The World's Leading LiDAR and Solution Provider

3D LIDAR

Collision Warning System v1.0

1. Product Profile

The 3D lidar Collision Warning System (CWS) employs Leishen intelligent's 3D lidar as the detection sensor, combined with a 3D anti-collision algorithm module to realize an all-round scanning of the surrounding environment. Detecting obstacles in real time, and outputting warning signals, the CWS can be used in AGV, robot, forklift and other fields.

With the most comprehensive lidar products on the market, from single-line to 16-line, 32-line, 64-line and 128-line products, LeiShen is enabled to customize special anti-collision systems for customers according to different application scenarios. In addition, the product algorithm unit provides a wealth of interfaces to choose, including network port, serial port, switch value output, and CAN output. With a variety of protected area combinations built in the algorithm unit, users can set different protected area groups based on their own needs.
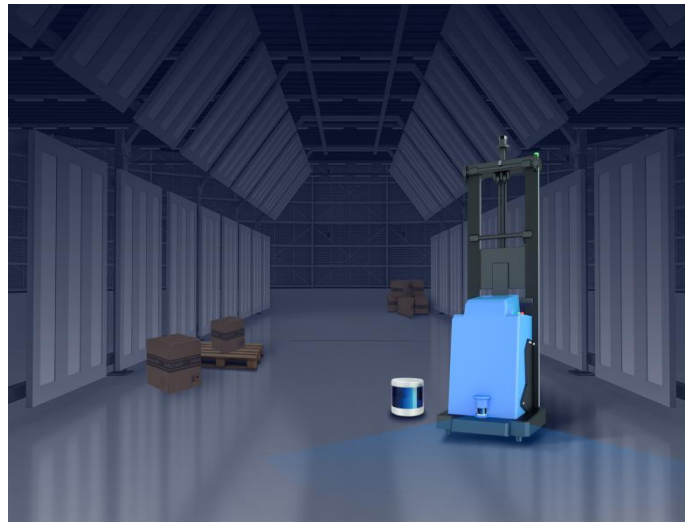

Figure 1. 3D Lidar Collision Warning System

2. System Features

● Flexible integrated system, the number of sensors can be flexibly configured according to actual scene requirements, and all current multi-line lidar products of LeiShen Intelligent can be equipped with to realize real-time 3D monitoring of the surrounding environment;

● Simple operation, the protected areas can be configured through algorithm software;

● A variety of protected areas can be stored for customers to switch and choose according to the scene;

● Algorithm integrated into the system to directly output alarm signals and obstacle information;

● With plenty of output interfaces, such as network port, serial port, CAN output, and switch value output, free switching of protected areas can be realized;

- Timely warning with low false rate;
- Stable and reliable, free from bad weather influence;

3. System Software

This system mainly integrates the 3D detection algorithm into the industrial computer. For the customers aiming at safety protection, it saves the manpower and material resources of developing algorithm. The system supports multiple lidars simultaneously for individualized safety requirements. For different scenarios, 15 different areas can be set in each lidar, and 3 levels warning can be set in each area. Algorithm software is the core of the system, through which the protected area is drawn, and the obstacle information and alarm signals in the area are output in real
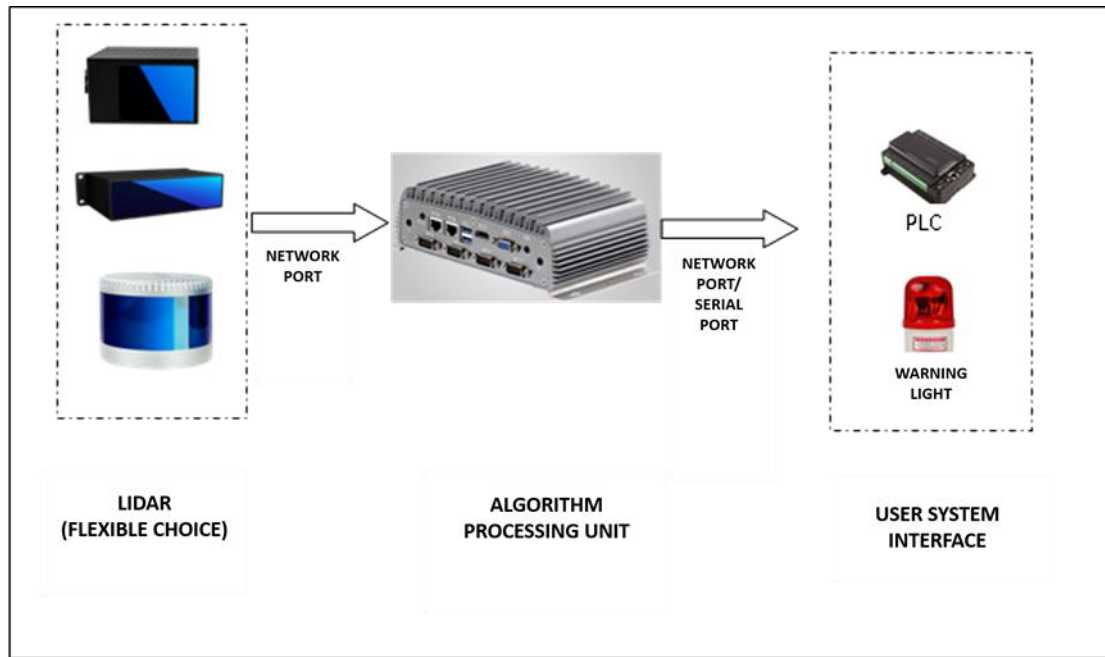
time.

Figure 2. System Hardware Architecture

Draw two-dimensional protected areas in the software. For each lidar, 15 areas can be set, and 3 levels warning can be set in each area, as shown in the figure below:
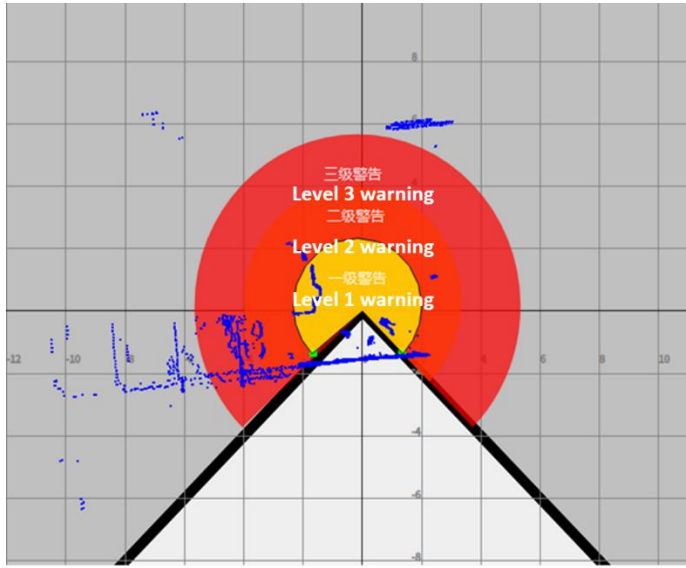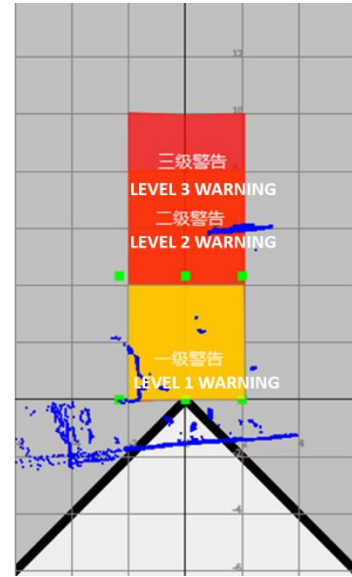
Figure 3 Annular Area

Figure 4 Polygonal Area

Set annular areas or polygonal areas separately, or combine the two shapes to meet the needs of a variety of scenes.

Perceive surrounding environment through 3D visualized point cloud image, as shown in the figure:

Figure 5 Obstacle point cloud in annular areas

Figure 6 Obstacle point cloud in polygonal areas

4. System Output

This system provides various output interfaces including network port, serial port, CAN and switch value output for users to choose according to their needs.

(1) The network port outputs: a. area alarm information; b. point cloud information of obstacles; c. obstacle information after clustering;

(2) The serial port, CAN, and switch value output alarm signals only.

5. System Parameters

System Parameters	
Measurement Method	Non-Contact Active Detection
Monitoring Range	Determined by Lidar Parameters
Protected Area Setting Method	Algorithm Software Settings
Input Method	Network Port, Serial Port, CAN and Switch Value
Output Method	Network Port, Serial Port, CAN and Switch Value
Output Content	Network Port: Alarm Information, Obstacle Point Cloud, Obstacle Clustering Result Serial Port, CAN and Switch Value: Alarm Information
Number of Protected Area	15 Groups
Type of Protected Area	Independent
Output Response Time	<150 ms
Supported Lidar Models	All the multi-line lidars of LeiShen Intelligent are supported. Please refer to the lidar manual for detailed parameters.

6. Application Scenarios

(1) Forklift/AGV Collision Avoidance

The Forklift AGV Scheduling System selects the optimal route to deliver goods to the designated storage location. However, due to the intricate application environment of the forklift AGV, there may be many safety-related issues when transferring goods, for example, when the forklift AGV encounters falling goods or other obstacles on the driving path, failing to stop in time will cause both parties to be damaged at the same time; or when multiple forklift AGVs are operating at the same time, collision may happen if they are not able to stop timely. Fortunately, setting protected areas and warning in time can avoid collisions.

Figure 7 Forklift Collision Avoidance

(2) Gantry Crane Collision Avoidance

The container terminal environment is complex, where collision is commonly seen. However, with this CWS, a 3-level warning area can be drawn for obstacle detection. When there is an obstacle in front, the gantry crane will perform operations such as braking and parking according to the warning to prevent collision.


Figure 8 Gantry Crane Collision Avoidance

Appendix 1: Instruction for the Upper Computer Software Operation

(1) Add Lidar

Different numbers of lidars can be used according to actual scenarios to achieve comprehensive monitoring. At present, 4 lidars at most can be added to this system to work at the same time. Follow the steps to add lidar:

①Select "Device" and right-click with the mouse -> click "Yes" to add lidar -> fill in the lidar information in the pop-up window; the "serial number" starts from 1 and the range is from 1 to 4.
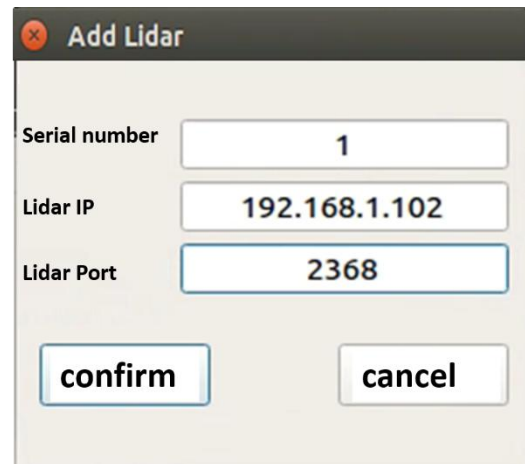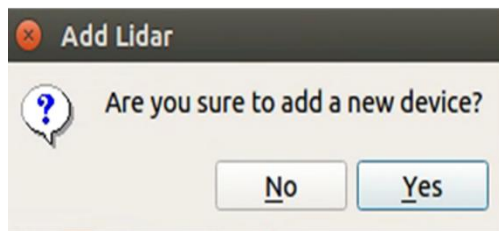
②Adding completed, 2 lidars are added as shown in the figure below.

③ To delete a lidar, select the to-be-deleted lidar and right-click ->remove. After deleting, restart the software to take effect.

(2) Draw Protected Areas

① Select the corresponding lidar and the corresponding area to set. As shown in the figure:

② Click the button , and the area drawing window will pop up, as shown in the figure:
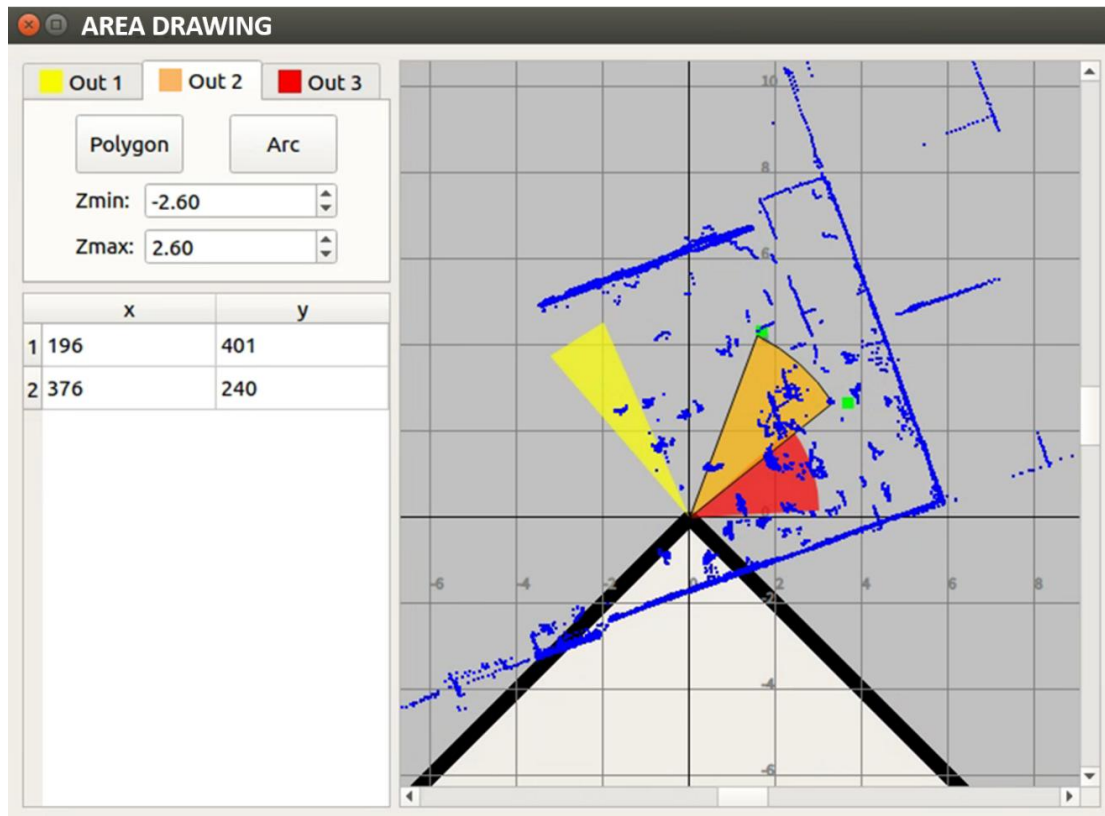
The yellow area is level 1 protected area, orange is level 2 area, and red is level 3 area. There are two forms of area drawing, which can be selected according to the actual situation. "Polygon" means polygonal mode, as the yellow triangle area in the above figure while "Arc" means fan-shaped mode, as the orange and red areas.

Drawing method: After selecting the area drawing mode, drag the point from the origin to form a polygon or fan-shaped protected area. By this time, the protected area is a two-dimensional area of "x-y", the height "z" needs to be manually added. Zmin and Zmax correspond to the minimum and maximum height, whose unit is m.

③ After finishing the area drawing, click the button to save the setting. And there is no need to set the protected area again after the software restarts.

(3) Other Parameter Settings

Menu bar function settings: click on the relevant settings in the menu bar.

① Clustering parameter setting:

Clustering radius: the minimum radius of the cluster.
Clustering points: the minimum number of points to cluster.
Shielding radius: the radius from the origin.

Warning threshold: the minimum number of frames indicating an obstacle exists.

② Lidar Calibration

Based on the actual mounting scene, select appropriate ground point cloud to calibrate the lidar angle.

③ Point cloud transmission: click to transmit the point cloud data of the obstacles, click again to cancel data transmission.

(4) Algorithm Monitoring Effect Under Actual Scene

The following figure shows the monitoring effect of LeiShen Intelligent's 16-line lidar under actual scene. The algorithm software supports multiple devices simultaneously, and the number of lidars can be added according to customer needs. The figure below presents the actual application effect of two lidars, where the interface displays the point cloud image in area 2 of lidar 2. The left side is the information of areas and obstacles, and the right side is the obstacle point cloud image.
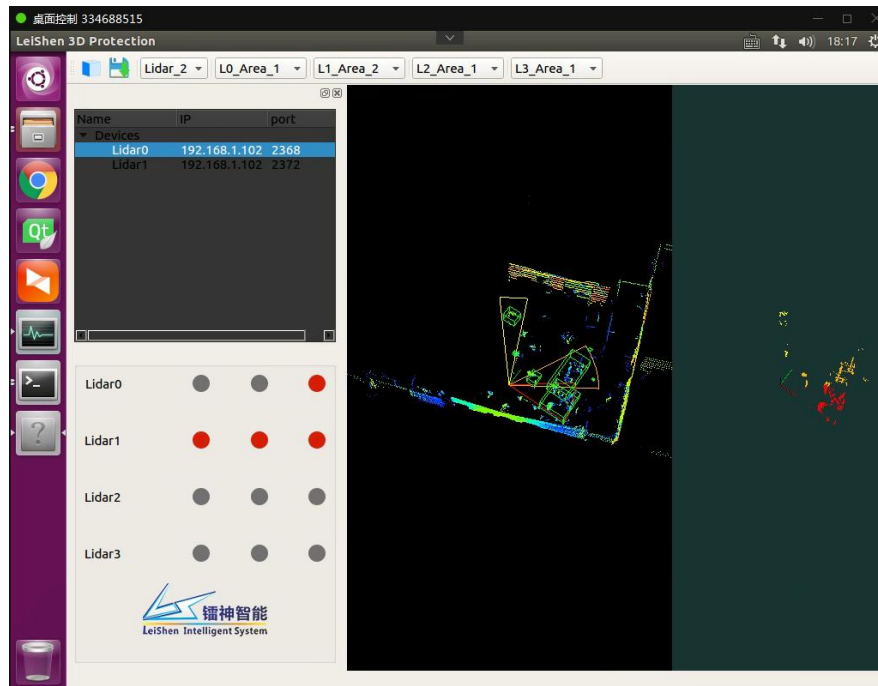
## Appendix 2: Network Port Output Communication Protocol

The communication between the industrial computer and the lidar adopts the Ethernet medium and the UDP protocol.

(1) Alarm output

Frame header	No. 1 lidar alarm 1 + area index	No. 1 lidar alarm 2 + area index	No. 1 lidar alarm 3 + area index	…	No. 4 lidar alarm 3 + area index	Check code	Frame tail
CCDD	0 (no alarm) 1 (alarm) Area (1-15)					The lower 8 bits of the sum of all the previous bytes	BB FF
2byte	2byte	2byte	2byte		2byte	1byte	2byte

(2) Obstacle Information Output Protocol (Obstacle Point Cloud)

The data format of obstacle information includes frame header, sub-frame, and frame tail. Each data packet includes 1250 bytes: 42 bytes UDP packet cost, 1208 bytes subframe (including 2 bytes header, 2 bytes total number of data packets, 2 bytes data representing the number of current data packets, 2 bytes data representing the index of the current lidar, and 100 data blocks). (The current version has no echo intensity information, so the value is 0.)
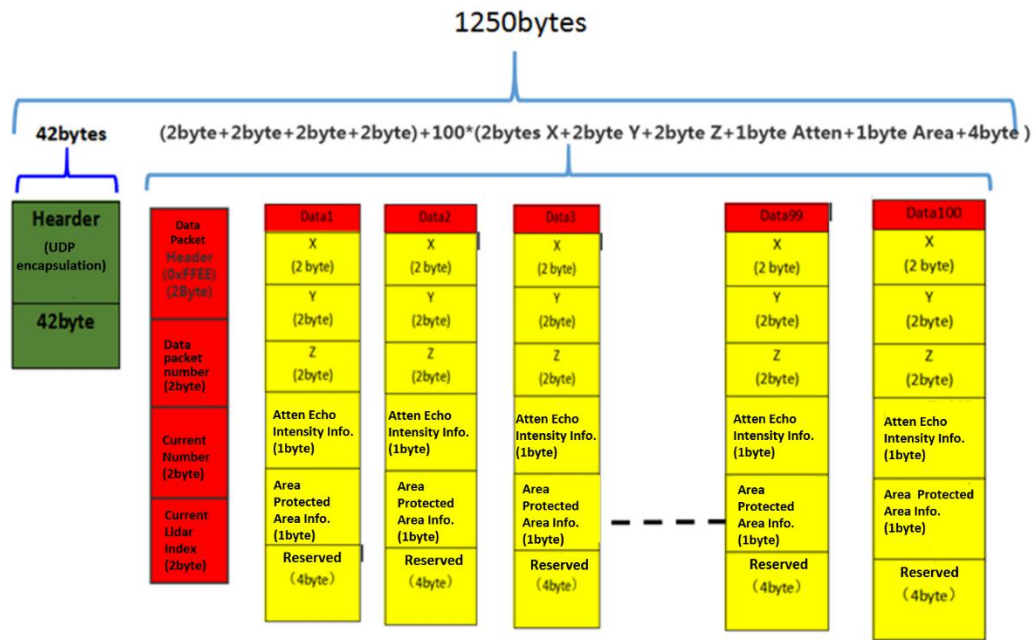
① Data Header

Data Header	
0xFF	0xEE
1byte	1byte

② The total number of data packets accounts for 2 bytes. The parsing method is as follows: For example, the hexadecimal numbers of the value of the total number of data packets are: 0x72, 0x06. Rewrite the numbers to 16-bit unsigned integer data, that is: 0x0672, the decimal number of which is 1650, indicating that there are 1650 data packets. (Pay attention to the analysis of negative numbers when parsing, the number whose decimal number is greater than 32768 is a negative number).

Data Packet Number	
1byte	1byte

③ The serial number of the current data packet is 2 bytes, and the parsing method is the same as the above, with the low bit in the front and the high bit in the back.

Current Num	
1byte	1byte

④ The point cloud data of the data packet has 1200 bytes and stores 100 point cloud data. Each data format is stated in the following table, where "x, y, z" represent the coordinate value of the point cloud, the unit is cm. Refer to ② for the specific parsing method. "Atten" represents the echo intensity, which of this version is 0. "Area" indicates the area where the point cloud exists. If there are less than 100 point clouds, fill with 0.

Data					
X	Y	Z	Atten	Area	Reserved
2byte	2byte	2byte	1byte	1byte	4byte

(3) Obstacle Point Cloud Clustering Processing Output Protocol (Obstacle Clustering Information)

The data format of obstacle information includes frame header, sub-frame, and frame tail. Each data packet includes 1250 bytes: 42 bytes UDP packet cost, 1208 bytes subframe (including 2 bytes header, 2 bytes total number of data packets, 2 bytes data representing the current number of data packets, 2 bytes data representing the index of the current lidar, and 30 object blocks).
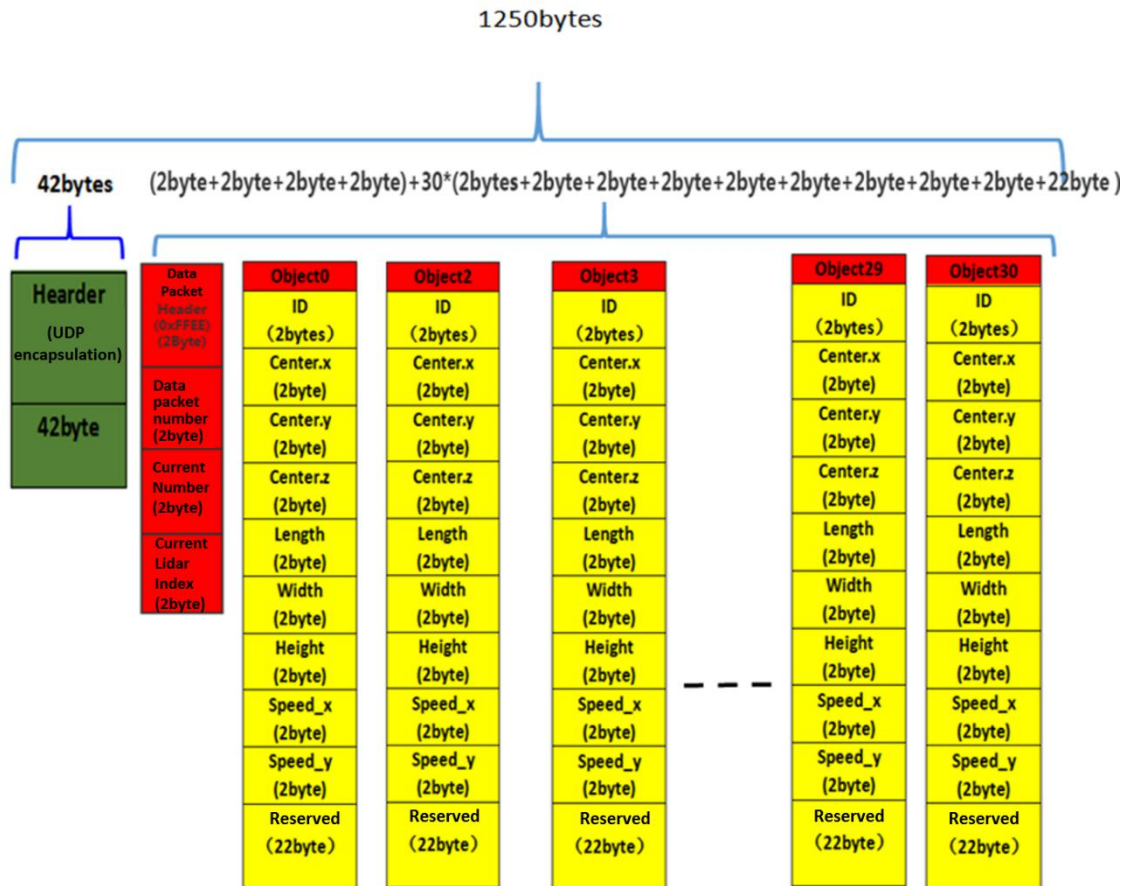
① Data Header

Data Header	
0xAA	0xBB
1byte	1byte

② The point cloud data has 1200 bytes and can store 30 point cloud data. Each data format is as in the following table, where "ID" represents the ID of the target; "Center.x, Center.y, Center.z" represents the xyz coordinates of the target's center point; "length" represents the length of the target; "width" represents the width of the target; "height" represents the target's height; "Speed_x" represents the speed x of the target; "Speed_y" represents the speed y of the target. (Pay attention to the parsing of negative numbers. The number whose decimal number is greater than 32768 is a negative number). (The "Reserved" 22 bytes will add 1 byte of area information, and the rest reserved will be added as needed later).

Object									
ID	Center.x	Center.y	Center.z	length	width	height	Speed_x	Speed_y	Reserved
2byte	2byte	2byte	2byte	2byte	2byte	2byte	2byte	2byte	22byte

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