is Fixed, the Pulse Duration Value is represented by the 14 bits following the 2nd bit.

6. Serial Communication

Frequency Setting Request (0x0F)

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x0F	Freq Ch	Check Sum

Frequency Channel
Channel 0 → 0x00
Channel 1 → 0x01
Channel 2 → 0x02
.
.
.
Channel 15 → 0x0F

You can change the frequency of the Light Source.
When measuring the same space simultaneously
with two or more CygLiDAR D2 devices,
interference between light sources can occur,
potentially causing errors in the measurement data.
Applying different frequencies to each device in this case
can help reduce data errors caused by interference.
CygLiDAR D2 utilizes 16 frequency channels.

Set Serial Baud Rate (0x12)

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x12	Value	Check Sum

Baud Rate Packet

Packet		Baud Rate	unit	f/w
0x39	→	57,600	bps	0.3.3~
0xAA	→	115,200	bps	0.2.4~
0x77	→	250,000	bps	0.2.4~
0x88	→	921,600	bps	0.2.4~
0x55	→	3,000,000	bps	0.2.4~

Change the Serial Baud Rate.
CygLiDAR D2 supports five Serial Baud Rates:
57,600bps, 115,200bps, 250,000bps, 921,600bps, and 3,000,000bps.
The default setting is 3,000,000bps,
and when the Serial Baud Rate is changed,
the device reboots and operates at the newly set Serial Baud Rate.
The modified Serial Baud Rate is stored in the ROM,
and even if the device's power is cut,
It will automatically be set to the changed value.

6. Serial Communication

Set New Filtering (0x13)

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x13	0x00	Check Sum

New Filter Setting	Filter Mode
0	None
1	Median Filter
2	Average Filter

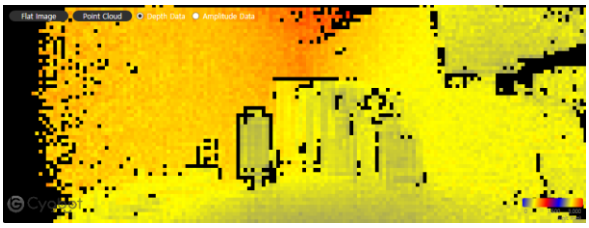
Change the filter in 3D and Dual Modes.
Filter Mode supports None, Median Filter, and Average Filter.
The default setting is None, and when the Filter Mode is changed, the selected filter is applied to the 3D Data.

Set Edge Filtering (0xD0)

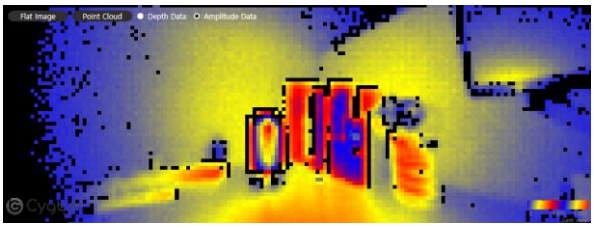
Request Packet	0x5A	0x77	0xFF	0x02	0x00	0xD0	LSB Value	MSB value	Check Sum

Set the Edge Filter.

- 3D Data Mode: Depth Data
- Edge filter Setting: 130



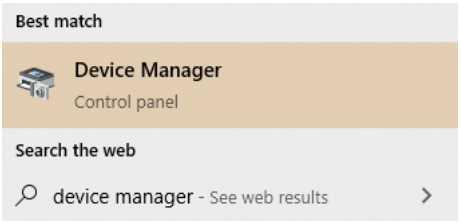
- 3D Data Mode: Amplitude Data
- Edge filter Setting: 130



7. Verification & Install

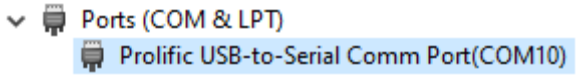
∗ Connect CygLiDAR to PC in respect of page 6

1. Open Device Manager on your PC.



2. Check if CygLiDAR is successfully verified on your computer.

The serial driver is named 'Prolific USB-to-Serial Comm Port(COM#)' as below:



In case of not finding any port connected to the USB, download a driver from the following website:
Window http://www.prolific.com.tw/US/ShowProduct.aspx?p_id=225&pcid=41
MAC http://www.prolific.com.tw/US/ShowProduct.aspx?p_id=229&pcid=41
LINUX(Ubuntu)

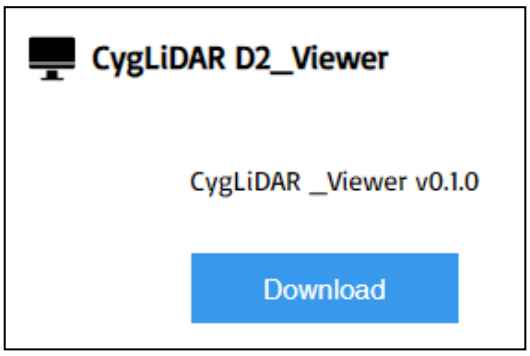
① $ lsusb
Bus 001 Device 005: ID 067b:2303 Prolific Technology, Inc. PL2303 Serial Port

② $ sudo modprobe usbserial vendor=0x067b product=0×2303

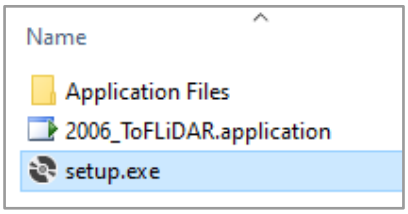
③ $dmesg

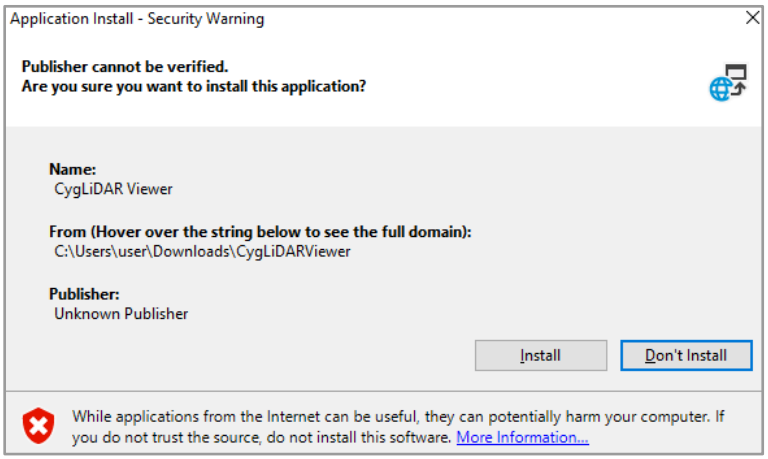
3. Download CygLiDAR Viewer

https://www.cygbot.com/downloads

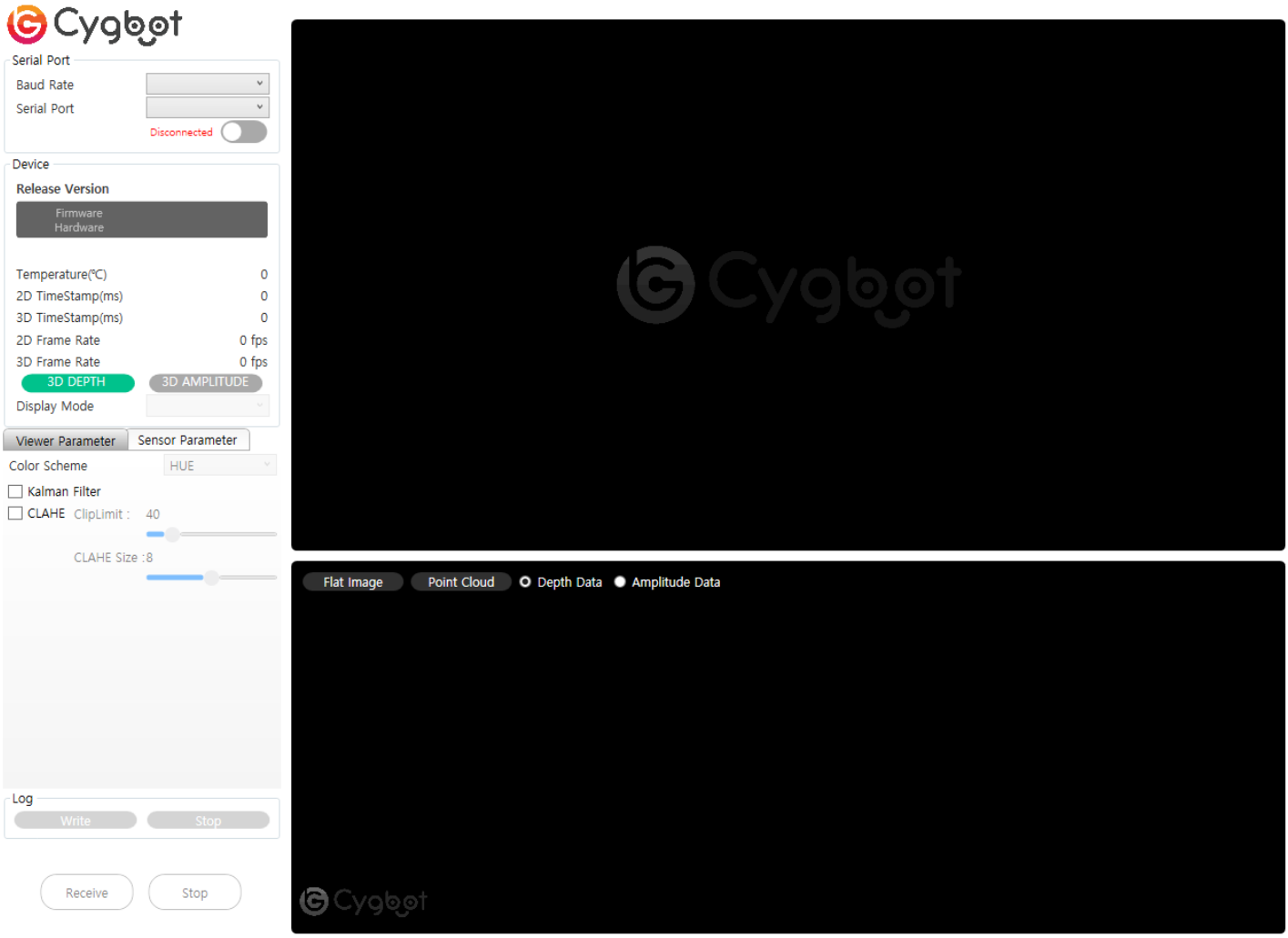


4. Install CygLiDAR Viewer

① 

② 

8. CygLiDAR Viewer



1) Serial Port
   - Select a baud rate and a serial port to use.

2) Device
   - Check on the release version of the latest update to CygLiDAR firmware and hardware.
   - Set up a 3D data and a display mode.

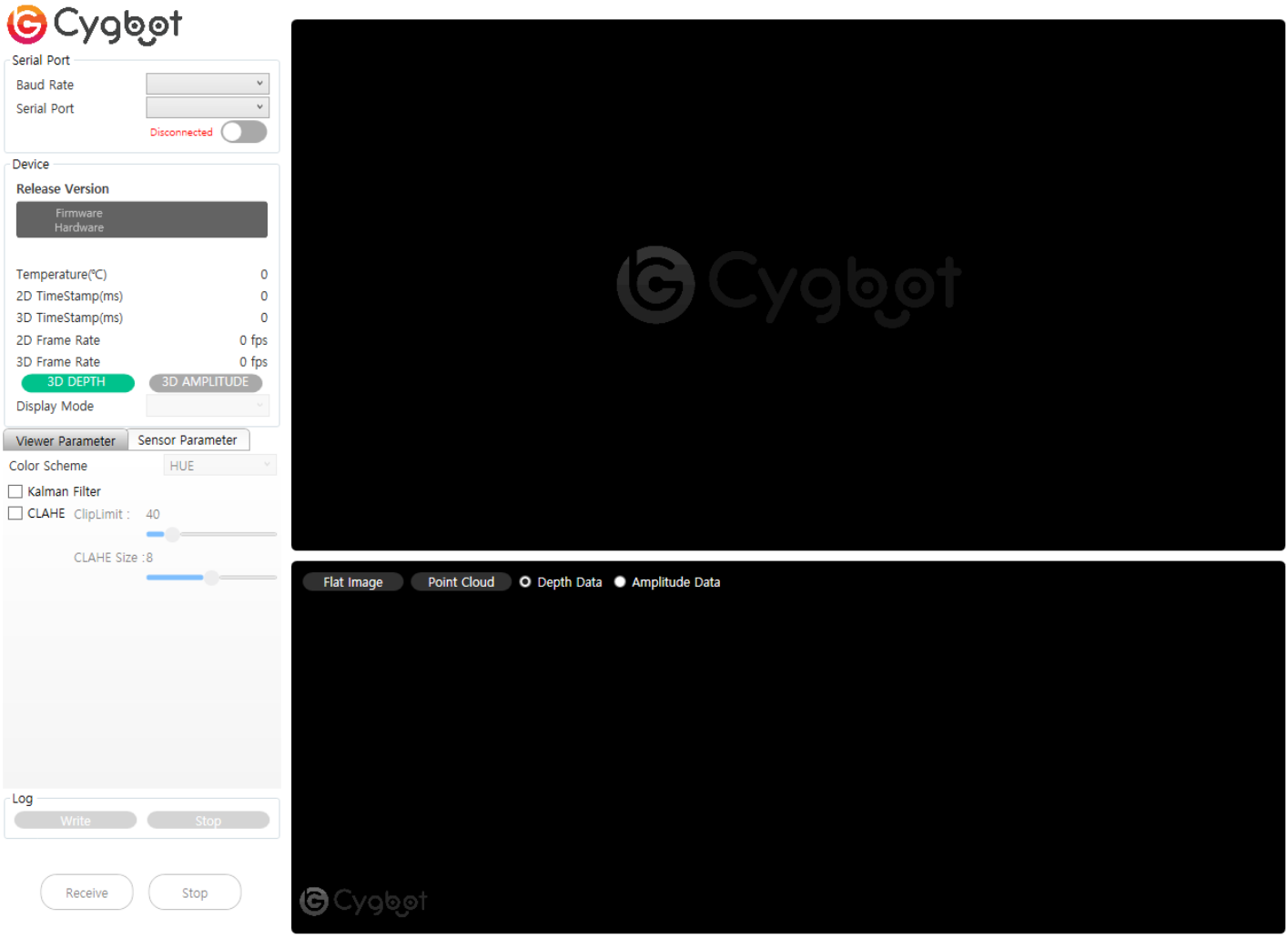
3) Viewer Parameter

   (1) Color Scheme
      - Set a color scheme of the following scales: Hue, RGB or Gray (Image samples on page 17).

   (2) Kalman Filter: Set a Kalman Filter

   (3) CLAHE: Set Clip Limit and CLAHE Size

8. CygLiDAR Viewer



4) Sensor Parameter

(1) 3D Pulse Duration Control

- Choose **Auto** and press **Apply** for a completion of Auto mode.
- Choose **Manual**, put a preferable value for the duration to send and press **Apply**.

(The duration is +0 to the minimum and +10000 to the maximum available to apply.)

(2) Frequency Channel

- Assign a channel restricted from +0 to +15 for light sources.

(3) Baud Rate Setting

- Select a baud rate

(4) Filter Setting

- Set a filter of the following mode: None, Median Filter or Average Filter.

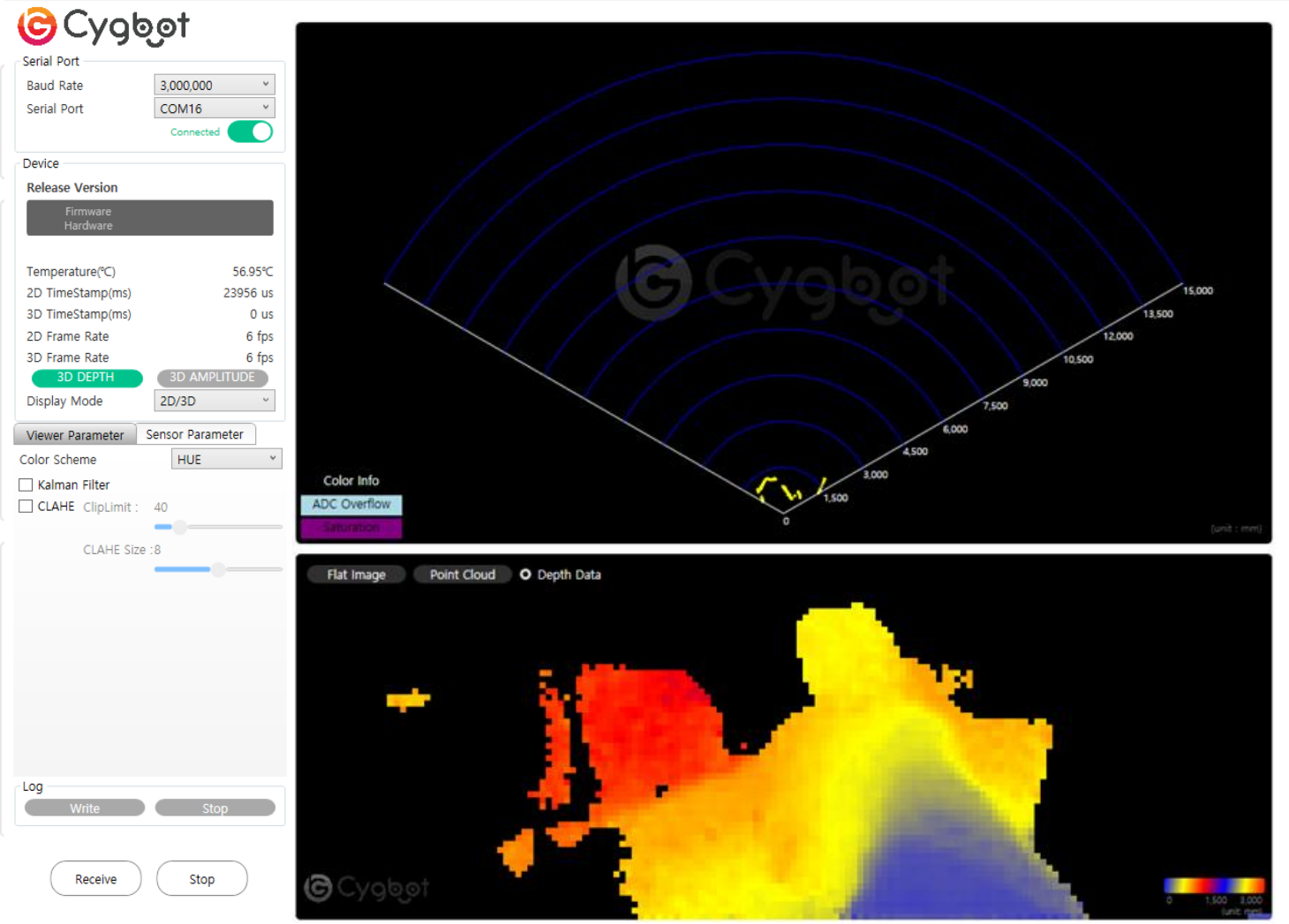
(5) Edge Filter Setting

- Provide a range of +10 to +100

(6) Log

- Provide logarithm for distance values

8. CygLiDAR Viewer

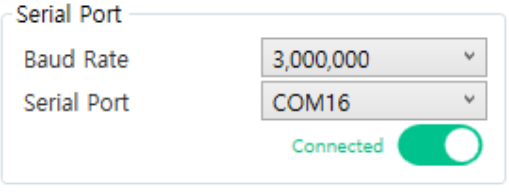


Example

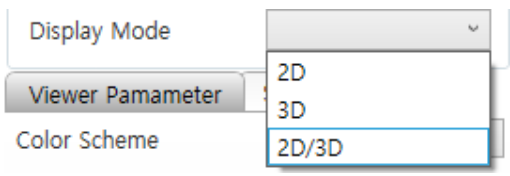
1) Baud Rate : 3,000,000 bps

2) Serial Port : Choose an available port for CygLiDAR.

After all sets up, press Connected button to turn on CygLiDAR.



3) Display Mode :
Select one of the following modes: Hue, RGB and Gray.

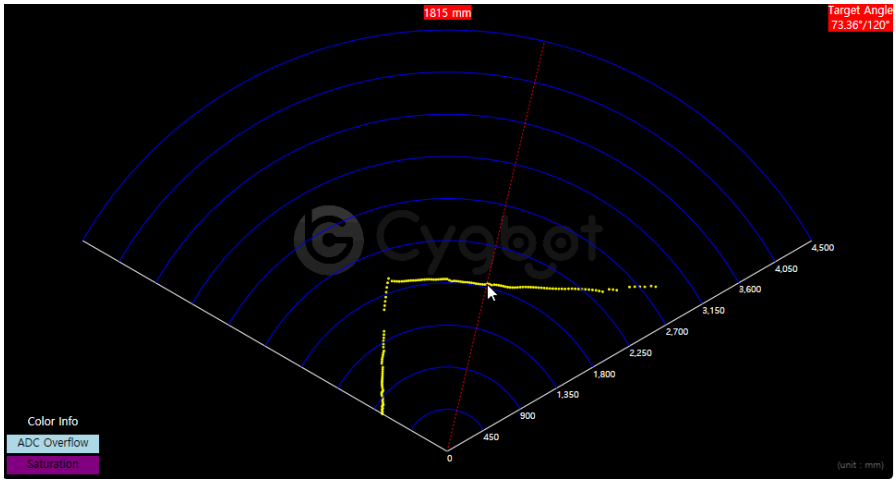


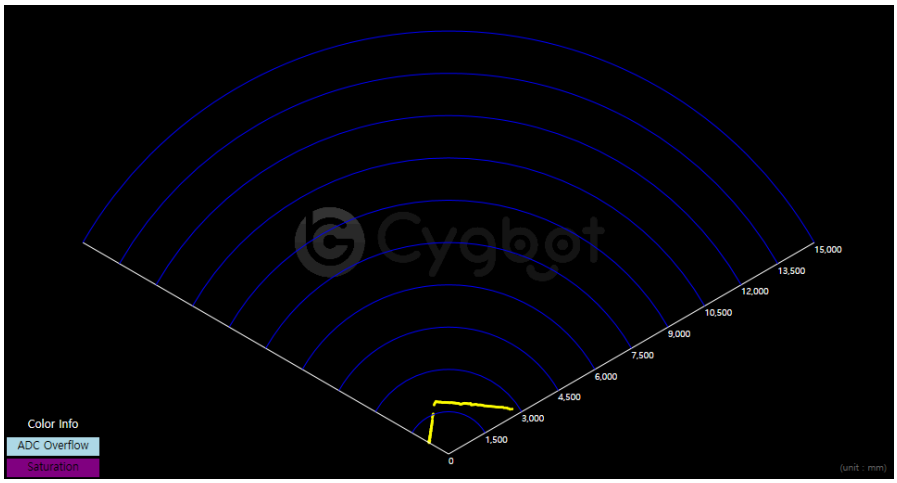
After all sets up, press Receive button to turn on CygLiDAR.

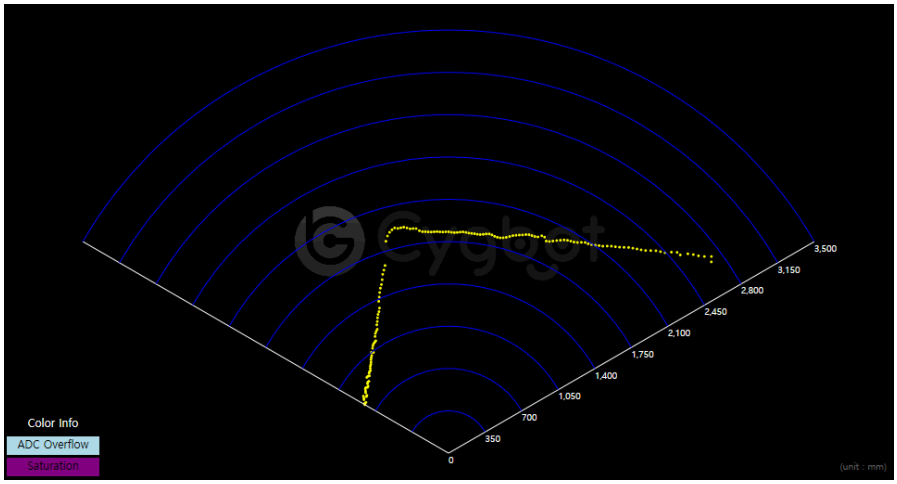
8. CygLiDAR Viewer

2D Data

- Mouse cursor: each distance at the particular angle prints out on the preview.
- Mouse wheel: the canvas image zooms in and out as above.



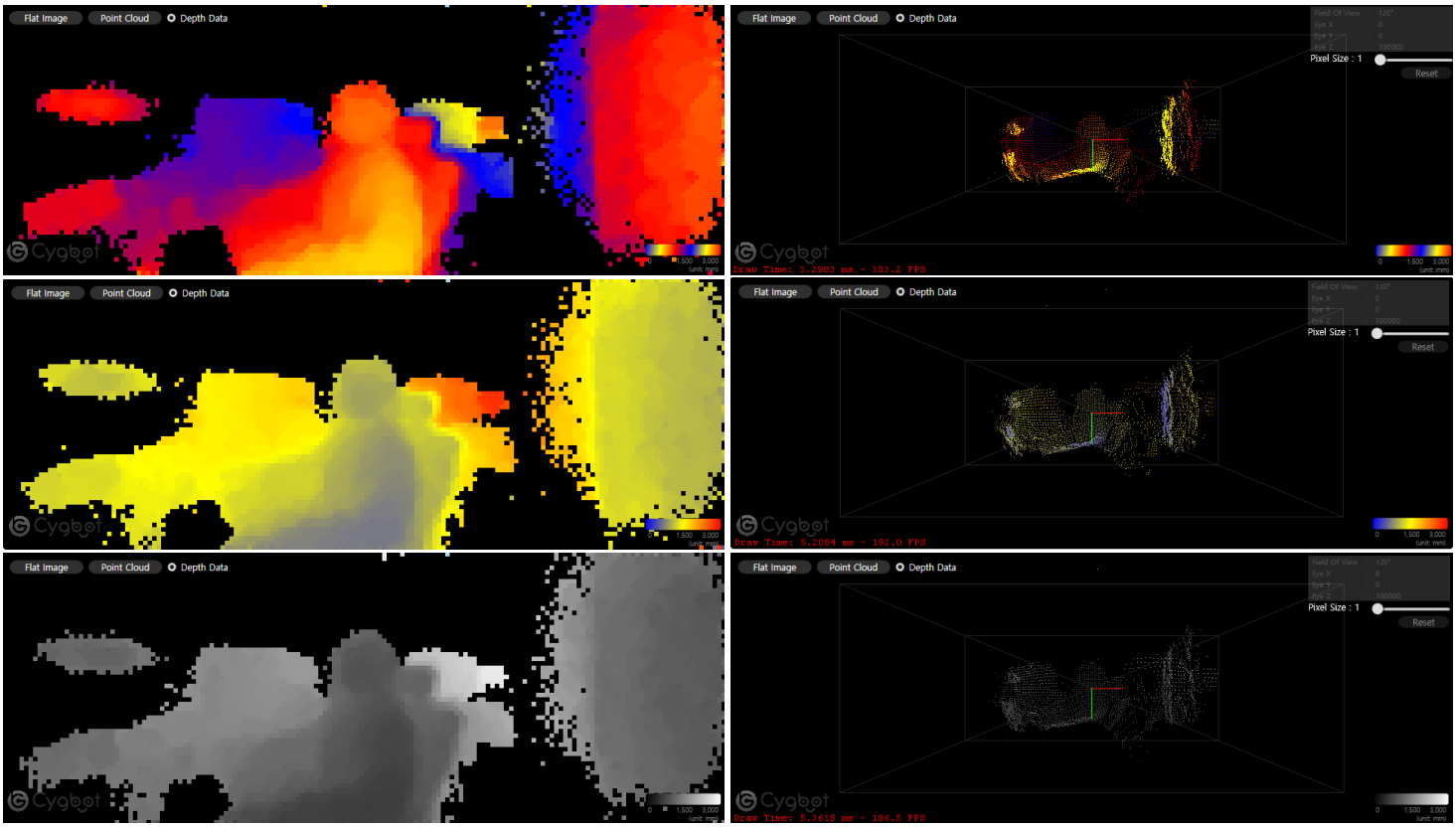




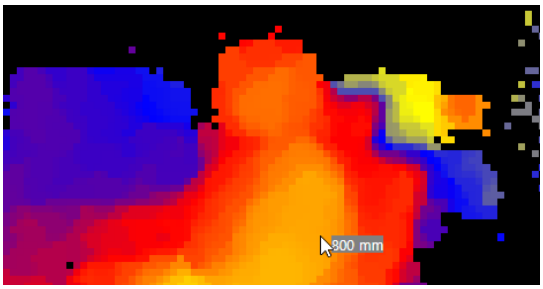
8. CygLiDAR Viewer

3D Data

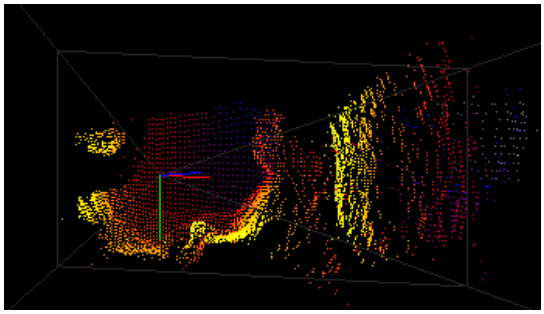
Each of the measured distances per pixel determines a color to be visualized on both 2D and 3D plans, and the color range is dependent on the selected Color Scheme.

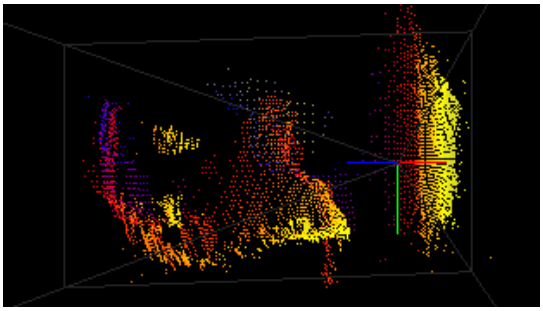


1) Flat Image
   - Moving a mouse cursor updates a distance at the coordinate.



2) Point Cloud(Object)
   - Mouse Left button and mouse cursor changes the view from the viewpoint.

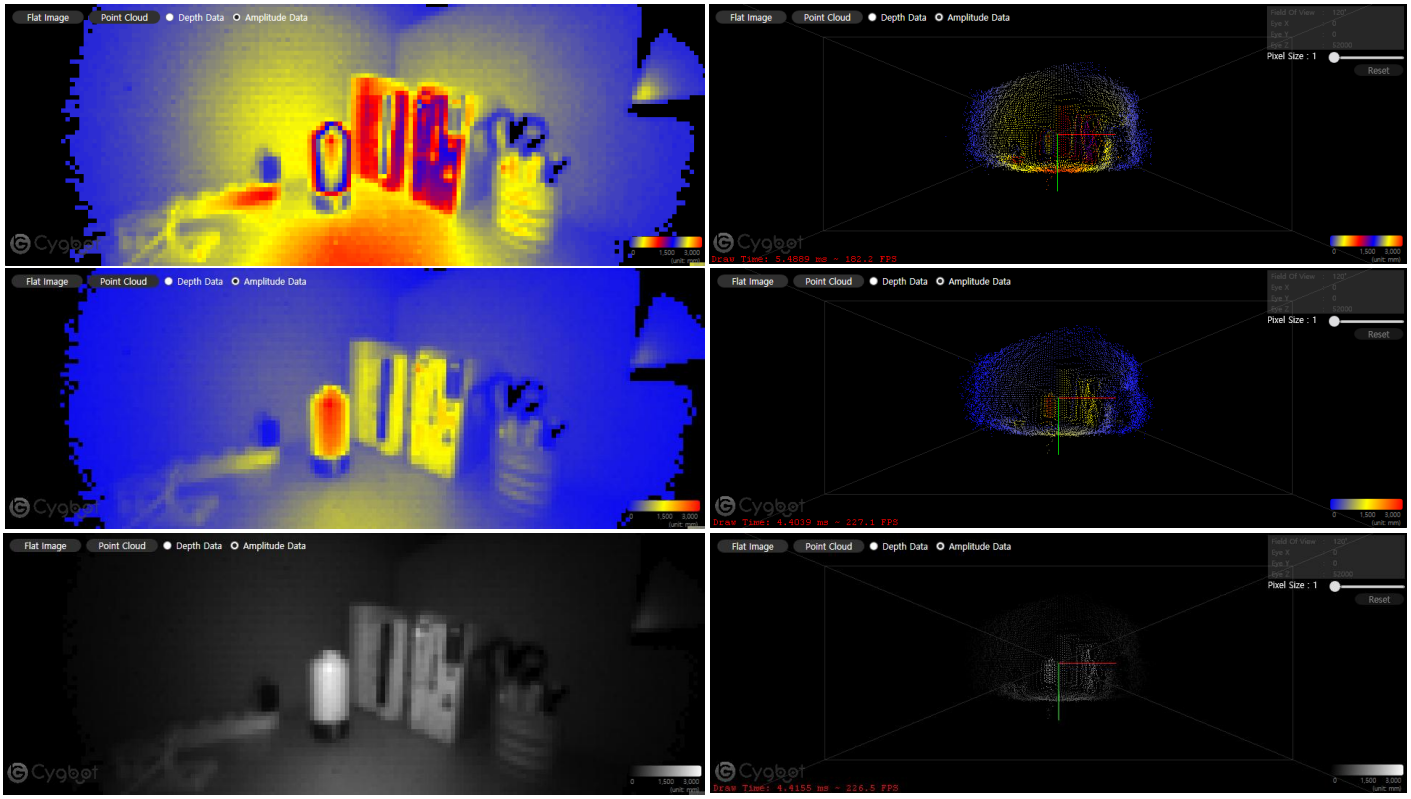




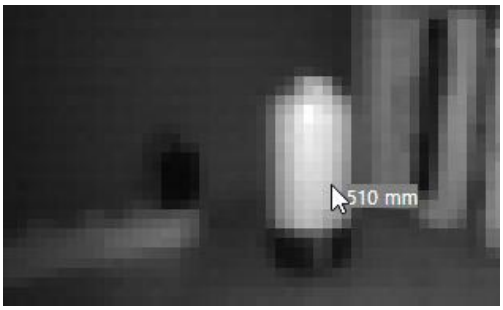
8. CygLiDAR Viewer

3D Amplitude

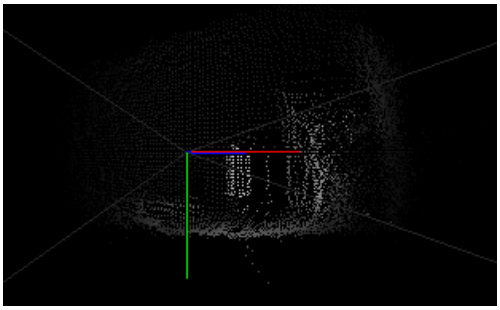
Each of the measured distances per pixel determines a color to be visualized on 3D plans, and the color range is dependent on the selected Color Scheme.

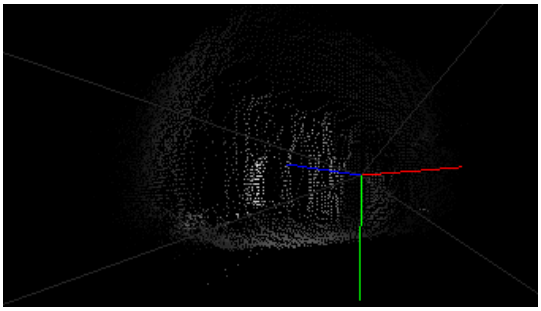


1) Flat Image
   - Moving a mouse cursor updates a distance at the coordinate.



2) Point Cloud(Object)
   - Mouse Left button and mouse cursor changes the view from the viewpoint.



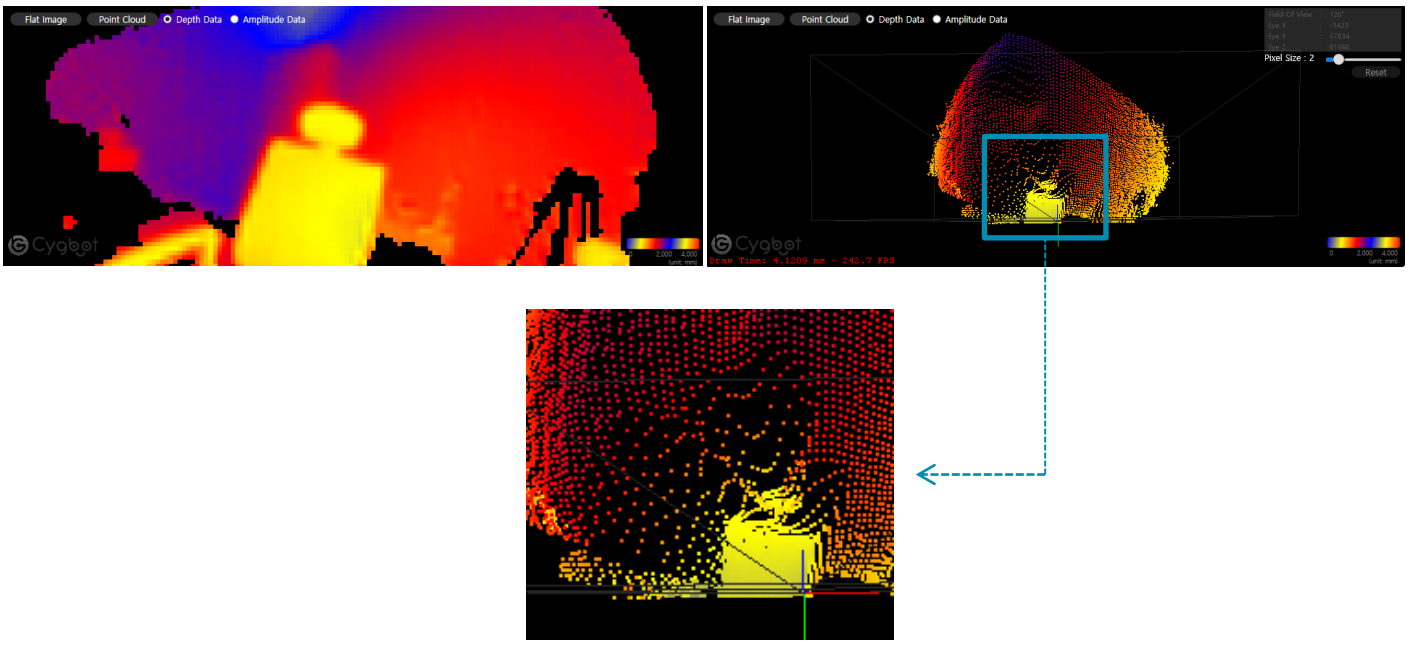


8. CygLiDAR Viewer

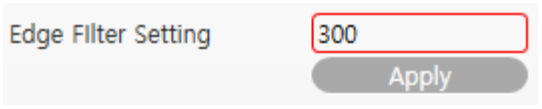
Edge Filter

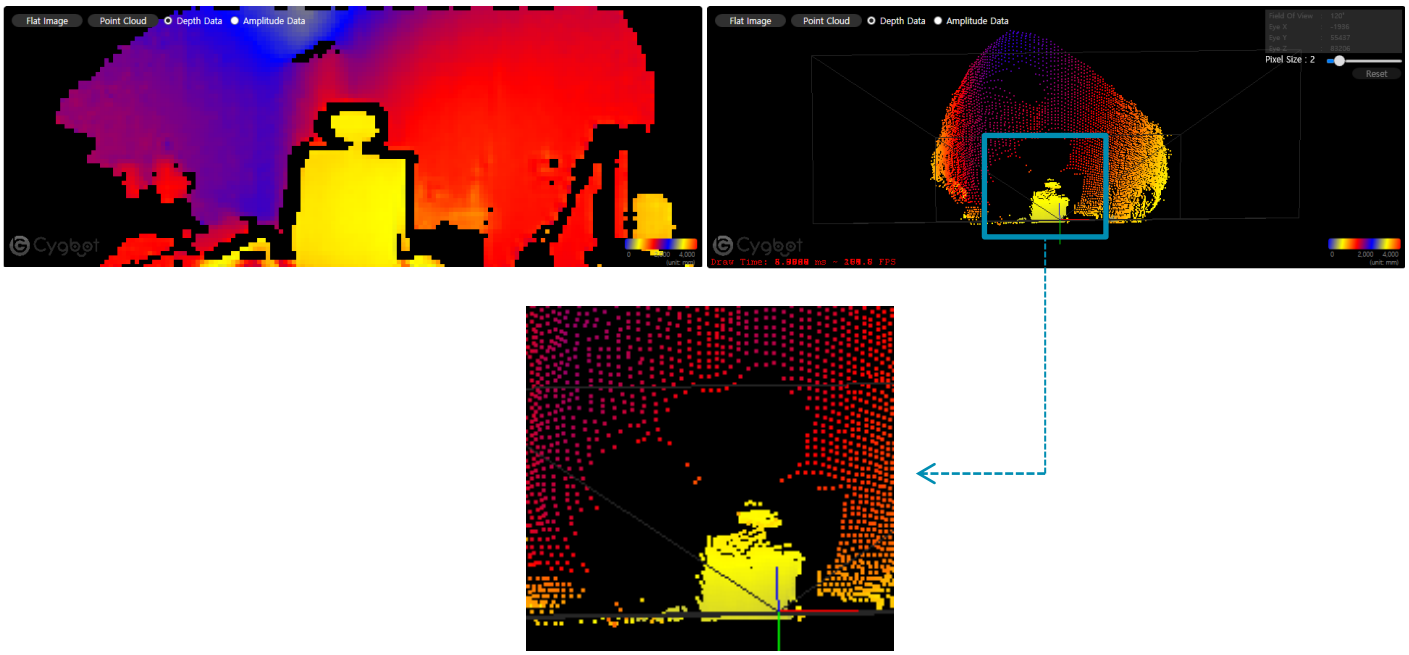
Indicates the boundary between the background and the object.

1) Edge Filter Off



2) Edge Filter On
- Edge Filter Setting: 300

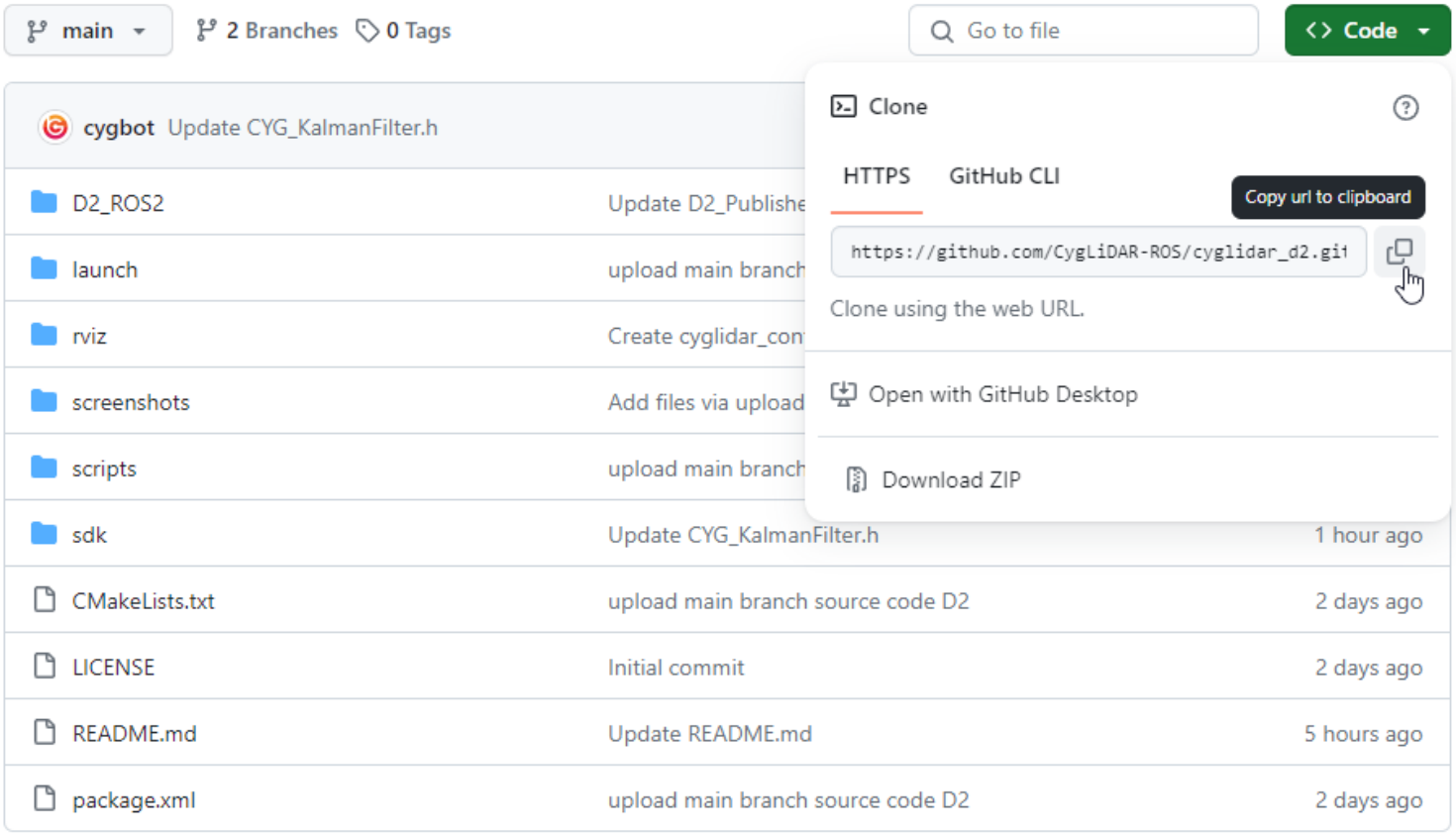




9. CygLiDAR ROS Driver

1) Copy ROS Package URL from the following Git repository page:

https://github.com/CygLiDAR-ROS/cyglidar_d2



2) Clone the remote repository to your local computer as below:

$ git clone https://github.com/CygLiDAR-ROS/cyglidar_d2.git

```
cygbot          )QQ:~/d2_ws/src$ sudo git clone https://github.com/CygLiDAR-ROS/cyglidar_d2.git
Cloning into 'cyglidar_d2'...
remote: Enumerating objects: 175, done.
remote: Counting objects: 100% (175/175), done.
remote: Compressing objects: 100% (157/157), done.
remote: Total 175 (delta 71), reused 69 (delta 15), pack-reused 0
Receiving objects: 100% (175/175), 5.02 MiB | 5.89 MiB/s, done.
Resolving deltas: 100% (71/71), done.
```

10. Revision history

Document Revision History

31-Jan-24	0.1.0	Updated - CygLiDAR D2 Manual
01-Feb-24	0.1.1	Updated - Specification - Correcting a typo
27-Mar-24	0.2.0	Updated - Specification
05-Apr-24	0.3.1	Updated - Specification
14-May-25	0.4.0	Added - CygLiDAR Viewer Edge Filter Updated - Specification

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