Solution Brochure

LiDAR Vehicle Contour and Axle Detection System

Version: 1.0

TraffiClair Technology Co., Ltd.

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1 Product Profile

1.1 Statement

All illustrations in this manual are for reference only, please refer to the latest product.

To avoid violating the warranty terms, please do not disassemble the lidar without permission. For relevant operations, please consult the technical support of TraffiClair.

1.2 Overview

The LiDAR Vehicle Contour & Axle Detection System is a set of fully automatic non-contact equipment for the detection of vehicle length, width, height and axle independently developed by TraffiClair. Aiming at the over-limit problem of large vehicles such as trucks and vans driving on the roads (highways, national roads, provincial roads, etc.), the system uses the most advanced high-speed lidars as the sensor, which quickly upload the vehicle's length, width, height, number of the axle, whether it exceeds the limit and other information in real time to the monitoring platforms of the highway bureau, traffic bureau or other management units. The detection accuracy is significantly higher than other current non-contact detection technologies like microwave, video, etc. What's more, this system has a strong anti-interference ability to work stably around the clock.

1.3 Components and Mechanism

Based on the world's leading LiDAR detection technology, the LiDAR Vehicle Contour & Axle Detection System scans the passing vehicle dynamically at high speed. The system measures the reflection distance of the surface point of the object and converts it into 3D space coordinates for real-time vehicle modelling, and calculates the

length, width and height of the vehicle in realtime.

The lidars of this system adopt the Time of Flight method. The lidar starts timing (t1) when the laser pulses are sent out. And when the laser pulses encounter the target object and return to the sensor unit, the lidar stops timing (t2).

Distance = Velocity of Light*(t2 – t1)/2

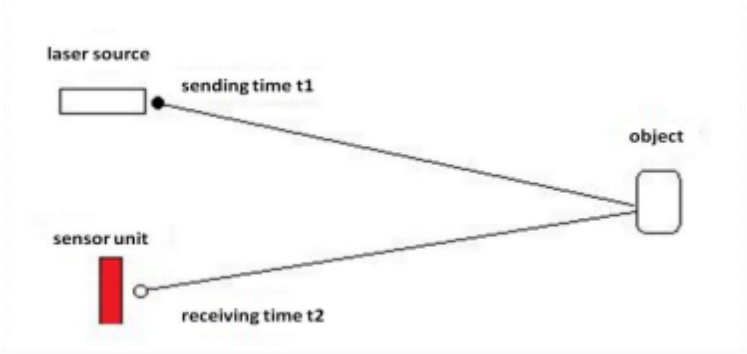


Figure 1.1 Lidar Mechanism

The system is mainly composed of Lidar, CPU (Central Processing Unit), camera, etc., among which the camera is optional according to the actual demand and can be applied to trigger vehicle capture. Adopting the lidar detection technology, the front-end equipment in the system is simple to install without damaging the road surface and is not affected by road construction.

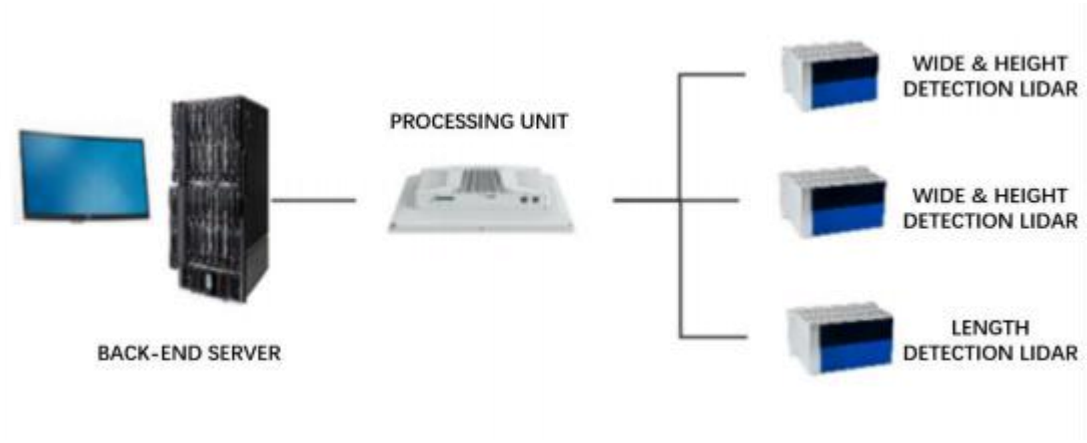


Figure 1.2 System Topography

2 Functions and Parameters

2.1 System Function

- Dynamically scan and model the passing vehicles.
- Accurately detect the length, width, height and axle of the passing vehicles on the lanes in realtime;
- Accurate and effective automatic separation of vehicles to prevent vehicle following-up;
- Record the time when vehicles pass the detection area;
- Detect the speed of the vehicles passing the detection area and their forward and reverse status;
- With self-monitoring function, automatic power-off restart and automatic recovery after crash functions;
- With self-test function to detect the hardware status of the equipment;
- Automatically save the vehicles' information and upload the data.

2.2 Specifications

Table 2.1 Lidar Specifications

Model	CLAIRLDR-L1				
Detection Method	ToF				
Wavelength	905 nm				
Laser Class	Class 1 (eye-safe)				
Channels	1				
Detection Range	150 m (@10% reflectivity)				
Range Accuracy	±3 cm				
Data Point Generating Rate (Single Echo Mode)	150,000 pts/sec				
Horizontal FOV	120°				
Scanning Frequency	30 Hz	60 Hz	90 Hz	120 Hz	150 Hz
Horizontal Angular	0.024°	0.048°	0.072°	0.096	0.12°

Resolution				°	
Communication Interface	Gigabyte Industrial Ethernet (1000 Base-T)				
Time Source	gPTP				
Operating Voltage	9 V ~32 VDC				
Operating Temperature	-40℃ ~ +85℃				
Storage Temperature	-40℃ ~ +105℃				
Shock Test	500 m/sec², lasting for 11 ms				
Vibration Test	5 Hz ~2000 Hz, 3G rms				
IP Grade	IP 6K9K				
Dimensions	110*100.4*45 mm				
Weight	635 g				

2.3 Dimensions

There are 4 mounting holes at the back of the lidar. Four M6*12 mechanical screws with spring washers and flat washers are needed for locking and fixing the lidar. There are 2 kinds of lidars (cable interface on the back or on the side) for you to choose from according to actual needs. See the figures below.

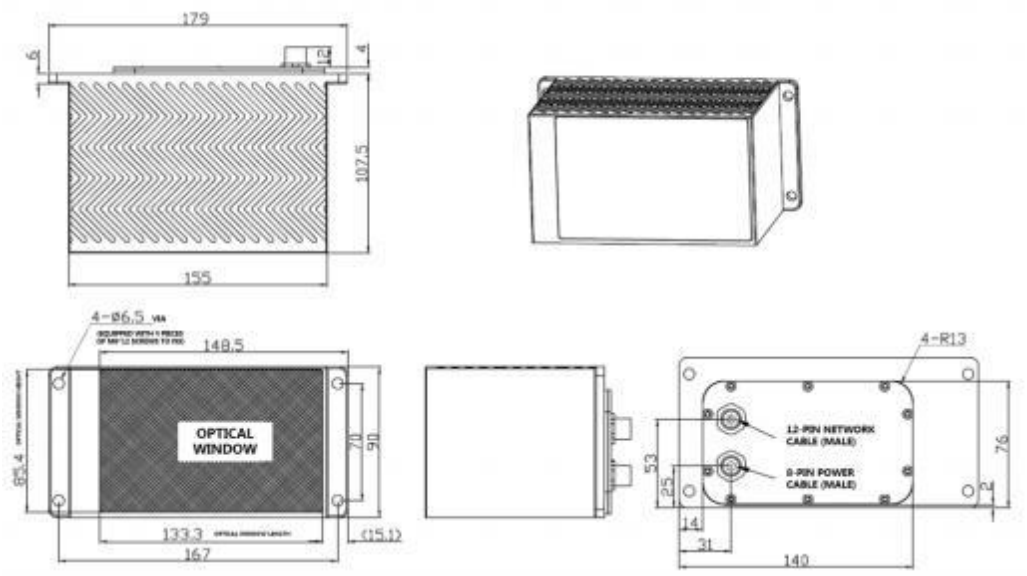


Figure 2.1 Lidar Mechanical Drawing (Cable Interface on the Back)

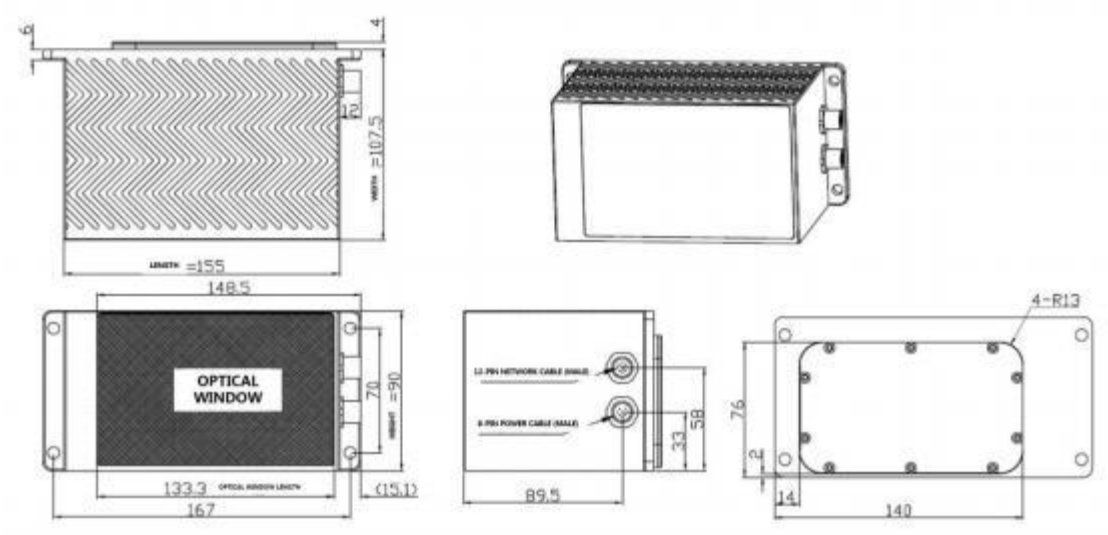


Figure 2.2 Lidar Mechanical Drawing (Cable Interface on the Side)

3 Electrical Interface

3.1 Power Supply

The lidar's power input range is 9 V～36 VDC. If other DC power supply is adopted, the recommended output voltage is 12 V. The maximum output current should be ≥2 A (the lidar requires a large instantaneous current to start, and a small starting current may cause its failure to start normally). The output ripple noise should be <120 mVp-pand output voltage accuracy <5%.

3.2 Electrical Interface

The cables connecting to the interfaces of the MS-HS1 lidar are a 12-pin cable and an 8-pin shielded cable, whose wiring definitions areas shown in the figures below.

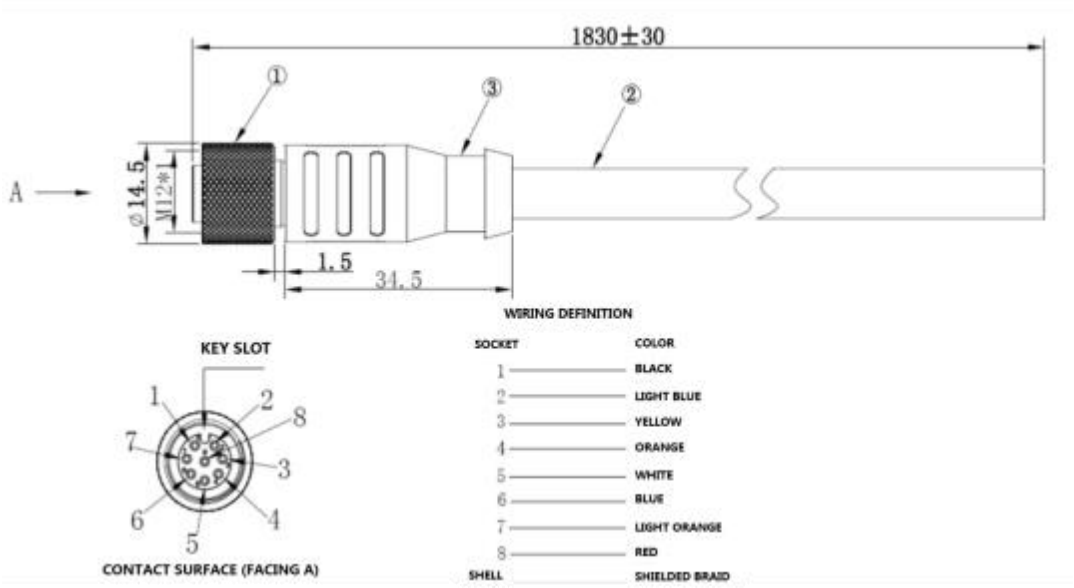


Figure 3.1 The 8-Pin Cable

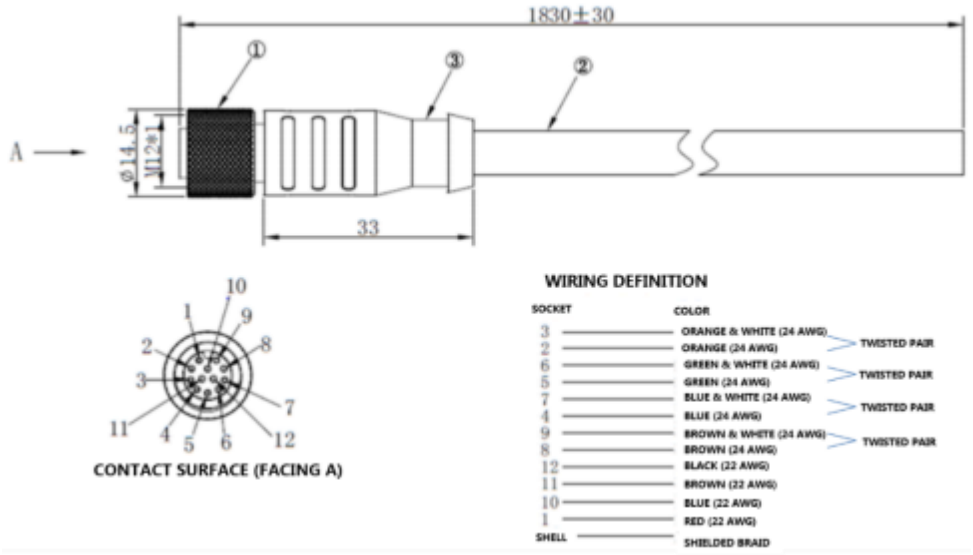


Figure 3.2 The 12-Pin Cable

Table 3.1 The 8-Pin Cable Wiring Definition

S/N	Color	Definition	Description
1	Black	GND	Power GND
2	Light Blue	GND	Power GND
3	Yellow	N.C	
4	Orange	GPS_GND	Signal GND
5	White	GPS_PPS	GPS inputting PPS signal
6	Blue	GPS_GPRMC	GPS inputting GPRMC signal
7	Light Orange	VCC	Power+
8	Red	VCC	Power+

Table 3.2 The 12-Pin Automotive Ethernet Cable Wiring Definition

S/N	Cable Color and Specification	Definition	Description
1	Red (22)	N.C	
2	Orange (24)	Ethernet TX1+	Ethernet TX+

3	White and Orange (24)	Ethernet TX1-	Ethernet TX-
4	Blue (24)	Ethernet TX3+	Ethernet TX+
5	Green (24)	Ethernet RX2+	Ethernet RX+
6	White and Green (24)	Ethernet RX2-	Ethernet RX-
7	White and Blue (24)	Ethernet TX3-	Ethernet TX-
8	Brown (24)	Ethernet RX4+	Ethernet RX+
9	White and Brown (24)	Ethernet RX4-	Ethernet RX-
10	Blue (22)	N.C	
11	Brown (22)	N.C	
12	Black (22)	N.C	
Shell	Shield	PE	GND

4 Installation and Calibration

This part mainly introduces the lidar's installation and calibration, the detailed procedures areas shown below.

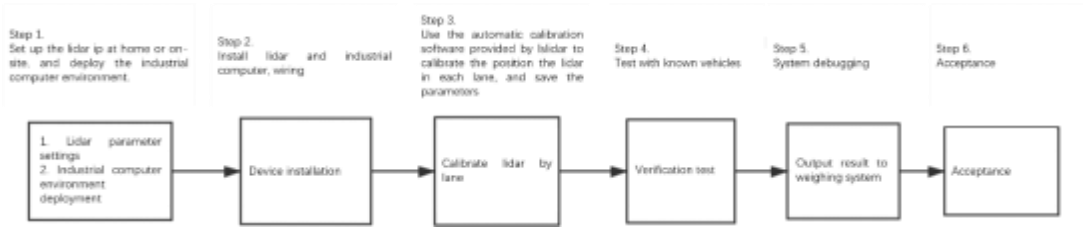


Figure 4.1 Procedure of the Lidar's Configuration

4.1 Parameters Configuration and IPC Deployment

- The parameters of the lidar are configured on the point cloud display software supplied along with the lidar.

The default IP address and port number of the lidar network areas follows: Table 4.1 Default Lidar Network Configuration

	IP Address	UDP Device Package Port	UDP Data Package Port
Lidar	192.168.1.200	2368 (Fixed)	2369 (Fixed)
Computer	192.168.1.102	2369	2368

Note:

1) The lidar IP (local IP) and the computer IP (destination IP) cannot be set to the same, otherwise the lidar will not work normally.

2) In the multicast mode, no two destination ports should be set to the same port number.

When connecting to the lidar, if the computer IP and the lidar IP are in different network segments, the gateway is needed to be set; if they are in the same network segment, only different IPs are needed to be set, for example: 192.168.1.x, and the subnet mask is 255.255.255.0. If you need to find the Ethernet configuration

information of the lidar, please connect the lidar to the computer and use “Wireshark” to capture the ARP (Address Resolution Protocol) packet of the device for analysis. For the feature identification of the ARP packet, see the figure below.

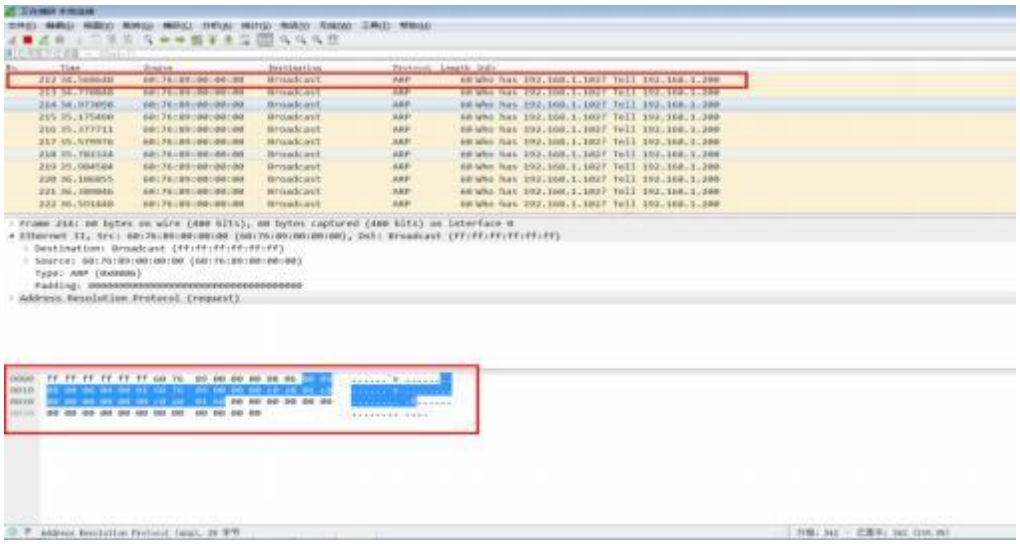


Figure 4.2 Wireshark captures APR packets

Note: Wireshark is a third-party software, and you may need to download it by yourself. TraffiClair bears no responsibility for any copyright and commercial disputes caused by your use of the software.

- IPC (Industrial Personal Computer) environment deployment

(1) Deployment of vehicle contour detection server program

(2) Program signature verification method

The software transmits the installation package file, public key file and signature file to the server. The server decrypts the encrypted signature to get a hash value, and at the sametime gets another hash value by signing the executable program. Compare these two hashes for equality. If they are equal, the Rsa_sha256 digital signature verification is passed. Note: The hash values generated by files with different principles must be different.

4.2 Installation

The system adopts high-precision lidar scanning detection technology which scans the vehicle in three dimensions and measures the vehicle length, width, height and axle information in realtime

automatically and accurately. There are 2 different types of lidars which are usually mounted on a gantry or L-shaped light pole, one for length-ranging and one for both width and height-ranging. The schematic diagrams areas follows.



Figure 4.3 Lidars Deployment

(1) Length-Ranging Lidar Installation

As shown in the figure below, the lidar's scanning plane is parallel to the driving direction of the vehicles, with an inclination angle of about 30°, facing the direction of the vehicles, and the installation position should be above the middle of the lane.



Figure 4.4 Length-ranging Lidar Installation

(2) Width and Height-Ranging Lidars Installation

These lidars are used for detecting the width, height and number of axles

of the passing vehicles. As shown in the figure below, the right lidar is installed
vertically downward, the cable connecting port is outwards and the installation position should be above the lane line as much as possible. While the left lidar is installed horizontally, the cable connecting port is downwards and the installation position should be at the height of about 1.5 meters.



Figure 4.5 Width and Height-ranging Lidars Installation

(3) Cable Connection

Connecting power supply Connecting Ethernet cable

(4) IPC Installation

4.3 System Interface

When the vehicles pass through the gantry, their point cloud data will be displayed on the interface in real-time. And as the vehicles fully drive out of the gantry, the data will be sent to the users and be displayed on the interface as well.

Stop Detecting: click to stop detecting, and click again to resume detection.

Point cloud saving: click after stop detecting to save the PCD data of the passed vehicles.

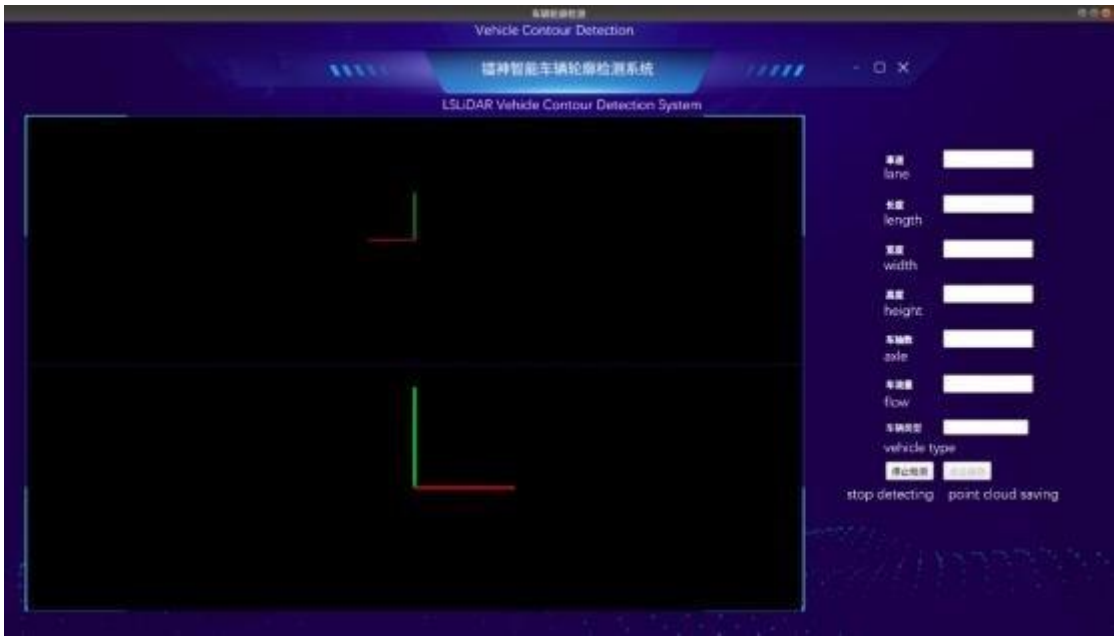


Figure 4.6 System Interface

4.4 Lidar Calibration

Calibrate the lidar before the test to obtain the mounting height and angle of the lidar.

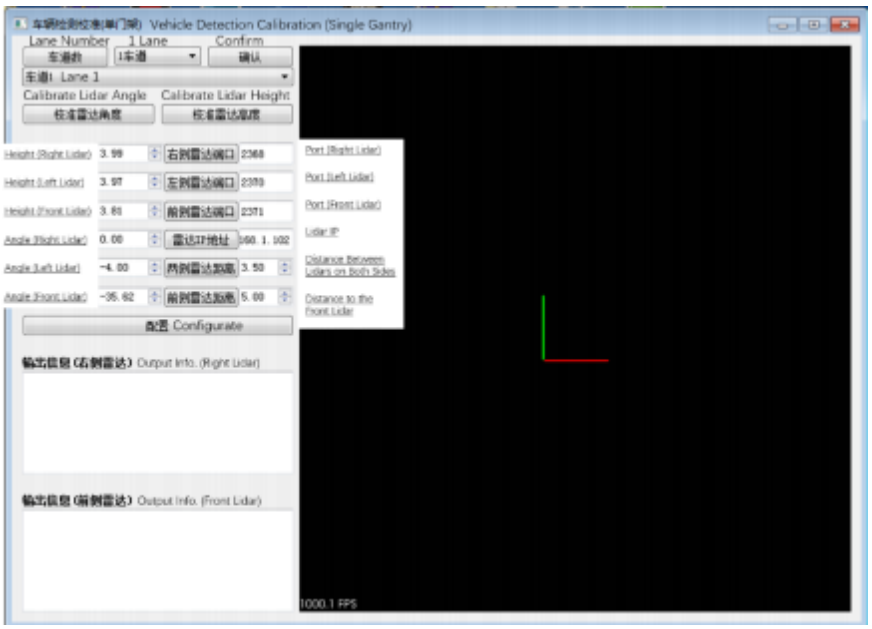


Figure 4.7 Lidar Calibration Software

(1) Select the number of lanes, click 'Confirm', then the program will reboot.

(2) Select the lane to be configured.

(3) Click on 'Calibrate Lidar Angle' and then select 'Calibrate Lidar Height'

(4) Distance between the lidars on both sides: place a paper box and observe if the 2 lines hitting the box overlap in the point cloud display, adjust the values until they overlap.

(5) Distance to the front lidar: Distance that lidar ranged.

(6) After calibration, copy the generated “device” file to the run directory of the software, then upload it to the IPC through the software or copy it to the IPC directly.

4.5 System Testing

Verify whether the calibration parameters and lidar installation are correct.

With lane 1 and lane 2 selected, one truck passes the gantry at different speeds for 30 times. Only when the error range is ±300 mm in length, ±100 mm in width and ±50 mm in height, is the test passed.

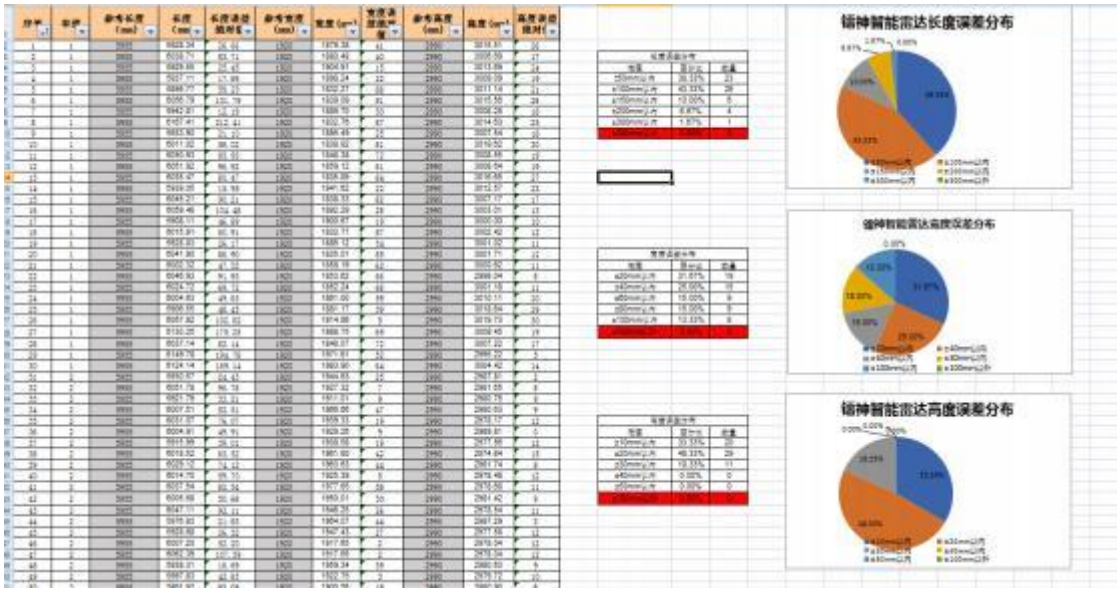


Figure 4.8 Testing Data

4.6 System Joint Debugging

The data transmission of vehicle information uses the TCP protocol. The total length of the data packet is 14 bytes. (Server)

Frame header: 0xAA 0xBB

Lane: Indicates the number of lanes (0x00 means the first lane)

Vehicle index: used for system matching, each time a vehicle passes by, index + 1. Determine whether the index value is consistent.

(re-assigned to 1 when the maximum value is exceeded)

Length, width, height: for example, if the length is 4.2 meters, it's represented as 0x10 0x68 (0x1068). When converting to decimal, divide 1000.

Frame tail: 0xEE 0xFF

Frame Header	Lane	Vehicle Index	Length	Width	Height	Axle	Checksum	Frame Tail
AA BB							The first 8 least significant values of the sum of all the front bytes	EE FF
2 bytes	1 byte	2 bytes	2 bytes	2 bytes	2 bytes	2 bytes	1 byte	2 bytes

4.7 Acceptance

4.8 Device List

S/N	Device Name	Unit	Quantity	Manufacturer	Note
1	Lidar	PCS	3	TraffiClair	-
2	Bracket for Lidar Installation	Set	3	TraffiClair	Subject to the actual bracket
3	CPU	Set	1	-	Subject to the actual CPU
4	Power Cable	Meter		-	
5	Ethernet Cable	Meter		-	Subject to the actual cable
6	Installation and Calibration	Item	1	-	-

Note: The gantry, civil construction and pipeline installation are not included.

The specific amount of civil construction shall be subject to the actual detection.

Appendix A Point Cloud Display Software

This part states the operation instructions of the TraffiClair's point cloud display software.

A.1 Application Scope

The software is for point cloud display, parameter configuration, simple lidartest and failure detection.

A.2 Installation

(1) Installation Environment

This software can only run under the Windows x64 operating system at present. The computer configuration requirements for installing the software are: CPU: Intel(R) Core (TM) i5 or higher; Graphics Card: NVIDIA GeForce GTX750 or higher achieves the best effect, otherwise the display of the point cloud maybe affected. To use the point cloud display software, it is necessary to install the **WinPcap** third-party library. This software has also been pre-stored in the USB flash drive provided with the lidar.

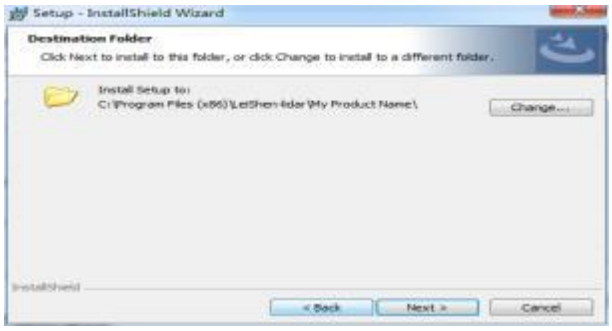
(2) WinPcap Installation

Step 1. Insert the USB driver into the computer port and open it.

Step 2. Find the WinPcap installation file and double-click it to initiate the installation.

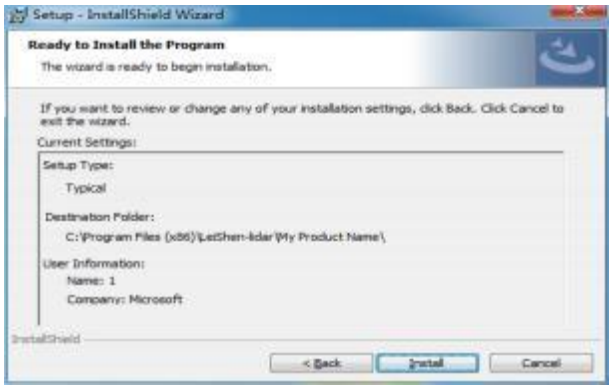


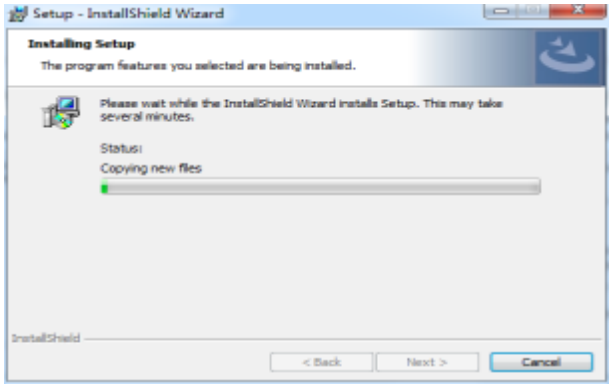
Step 3. Click "next" to enter the installation path selection interface.



Step 4. Click "next" to enter the installation interface.

Step 5. Click the "install" button, and wait for the installation to be completed.

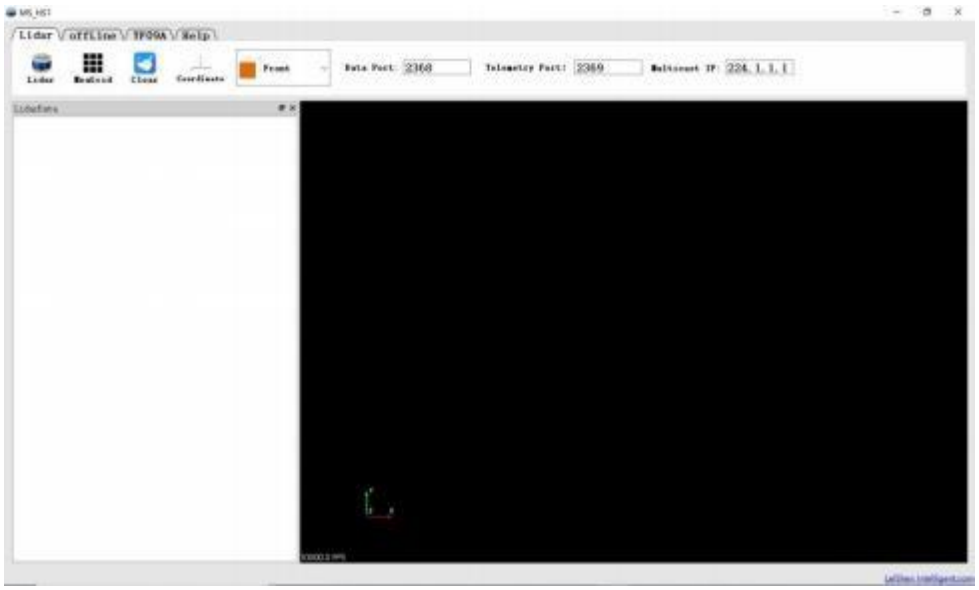




A.3 Software Introduction and Operation

(1) Software Interface

The software interface includes menu area, tool bar area, 3D window area, data table area, etc.



Note: To view the software version, click “Help->About” in the toolbar. Point cloud display interface supports the following operations:

1) Zoom in/out the display interface with the mouse wheel; hold the right mouse button and drag it up/down to zoom in/out;

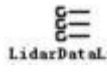
2) Hold the left mouse button and drag it to adjust the angle of view;

3) Hold the mouse wheel and drag it to pan the display interface; or hold the shift key on the keyboard and the left mouse button to pan the interface.

Menu button function introduction

- Lidar Menu

Button	Description
 Lidar	Click to start receiving point cloud data
 MeaGrid	Show/hide measurement grid
 Select	Mark the selected points in the point cloud image
 Suspend Data	Pause point cloud image and data generating
 SelectRange	Select point clouds from different angles
 Clear	Clear screen

	Show/hide coordinate	
	Show/hide the column on the left	
	Three-view option: set the observation angle from top, front, and left.	

Note: In the point cloud display area, with 20 circles and 40*40 grids, the radius of every two adjacent circles differs by 10 m. The difference between each two grids (horizontal or longitudinal) is 10 m. And the radius of the outermost circle is 200 m.

The grids and circles make it easy to view the position of the point cloud. The direction of the coordinate axis in the 3D display interface is consistent with the direction of the X-Y axis in the point cloud reference system.

- Offline Menu

Button	Description	
	Open offline data	
	Record and saved data, valid only when lidar receives data in realtime	
	Skip to the beginning	
	When paused, view the previous frame; When playing, rewind (click multiple times to select 2x, 3x, 1/2x, 1/4x and 1x speed)	
	Click to start playing after the point cloud file is loaded When playing, click to pause	
	When paused, view the next frame; When playing, fast forward (click multiple times to select 2x, 3x, 1/2x, 1/4x and 1x speed)	
	Skip to the end	

	Drag the progress bar or enter the frame number to skip to a specified position

- Setup Menu

Button	Description	
	Open lidar parameter form	The upper part of the form shows the lidar configuration. The parameters include local IP, destination IP, subnet mask, gateway, data port, device port, and motor speed setting (different speed can be selected under combobox), whether to obtain the local time, Mac address information, and device packetsending interval. The lower part shows the real-time status information. According to the DIFOP status packet
		sent out regularly by the lidar, the current status information is displayed, including GPS position information, satellite time information, motor speed, current lidar IP, and current lidar port number.
	Select laser channel	Vertical Angle column represents the vertical angle of the corresponding channel data and Channel column represents the data sequence number corresponding to the channel.
	Save the data	The data includes Points_X,

	in .csv format	Points_Y, Points_Z, Laser_id, Azimuth, Distance, Intensity.
Intensity	Set the display mode of the point cloud	Intensity, laser ID, azimuth angle, etc.

Note: The computer graphics card must support OpenGL 2 or higher graphics acceleration to display the point cloud normally.

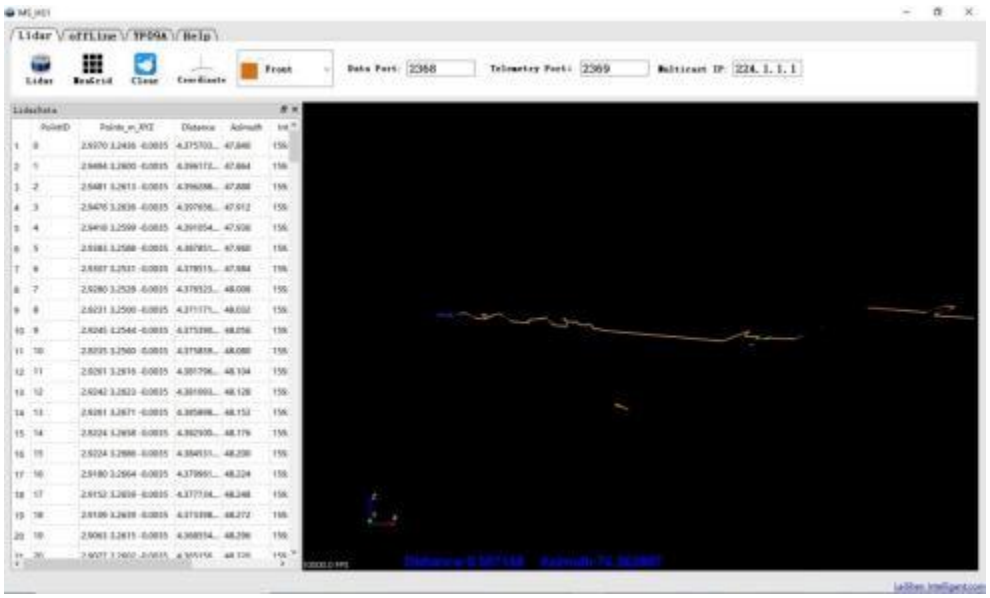
(2) Operation Procedure

Step 1. Set the data port number (default 2368), device port (or telemetry port in the picture below) number (default 2369).



Step 2. When the power supply of the lidar is connected to the network cable, click  to receive the lidardata in realtime.

Step 3. The data table contains ID, Points_m_XYZ, Distance, Azimuth, Intensity, in which ID is the lidar channel number; Points_m_XYZ are the coordinates; Distance is the distance value; Azimuth is the azimuth angle; and Intensity is the reflection intensity.

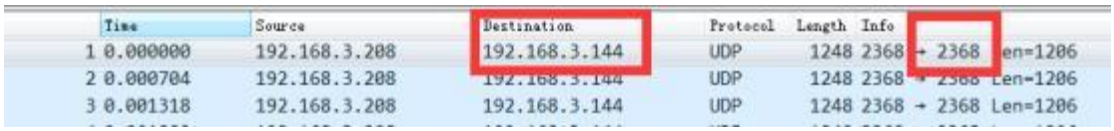


(3) Notice about the lidar setting and usage:

1) It is not possible to use the point cloud display software to receive data in two processes (open twice at the sametime) on the same computer. The port occupancy of the PC is generally exclusive, so the other software that uses the same process or the same port number cannot work normally after a process is bound to a specified port number. When the software detects that the port is occupied, it will prompt that the communication network port configuration has failed, and automatically close the software. You need to close the software process that occupied the port, and reopen the software to use it normally.

2) At the sametime, since Qt is adopted in the low-level software development, please create English paths when naming files and path folders.

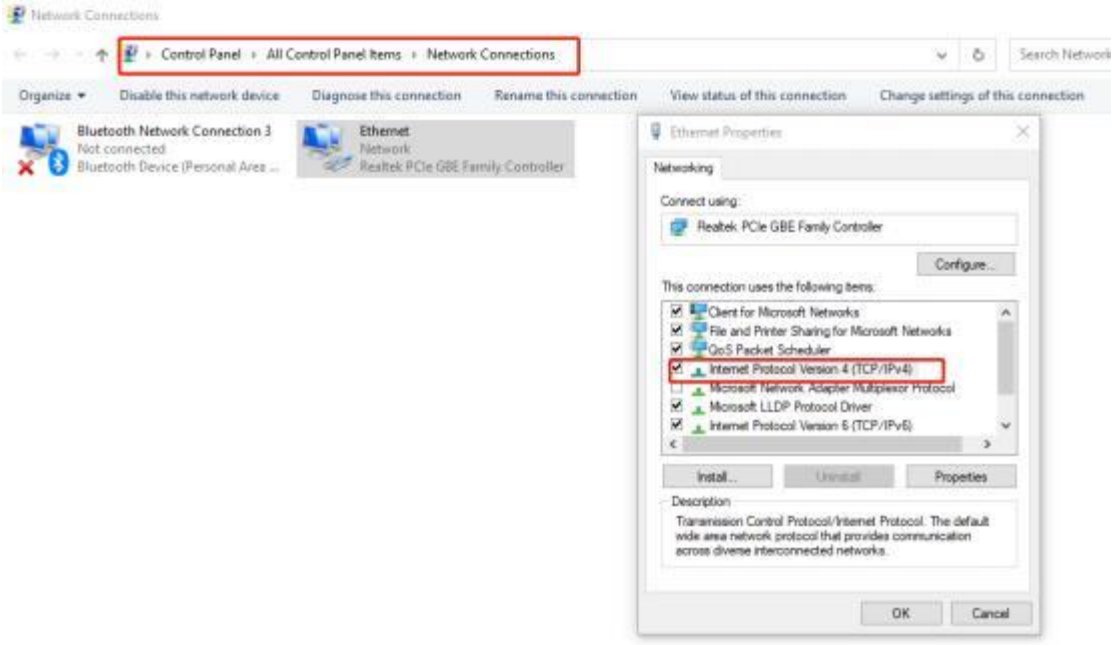
3) Since the port number of the lidar can be modified through user configuration, and the lidar sends data to the host computer through the preset destination IP and port. Therefore, when the local laptop or desktop computer and other devices are receiving data, their IP address should be the same as the destination IP, and the port bound to the local host computer program needs to be the same as the destination port number, as shown in the figure below (these are the data packet parameters captured and analyzed by Wireshark software). The data in the red boxes indicate the destination IP and port number of the lidar.



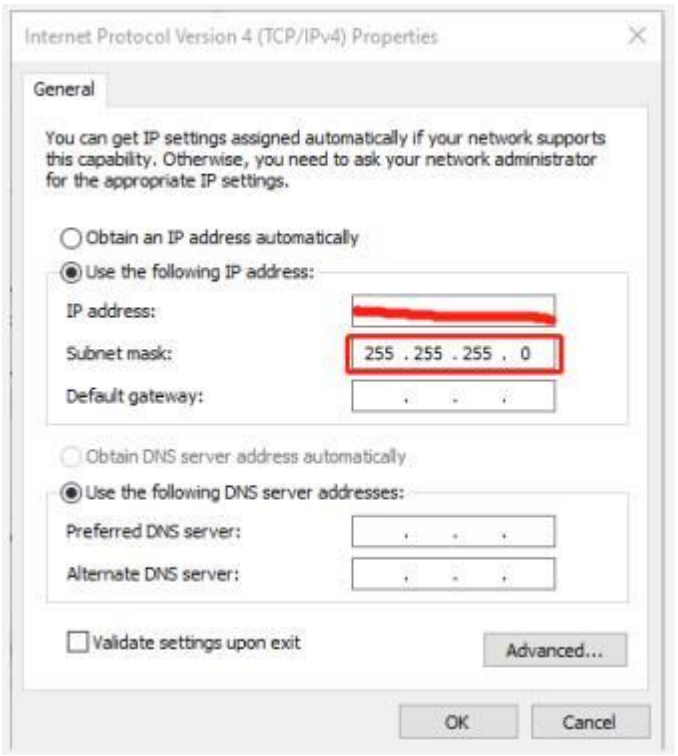
Please set the host computer IP according to the following steps:

Step 1. In the Control Panel -> All Control Panel Items -> Network Connections, click the "Ethernet" icon.

Step 2. Click "Properties" in the pop-up status box, and click "TCP/IPv4 protocol" in the pop-up Ethernet properties box, as shown in the figure below.



Step 3. In the TCP/IPv4 property settings, set the IP address to the lidar's destination IP (The default destination IP of the lidar is 192.168.1.102), and the subnet mask is set to 255.255.255.0.



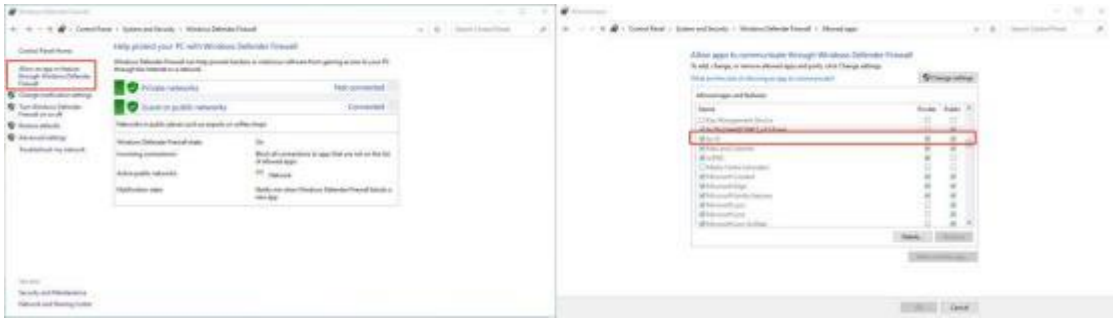
4) Since the point cloud display software needs to obtain a large number of data packets through the network in a short time, it maybe considered as a malicious program by the network firewall and be prohibited. Therefore, there may be situations in which the data packet has been sent to the computer by the Wireshark software, but the software cannot display it.

To address this problem, in Control Panel -> System and Security -> Windows Firewall Settings, click to allow this program to pass through Windows Firewall, setting steps areas shown in the figures below:

Step 1. In Control Panel -> System and Security -> Windows Defender Firewall, click “Allow an app or feature through the Windows Defender Firewall”.

Step 2. Browse to find the software installation path, select it and click OK.

Step 3. Tick the part marked in the red box according to the nature of your network,and click OK to see the data.



Computer graphics settings

When installing the point cloud display software on a desktop or laptop with dual graphics cards, the default global settings of the computer operating system is to use the global settings (automatic selection: integrated graphics), which affects the display efficiency of the software. In order to ensure the use and display efficiency of the software, you need to manually set the computer graphics.

The condition of dual graphics cards can be checked in the computer configuration, and the condition of the display adapter can be seen in My Computer->Properties->Device Manager.

Take a laptop with Intel(R)HD Graphics 530 integrated graphics and NVIDIA GeForce GTX 960 discrete graphics as an example. The setting steps to manually switch the applicable graphics card of the software to high-performance discrete graphics card areas follows:

Step 1. Right-click on a blank space on the desktop to popup a right-click menu and select “NVIDIA Control Panel”.

Step 2. Select the “Manage 3D Settings” in the NVIDIA Control Panel interface. **Step 3**. Click the “Program Settings” button in the Manage 3D Settings interface.

Step 4. Click the “Add” button on the Manage 3D Settings interface.

Step 5. Click the “Browse” button in the pop-up interface.

Step 6. Find the application file (.exe file) of the software according to its installation path in the pop-up browsing interface.

Step 7. Click “OK” to automatically return to the NVIDIA control panel, select the high-performance NVIDIA processor in the combo box of the preferred graphics processor for this program in Option -2., and click “Apply” in the lower right corner.

After the computer application is set, close the NVIDIA Control Panel to complete the setting.

Appendix B Security and Privacy Statement

1. Protect user privacy and keep user information confidential. It shall not be disclosed to others without the consent of the user, except as otherwise provided by law.
2. The system software supports the security encryption protocol. We will use this software and adopt a variety of methods to ensure that the information you provide is not illegally accessed to the greatest extent possible.
3. Without the permission of the administrator user, the data in the systemshall not be distributed and stored in anyway. The scope of collection and purpose of use of personal data shall not exceed the privacy statement and follow the principle of minimization. When the scope of collection and purpose of use of personal data changes, the privacy statement should be updated in a timely manner.
4. Work together to maintain the security of usernames and passwords. Once successfully registered, you will get a unique username and password. You shall keep the username and password properly, and not tell others. Otherwise, the risks and losses arising therefrom shall be borne by yourself. You are solely responsible for all activities and events under your username. You can change the password at anytime as needed. If you find any illegal use of yourusername, please notify us immediately.
5. Without the prior written permission of TraffiClair, the contents of this manual shall not be reproduced, disseminated, or stored in the retrieval system in any way.
6. The company has made every effort to ensure the accuracy and completeness of the information in the manual. If you find any errors or omissions, please contact us, for which wearevery grateful.

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