Ver 0.2.2

2D/3D Dual CygLiDAR

CygLiDAR D1

User Manual

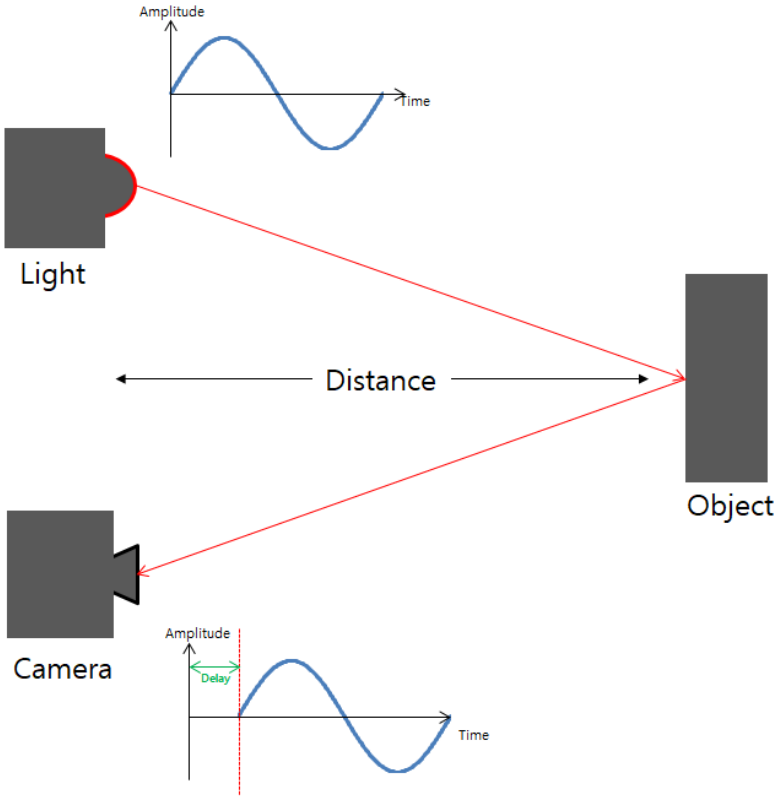
Cygbot

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. This is the Phase shift method that measures time and calculates distance.



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.

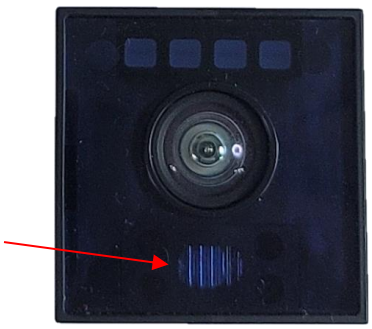
2. Specification

Detection range	Range affected by reflectivity 2D : 200mm ~ 8,000mm 3D : 50mm ~ 2,000mm (*DRM)
Distance accuracy	±1%
Resolution (Measure in mm)	2D : 1° (Angle) 3D : 160 x 60 (Pixel)
FOV : Field of View	2D/3D Horizontal : 120° 3D Vertical : 65°
Wavelength	*Laser Diode : NIR 808nm LED : NIR 808nm
Measuring speed	2D : 15Hz 3D : 15Hz
Size (W * H * D)	37.4 * 37.4 * 24.5 (mm^3)
Weight	28g
Interface	UART TTL 3.3V 3,000,000 bps
Input power source	5V, 500mA
Operating Temperature	-10°C ~ 50°C
Use environment	Indoor

*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.

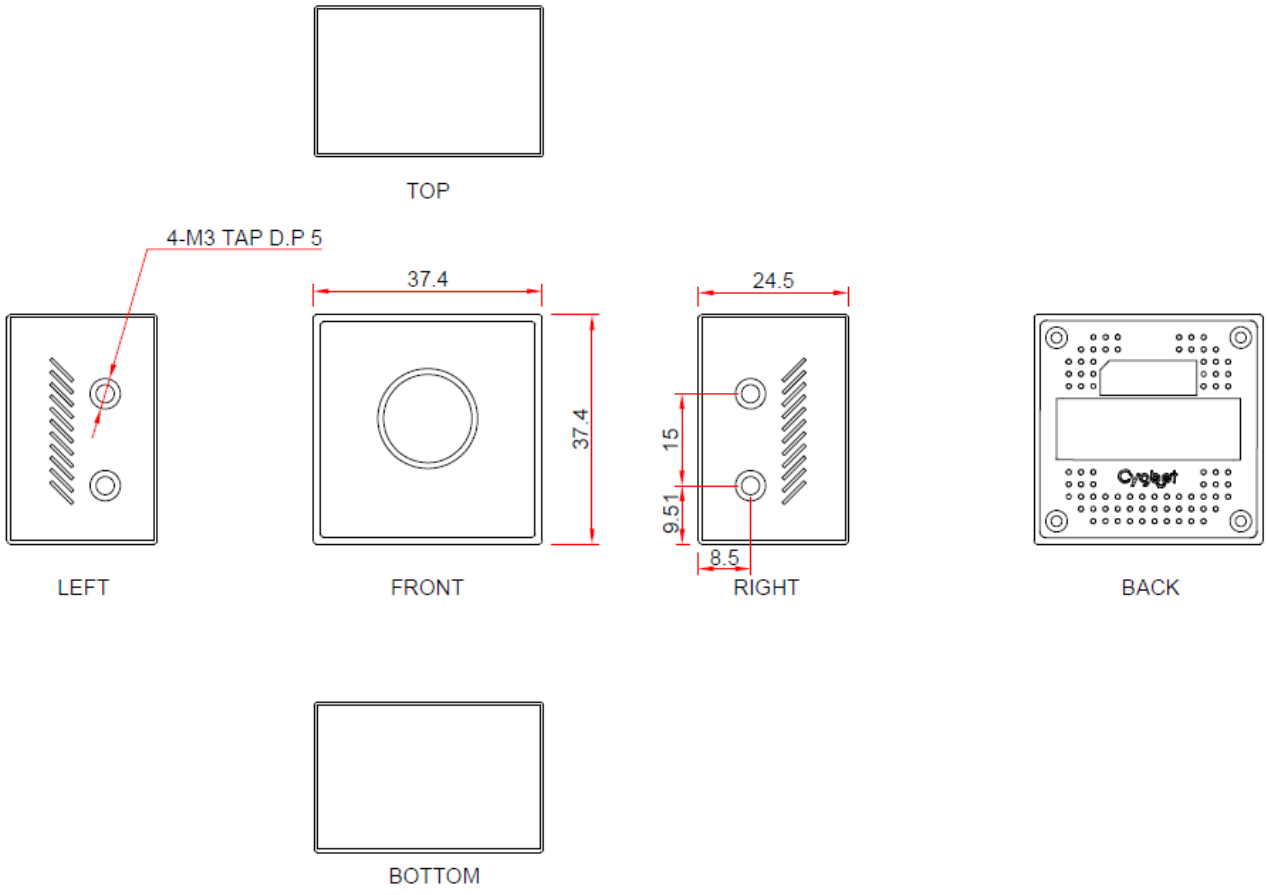


3. Component

			
CygLiDAR D1	Connector	USB to UART Converter	5pin USB Cable

* Components other than CygLiDAR D1 are provided separately and may differ from the image above.

4. Hardware Design

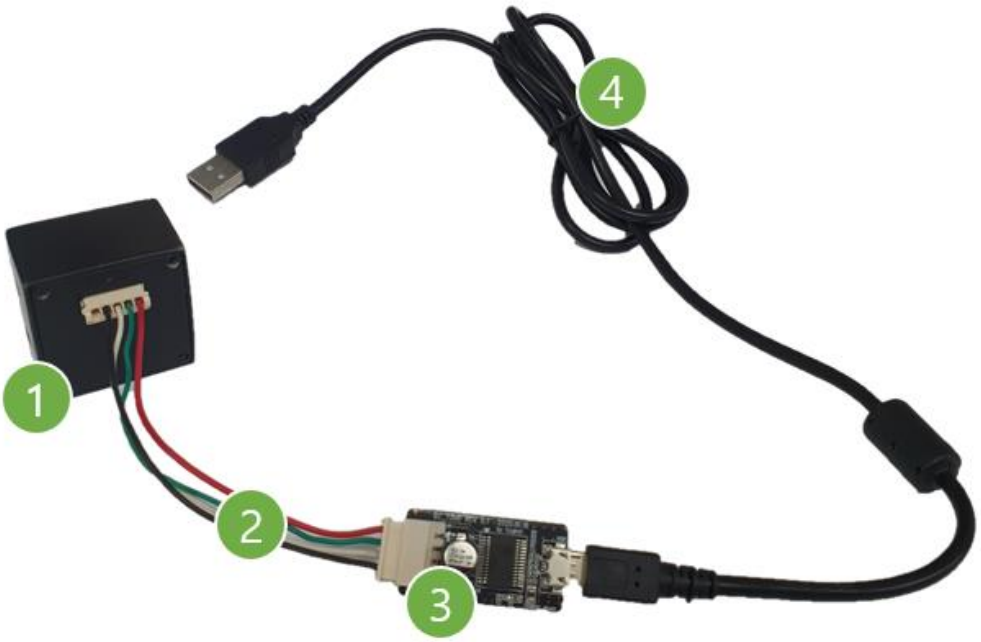


5. How to Use

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

				
CygLiDAR D1	Connector	USB to UART Converter	5pin USB Cable	PC or Rasberry Pi

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



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

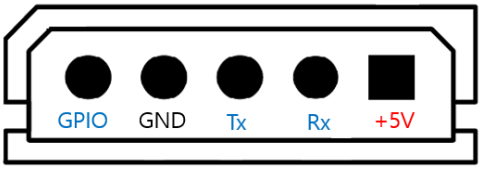
6. Serial Communication

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;
}
```

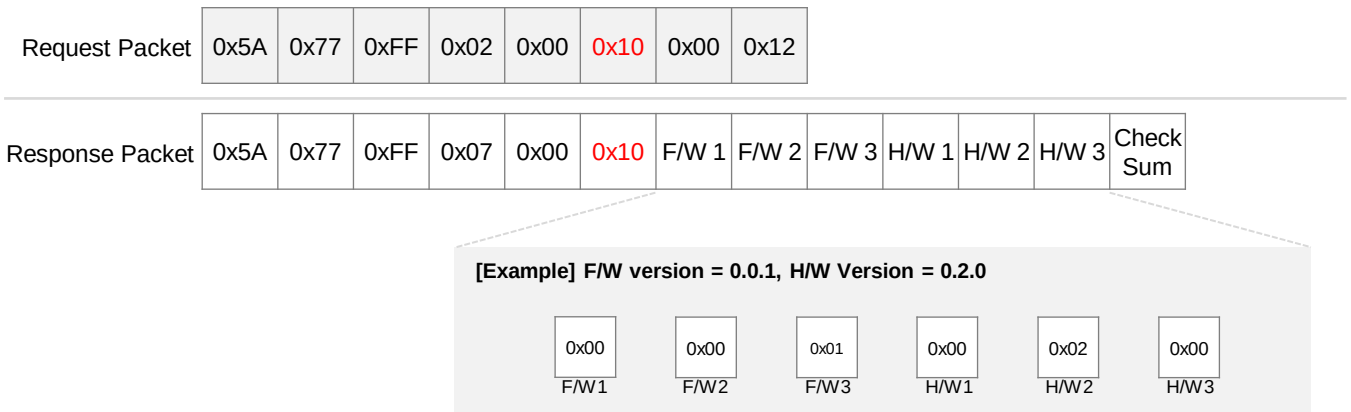
6. Serial Communication

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
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
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 Sensitivity	0x11	2	X	Control measurement sensitivity.	0.0.2
Set Baud Rate	0x12	2	X	Change seral baud rate	0.2.4

Get Device Info Request



Both versions of firmware and hardware are provided.

6. Serial Communication

Run 2D Mode Request (0x01)

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

Response Packet	0x5A	0x77	0xFF	0xF3	0x00	0x01	LSB -60º	MSB -60º	…	LSB +60º	MSB +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 to 2D Mode in order to receive 2D datasets from the device.
Sequence of 2D datasets is 0.75 º resolution from -60º to +60º.

Run 3D Mode Request (0x08)

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

Response Packet	0x5A	0x77	0xFF	0x41	0x38	0x08	3D Data format	Check Sum

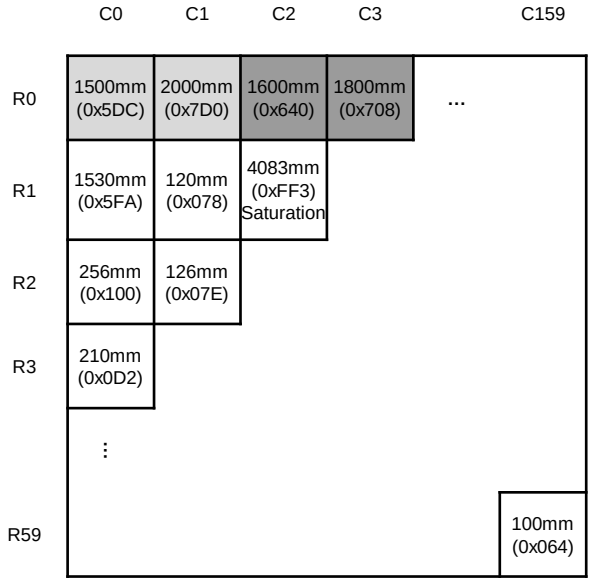
Light source : LED
Resolution : 160 x 60
Horizontal FOV : 120°
Vertical FOV : 65°
Range : 50 ~ 2,000mm
Data Type : 12 bit

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

Switch to 3D Mode in order to receive 3D datasets from the device.

6. Serial Communication

3D Data format



R0C0	R0C0 & R0C1	R0C1	R0C2	R0C2 & R0C3	R0C3	…	R59C159
0x5D	0xC7	0xD0	0x64	0x07	0x08	…	0x64

Run Dual Mode Request (0x07)

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x07	0x00	0x05

Response Packet	0x5A	0x77	0xFF	0xF3	0x00	0x01	2D Data format	Check Sum
	0x5A	0x77	0xFF	0x41	0x38	0x08	3D Data format	Check Sum

Switch to Dual Mode in order to receive Dual datasets from the device.
When switching to Dual Mode device is measure 2D Data and 3D Data alternately.

6. Serial Communication

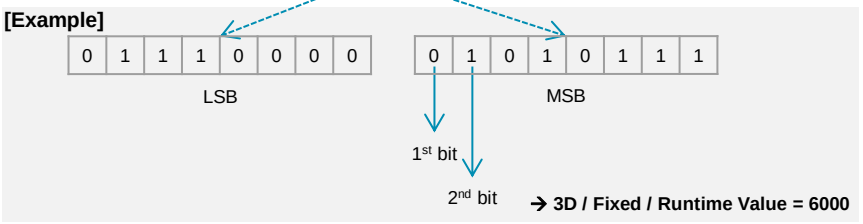
Stop (0x02)

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



3D Data is used in 3D Mode and Dual Mode.
You can adjust the pulse duration with the Set 3D pulse duration packet. Adjustable time is limited to 0-10,000us. Pulse Duration can be Auto that LiDAR adjusts itself, or Fixed that uses a user-specified value.
If Pulse Duration is fixed, 14 bits after the 2nd bit are Pulse Duration Value.

1st bit	2nd bit	Result
0	0	3D, Auto
0	1	3D, Fixed
1	0	Dual, Auto
1	1	Dual, Fixed

6. Serial Communication

Frequency Setting Request (0x0F)

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

You can change the frequency of light source.
Interference errors can increase if two or more devices measure the same space.
You can avoid interference errors by applying different Frequency Channels to different devices. CygLiDAR D1 has 16 Channels.

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

Sensitivity Setting Request (0x11)

Request Packet	0x5A	0x77	0xFF	0x02	0x00	0x11	Value	Check Sum

You can adjust the measurement sensitivity of 2D Data. (Default = 20)
If the measurement sensitivity is low, you can see data over a long distance, but the measurement error increases. The higher the sensitivity of measurement, the more accurate the distance measurement is, but the smaller range of measurement is possible.

Set Serial Baud Rate (0x12)

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

Set the Serial Baud Rate.
Serial Baud Rate can be operated at 57600 bps,115200 bps, 250,000bps, 3000000bps. Default setting is 3000000bps.
When baud rate is set, the value is stored in flash ROM and device is rebooted.

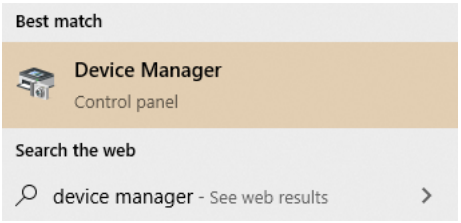
Baud Rate Packet

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~
0x55	→	3,000,000	bps	0.2.4~

7. Verification & Install

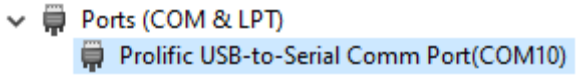
∗ Connect CygLiDAR to PC in respect of page 6

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)

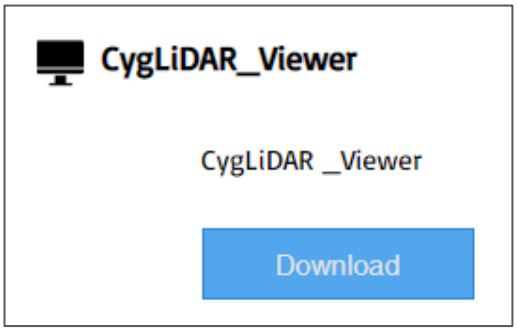
① $ lsusb
Bus 001 Device 005: ID 067b:2303 Prolific Technology, Inc. PL2303 Serial Port

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

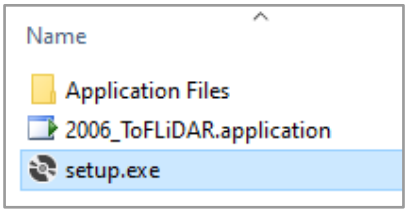
③ $dmesg

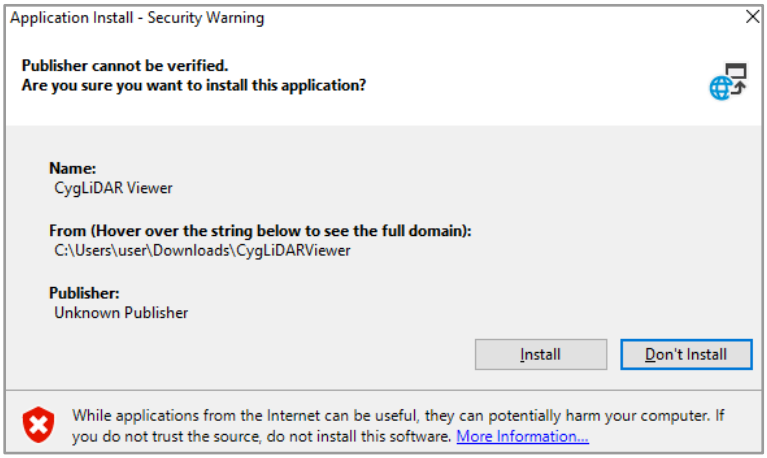
3. Download CygLiDAR Viewer

https://www.cygbot.com/downloads

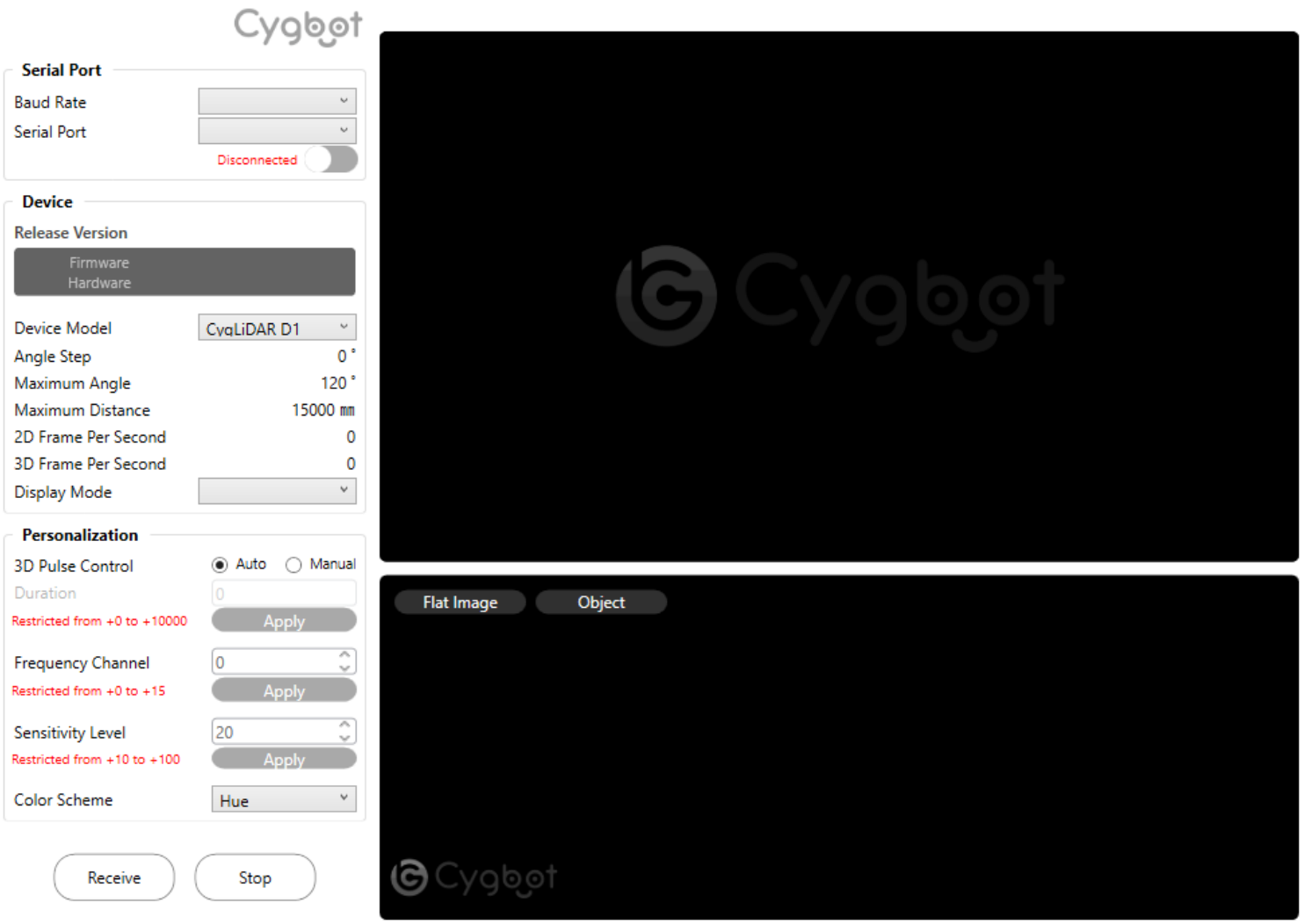


4. Install CygLiDAR Viewer

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 device model and a display mode.

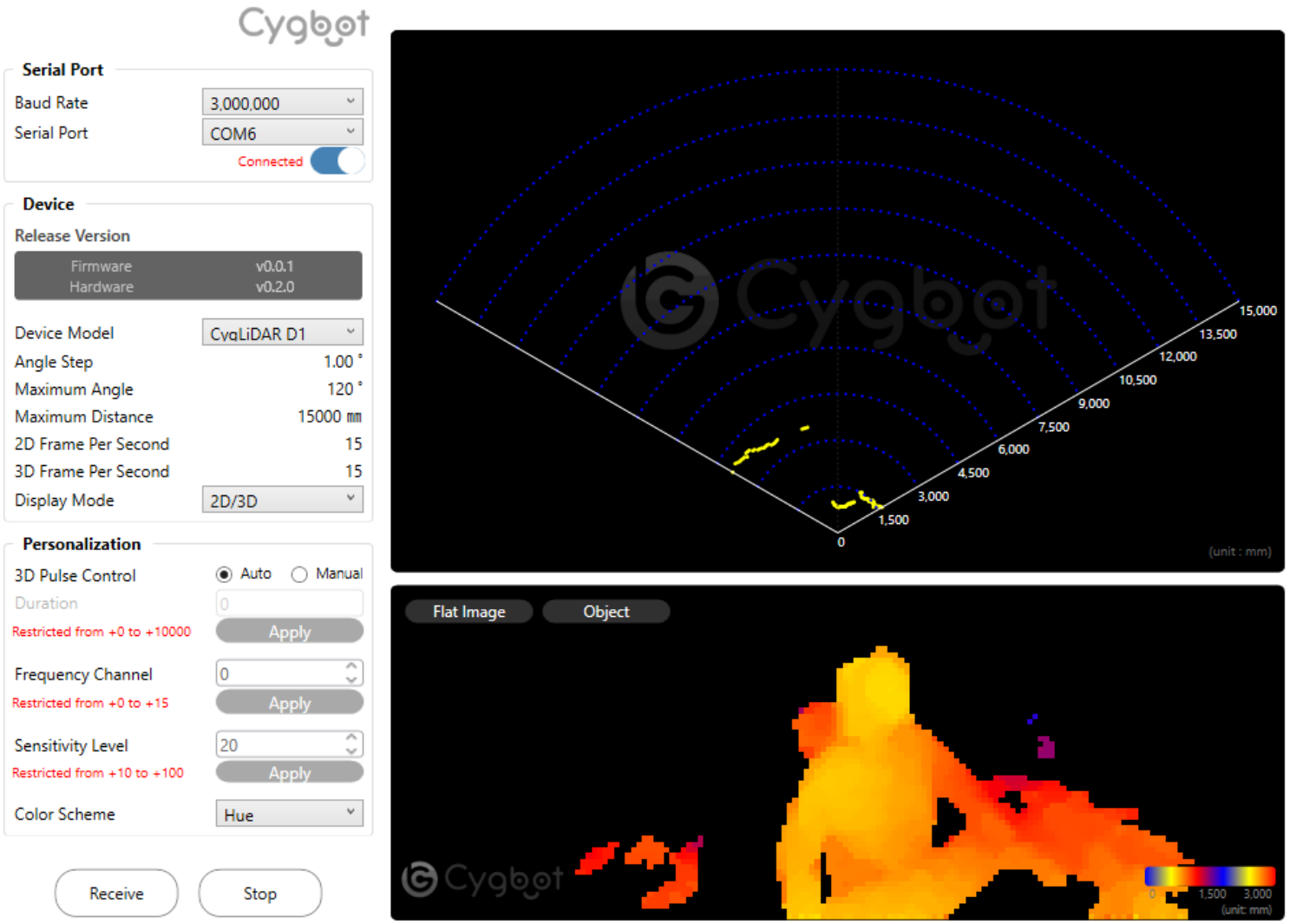
3) 3D Pulse Duration Control
   - Choose **Auto** and press **Apply** for a completion of Auto mode.
   - Choose **Manual**, put a preferable value for the duration to send and press **Apply**.
     (The duration is +0 to the minimum and +10000 to the maximum available to apply.)

4) Frequency Channel
   - Assign a channel restricted from +0 to +15 for light sources.

5) Sensitivity Level
   - Provide a specific level of the detection sensitivity, ranging from +10 to +100.

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

8. CygLiDAR Viewer



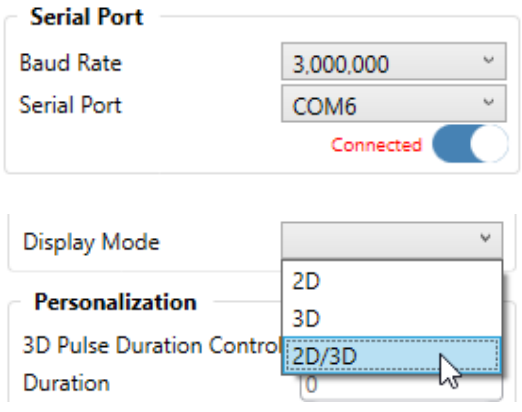
Example

1) Baud Rate : 3,000,000 bps

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

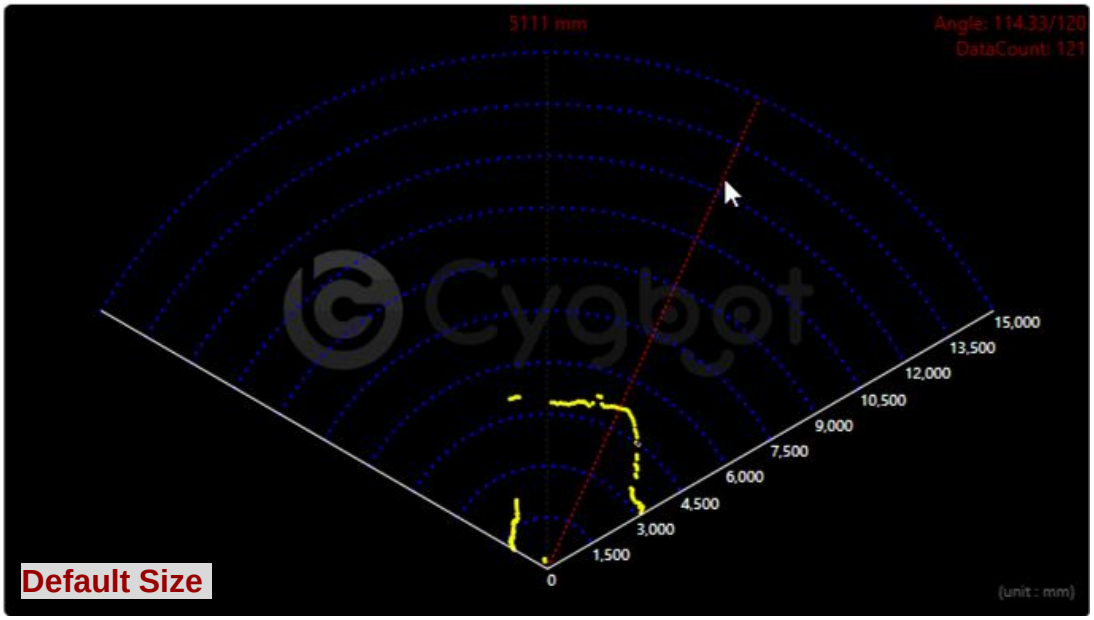
3) Device Model : CygLiDAR D1

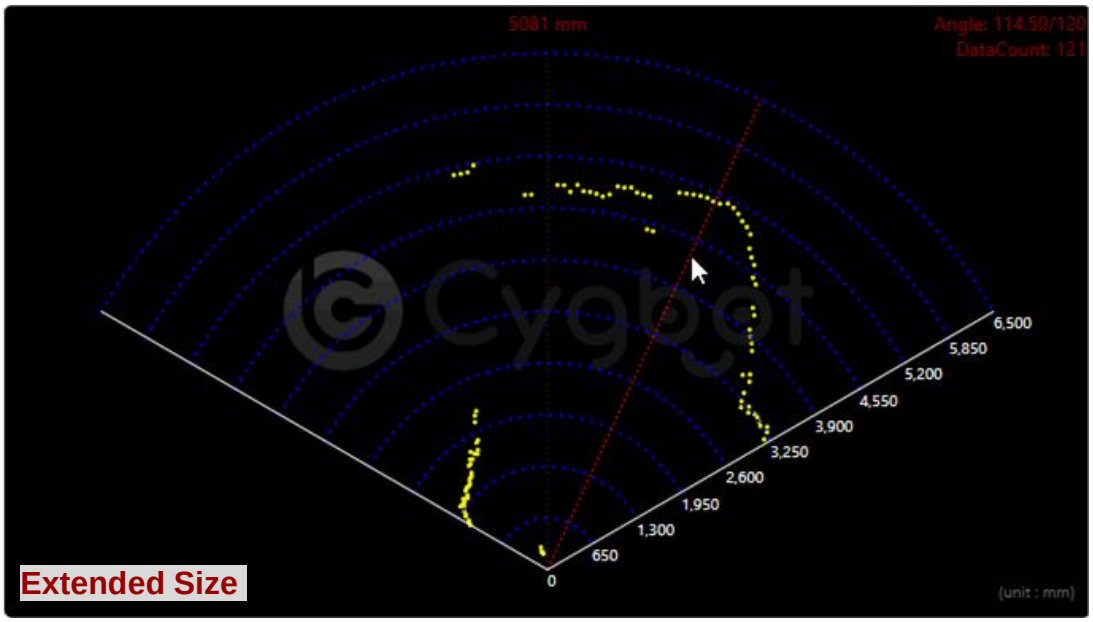
4) Display Mode :
Select one of the following modes: Hue, RGB and Grey.



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

8. CygLiDAR Viewer





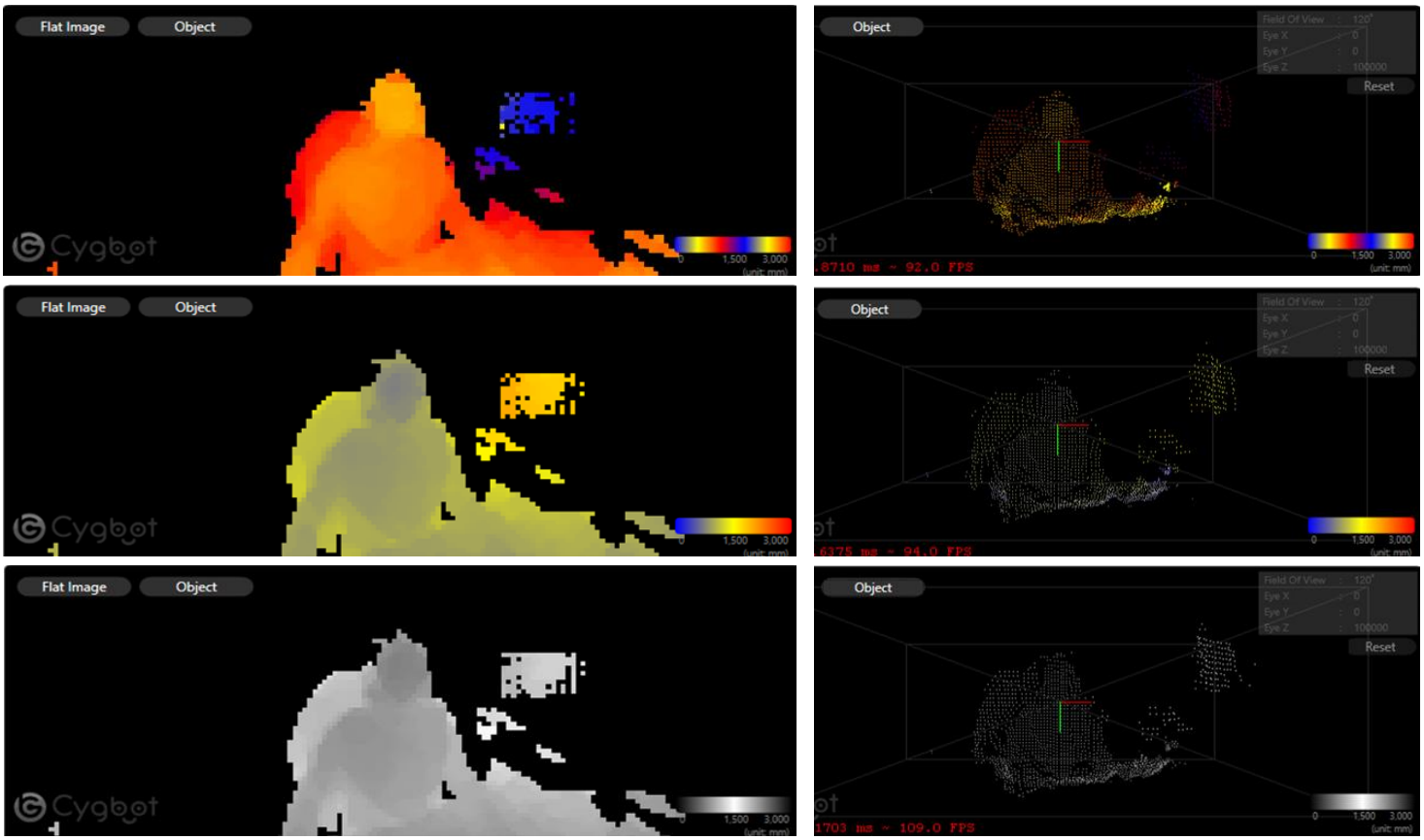
2D Data

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

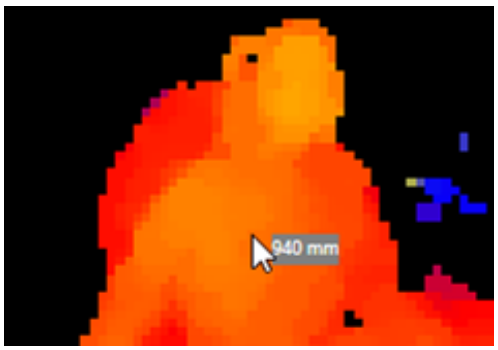
8. CygLiDAR Viewer

3D Data

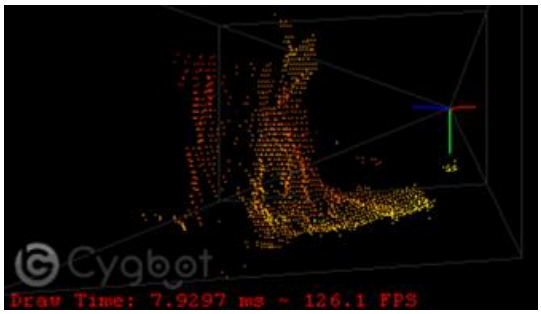
Each of the measured distances per pixel determines a color to be visualized on both 2D and 3D plans, and the color range is dependent on the selected Color Scheme.

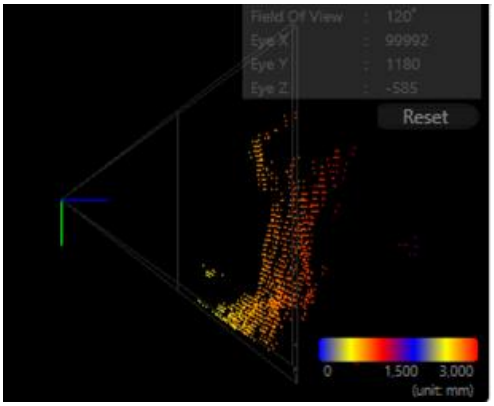


1) Flat Image
   - Moving a mouse cursor updates a distance at the coordinate.



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

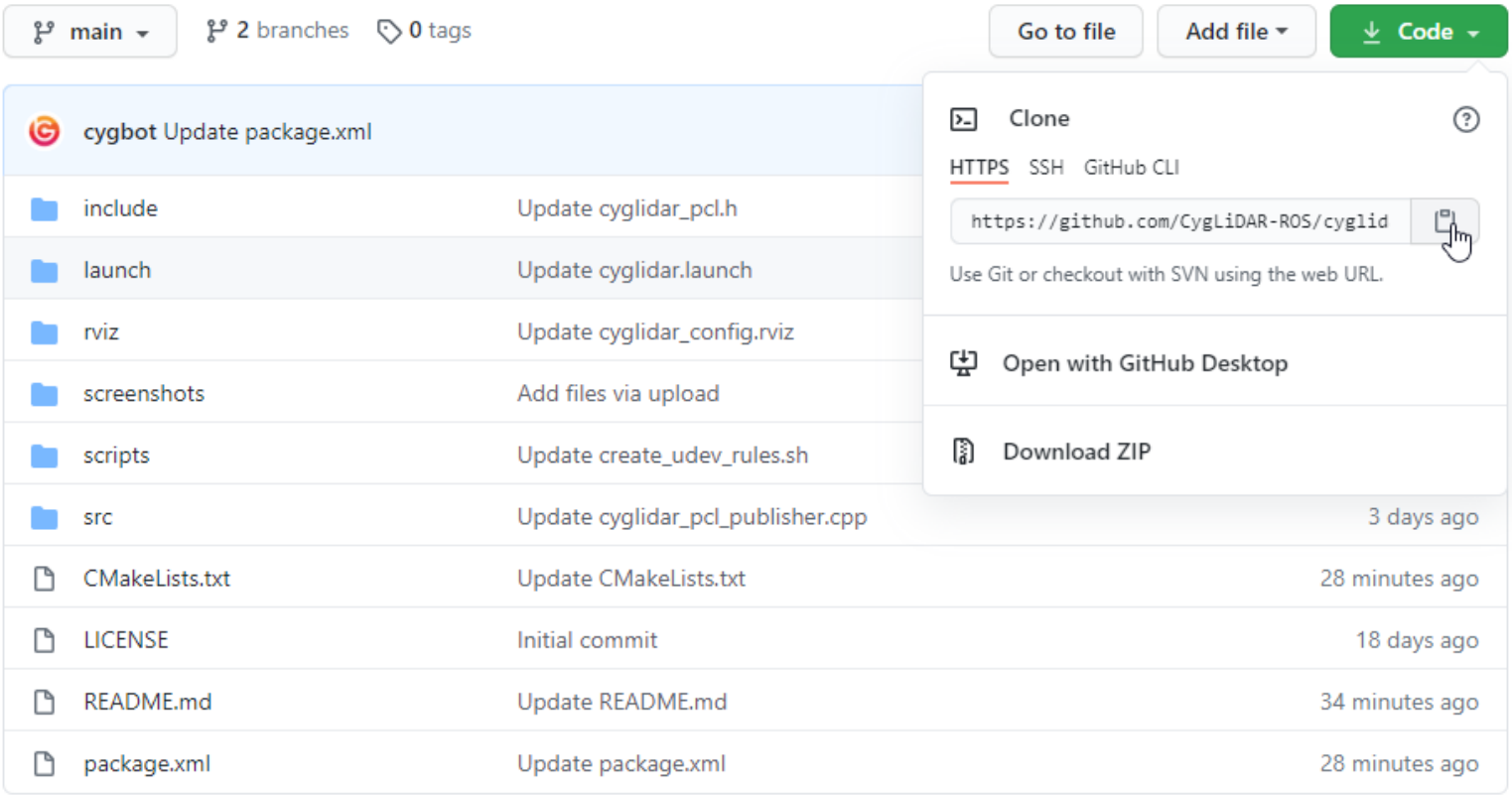




9. CygLiDAR ROS Driver

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

https://github.com/CygLiDAR-ROS/cyglidar_d1



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

$ git clone https://github.com/CygLiDAR-ROS/cyglidar_d1.git

```
cygbot@cygbot-       -DeskTop-System:~/catkin_test/src$ git clone https://github.com/CygLiDAR-ROS/cyglidar_d1.git
Cloning into 'cyglidar_d1'...
remote: Enumerating objects: 33, done.
remote: Counting objects: 100% (33/33), done.
remote: Compressing objects: 100% (32/32), done.
remote: Total 224 (delta 11), reused 0 (delta 0), pack-reused 191
Receiving objects: 100% (224/224), 444.40 KiB | 675.00 KiB/s, done.
Resolving deltas: 100% (107/107), done.
```

10. Revision history

Document Revision History

29-Sep-20	0.1.0	Initial release.
20-Nov-20	0.1.1	Added: - Packet - ROS Package Minor text edits across the whole document.
26-Jan-21	0.1.8	Added: - Set Amplitude Updated: - Packet - ROS Package - Serial Communication design and description - Hardware Design - Software user interface and description on new functions Minor text edits across the whole document.
25-May-21	0.1.9	Added: - Usb Driver for Linux - Set Serial Baud Rate Updated: - CygLiDAR Viewer DowNLoad URL
09-Aug-21	0.2.2	Added: - baud rate update function in software

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