

# Part 1 Introduction to Lidar

## 1. Lidar Description

Lidar is a **remote sensing method** that **uses laser to detect the position and speed of the target**. It features **high ranging resolution**, **strong penetrability**, **excellent anti-interference ability** and **eminent anti-stealth ability**.

There are three kinds of Lidar in terms of ranging principle, including **Triangulation Lidar**, **Pulse Lidar** and **Coherent Lidar**. And the Lidar comes with JetAuto is **Triangulation Lidar**.



## 2. Lidar Working Principle

Lidar is composed of **laser emitting system**, **scanning system**, **laser receiving system** and **signal processing system**.

**Firstly**, **laser emitting system will send the detection signal (laser beam)**, and **the scanning system takes charge of scanning the surrounding to receive the related information**.

**Next**, **the laser receiving system will receive the laser reflected by the target object to generate receiving signal**.

**Lastly**, **the signal system will process the receiving signal to get the features of the target, such as shape and physical properties (position, height and speed), then build the model**.

## 3. Lidar Parameter

### 3.1 Performance Parameter

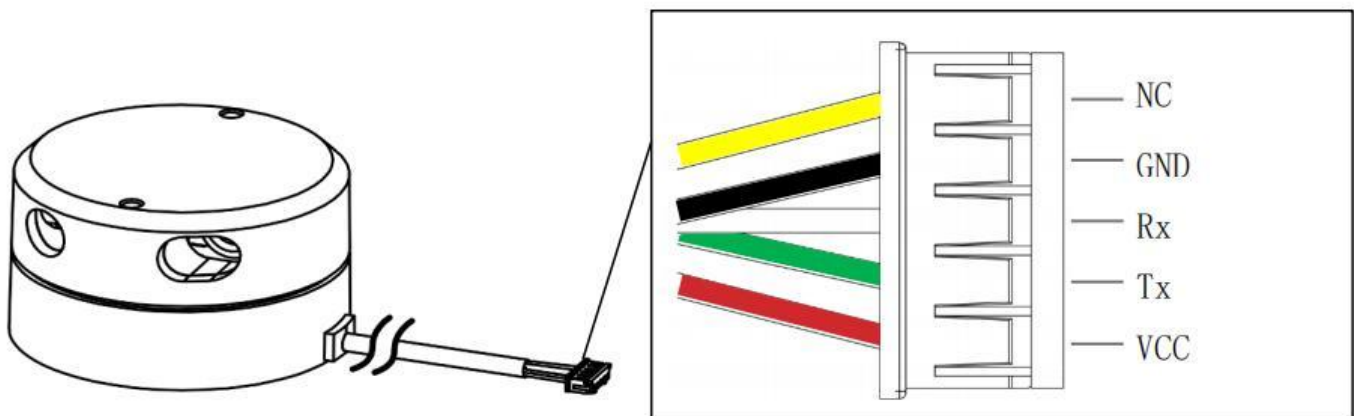
Parameter	Minimum value	Classic value	Maximum value	Note
Ranging frequency (Hz)	/	9000	/	
Scanning frequency	5	7	12	Can be adjusted on the app. The default rotation speed is 7Hz.
Ranging distance (m)	0.12	/	16	Ranging frequency=4kHz; The reflectivity of the laser to the object is 80%
	0.26	/	16	Ranging frequency=8kHz; The reflectivity of the laser to the object is 80%
	0.28	/	16	Ranging frequency=9kHz; The reflectivity of the laser to the object is 80%
Scanning angle (Deg)	/	0-360	/	
Absolute error (cm)	/	2	/	Ranging distance $\leq$ 1m
Relative error	/	2.0%	/	1m < ranging distance < 8m
Pitch angle (Deg)	0.25	1	1.75	
Angle resolution (Deg)	0.2@5Hz	0.28@ 7Hz	0.48@12Hz	Scanning frequency is 7Hz, and the ranging frequency is 9kHz.

### 3.2 Electrical Parameter

Parameter	Minimum value	Classic value	Maximum value	Note
Absolute error (V)	4.8	5	5.2	Too large value will destroy the device, and too small value will affect the ranging performance
Relative error (mA)	1000	/	/	The power supplied to Lidar should be with sufficient driving capability
Pitch angle (mA)	/	/	50	System will enter sleep mode, and the motor will stop working
Pitch angle (mA)	/	350	500	System will start working, and the rotation speed of the motor is 7Hz

### 3.3 Lidar Interface

Lidar is equipped with **PH2.0-5P male interface** for **power supply and data communication**



Pin	Type	Function	Default value	Note
VCC	Power supply	For positive electrode of the power	5V	
TX	Output	For system serial port output	/	Data flow: Lidar-> external device
RX	Input	For system serial port input	/	Data flow: external->Lidar
GND	Power supply	For negative electrode of the power	0V	
NC	Reserve pin	Reserve pin	/	

### 3.4 Serial Port Specification

You can connect the external devices to the interfaces on Lidar. Then the point cloud data, device information and device status can be obtained in real time through communication protocol, and the working mode of the device can be set.

Parameter	Minimum value	Classic value	Maximum value	Note
Baud rate (bps)	/	230400	/	8 data bits,1 stop bit, no check,
High level signal (V)	2.4	3.3	3.5	
Low level signal (V)	0	0.3	0.6	

## 4. Communication mechanism

The G4 **interacts with external devices via the serial port for commands and data**. When an external device sends a system command to G4, G4 analyzes the system command and returns the corresponding answer message, and switches the corresponding working state according to the command content, and the external system parses the message according to the content of the message to get the answer data.

# Part 2 Basic Lidar Knowledge

## 1. Lidar Ranging

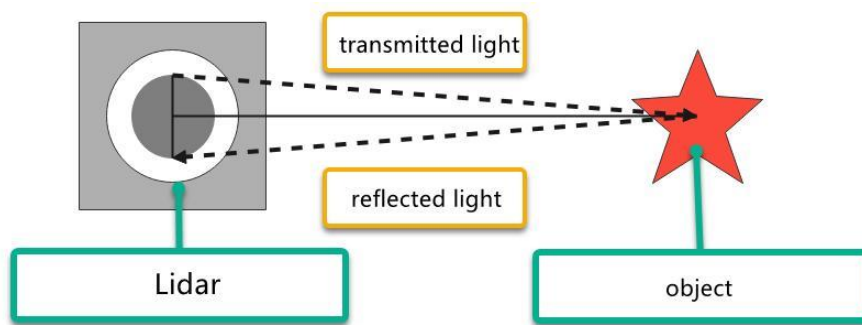
Lidar can range the distance in two ways, including **triangulation ranging** and **TOF**.

### 1.1 Triangulation Ranging

In triangulation ranging, **the laser transmitter will transmit the laser at the specific angle. When the laser hit the surface of the object, it will be reflected to CCD (Charge Coupled Device) sensor and image on CCD.**

**The change of the interval between the laser transmitter and the object will affect the laser path. Therefore when the object moves along the direction of laser, the facula on CCD will move with the object. The displacement of the facula relates to the travel distance of the object, so the distance between the object and Lidar can be calculated according to the displacement of the facula.**

As the **transmitted light and the reflected light has formed a triangle**, trigonometry can be adopted to calculate the displacement of the facula. That's why it is called triangulation ranging.

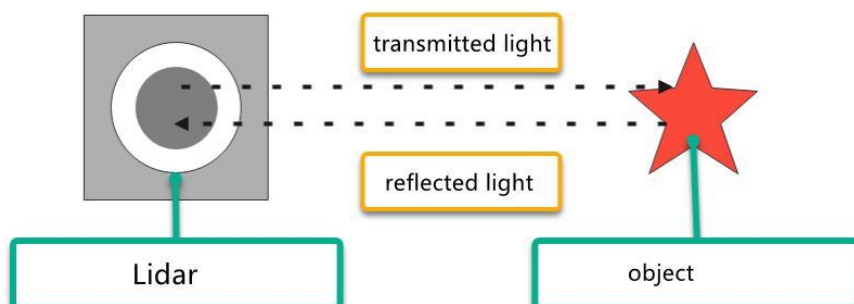


Features of Lidar adopting triangulation ranging:

- 1) Low cost
- 2) Applicable to measure medium and short distance. And the long-distance ranging is not so accurate.
- 3) As it is susceptible to interference, it is usually applied in indoor localization.

### 1.2 TOF (Time Of Flight)

**TOF (Time Of Flight) is a two-way ranging method to solve the distance between the object and Lidar by calculating the duration of laser from being transmitted to being reflected and received, and combining the duration and the speed of light.**

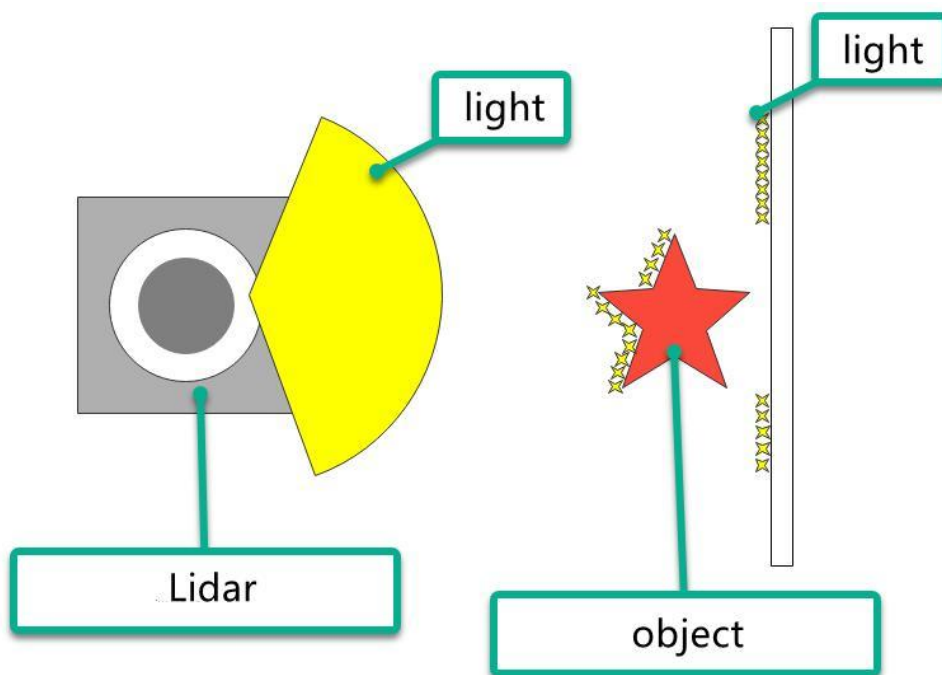


Characteristics of the Lidar based on TOF ranging.

- 1) Low cost
- 2) **Applicable to measure long, medium and short distance.**
- 3) High accuracy. Not influenced by the humidity, air pressure and temperature
- 4) Cannot work in the environment with strong light, because strong light will lead to the rapid saturation of sensor pixel, which will affect the detection of the reflected light.

## 2. Lidar Working Result

Its working result is as follows. **Lidar will emit light and shine it on the object surface. When receiving the light reflected by the object, Lidar will mark the contour of the object at the position where the light is reflected.**



## Part 3 Lidar Following

JetAuto is capable of measuring the distance between itself and the object in front. **If the distance measured is greater than 35cm, it will move along with the object. However, if the distance is less than 35cm, it will move backwards and stop when it is 35cm away from the object.**

## Part 4 Lidar Guarding

JetAuto is capable of measuring the distance between itself and the object in front. If any object appears within the set distance, it will turn its body and make its camera face the object.

## Part 5 Lidar Obstacle Avoidance

JetAuto is capable of measuring the distance between itself and the object in front. In the event that an obstacle is detected within the preset distance, JetAuto will be able to turn left or right to avoid the obstacle.