CygLiDAR D1
User Manual
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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.

![ToF Diagram](image)

**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

<table>
<thead>
<tr>
<th>Specification</th>
<th>Range affected by reflectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection range</td>
<td>2D : 200mm ~ 8,000mm</td>
</tr>
<tr>
<td></td>
<td>3D : 50mm ~ 2,000mm (DRM)</td>
</tr>
<tr>
<td>Distance accuracy</td>
<td>±1%</td>
</tr>
</tbody>
</table>
| 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 (mm³)                                            |
| 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

<table>
<thead>
<tr>
<th>CygLiDAR D1</th>
<th>Connector</th>
<th>USB to UART Converter</th>
<th>5pin USB Cable</th>
</tr>
</thead>
</table>

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

4. Hardware Design

![Hardware Diagram]

* TOP
* LEFT
* FRONT
* RIGHT
* BACK
* BOTTOM
5. How to Use

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

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>CygLiDAR D1</td>
<td>Connector</td>
<td>USB to UART Converter</td>
<td>5pin USB Cable</td>
<td>PC or Raspberry Pi</td>
</tr>
</tbody>
</table>

- 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

<table>
<thead>
<tr>
<th>Packet</th>
<th>Payload</th>
<th>Packet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Header1</td>
<td>Payload Length LSB</td>
<td>Payload Header</td>
</tr>
<tr>
<td>1 byte</td>
<td>1 byte</td>
<td>1 byte</td>
</tr>
<tr>
<td>Header2</td>
<td>Payload Length MSB</td>
<td>Payload Data 0</td>
</tr>
<tr>
<td>1 byte</td>
<td>1 byte</td>
<td>n byte</td>
</tr>
<tr>
<td>Header3</td>
<td>Payload Data 1</td>
<td>Payload Data n</td>
</tr>
<tr>
<td>1 byte</td>
<td>...</td>
<td>1 byte</td>
</tr>
</tbody>
</table>

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.

```c
#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

<table>
<thead>
<tr>
<th>Request Name</th>
<th>Payload Header Value</th>
<th>Payload Length</th>
<th>Response Packet</th>
<th>LiDAR Operation</th>
<th>Supported Firmware Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get Device Info</td>
<td>0x10</td>
<td>2</td>
<td>O</td>
<td>Get the release versions of the latest update to F/W and H/W</td>
<td>0.0.1</td>
</tr>
<tr>
<td>Run 2D Mode</td>
<td>0x01</td>
<td>2</td>
<td>O</td>
<td>Start 2D Data measurement.</td>
<td>0.0.1</td>
</tr>
<tr>
<td>Run 3D Mode</td>
<td>0x08</td>
<td>2</td>
<td>O</td>
<td>Start 3D Data measurement.</td>
<td>0.0.1</td>
</tr>
<tr>
<td>Run Dual Mode</td>
<td>0x07</td>
<td>2</td>
<td>O</td>
<td>Start Dual Data measurement.</td>
<td>0.0.1</td>
</tr>
<tr>
<td>Stop</td>
<td>0x02</td>
<td>2</td>
<td>X</td>
<td>Change status to Idle.</td>
<td>0.0.1</td>
</tr>
<tr>
<td>Set 3D Light pulse duration</td>
<td>0x0C</td>
<td>3</td>
<td>X</td>
<td>Control 3D Light pulse duration.</td>
<td>0.0.1</td>
</tr>
<tr>
<td>Set Frequency Channel</td>
<td>0x0F</td>
<td>2</td>
<td>X</td>
<td>Change frequency channel.</td>
<td>0.0.1</td>
</tr>
<tr>
<td>Set Sensitivity</td>
<td>0x11</td>
<td>2</td>
<td>X</td>
<td>Control measurement sensitivity.</td>
<td>0.0.2</td>
</tr>
<tr>
<td>Set Baud Rate</td>
<td>0x12</td>
<td>2</td>
<td>X</td>
<td>Change serial baud rate</td>
<td>0.2.4</td>
</tr>
</tbody>
</table>

Get Device Info Request

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

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 -60° MSB +60° … LSB +60° MSB +60° Check Sum

Light source: Laser, LED
FOV: 120°
Resolution: 0.75°
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° resolution from -60° to +60°.

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

![3D Data format Diagram]

Run Dual Mode Request (0x07)

Request Packet

<table>
<thead>
<tr>
<th>0x5A</th>
<th>0x77</th>
<th>0xFF</th>
<th>0x02</th>
<th>0x00</th>
<th>0x07</th>
<th>0x00</th>
<th>0x05</th>
</tr>
</thead>
</table>

Response Packet

<table>
<thead>
<tr>
<th>0x5A</th>
<th>0x77</th>
<th>0xFF</th>
<th>0xF3</th>
<th>0x00</th>
<th>0x01</th>
<th>2D Data format</th>
<th>Check Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x5A</td>
<td>0x77</td>
<td>0xFF</td>
<td>0x41</td>
<td>0x38</td>
<td>0x08</td>
<td>3D Data format</td>
<td>Check Sum</td>
</tr>
</tbody>
</table>

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)

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.

<table>
<thead>
<tr>
<th>1st bit</th>
<th>2nd bit</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>3D, Auto</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>3D, Fixed</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>Dual, Auto</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Dual, Fixed</td>
</tr>
</tbody>
</table>
6. Serial Communication

**Frequency Setting Request (0x0F)**

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.

<table>
<thead>
<tr>
<th>Channel</th>
<th>0x00</th>
<th>0x01</th>
<th>0x02</th>
<th>0x03</th>
<th>0x04</th>
<th>0x05</th>
<th>0x06</th>
<th>0x07</th>
<th>0x08</th>
<th>0x09</th>
<th>0x0A</th>
<th>0x0B</th>
<th>0x0C</th>
<th>0x0D</th>
<th>0x0E</th>
<th>0x0F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freq Ch</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
</tbody>
</table>

**Sensitivity Setting Request (0x11)**

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)**

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

<table>
<thead>
<tr>
<th>Baud Rate Packet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packet</td>
</tr>
<tr>
<td>0x39</td>
</tr>
<tr>
<td>0xAA</td>
</tr>
<tr>
<td>0x77</td>
</tr>
<tr>
<td>0x55</td>
</tr>
</tbody>
</table>
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:

   ![Ports (COM & LPT)](image)

   Prolific USB-to-Serial Comm Port(COM10)

   In case of not finding any port connected to the USB, download a driver from the following website:
   - **LINUX(Ubuntu)**

   ![codes](image)

   ![dmesg](image)

3. Download CygLiDAR Viewer
   [https://www.cygbot.com/downloads](https://www.cygbot.com/downloads)

4. Install CygLiDAR Viewer

   ![Application Install - Security Warning](image)
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
## 10. Revision history

### Document Revision History

<table>
<thead>
<tr>
<th>Date</th>
<th>Version</th>
<th>Release Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>29-Sep-20</td>
<td>0.1.0</td>
<td>Initial release.</td>
</tr>
<tr>
<td>20-Nov-20</td>
<td>0.1.1</td>
<td>Added: - Packet - ROS Package Minor text edits across the whole document.</td>
</tr>
<tr>
<td>26-Jan-21</td>
<td>0.1.8</td>
<td>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.</td>
</tr>
<tr>
<td>25-May-21</td>
<td>0.1.9</td>
<td>Added: - Usb Driver for Linux - Set Serial Baud Rate Updated: - CygLiDAR Viewer Dow nLoad URL</td>
</tr>
<tr>
<td>09-Aug-21</td>
<td>0.2.2</td>
<td>Added: - baud rate update function in software</td>
</tr>
</tbody>
</table>
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