MR72-open source CAN protocol UAV obstacle avoidance
User's manual

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Description of the manual

The purpose of this manual is to let users understand some basic parameters of MR72 UAV obstacle avoidance millimeter wave radar and the application of MR72 CAN protocol obstacle avoidance radar to UAV. It includes the connection between radar and UAV and the precautions for radar use. Users can set some basic parameters for UAV obstacle avoidance according to the steps in the manual, so as to realize the communication and obstacle avoidance between UAV and radar.

Catalog

I. Introduction

MR72 UAV Obstacle Avoidance 77 GHz millimeter wave radar provides short-range and medium-range dual-beam scanning coverage. It can detect the distance, speed and position information of the target by receiving the radar reflection wave. In this version, it supports the CAN protocol of the ArduPliot platform, and can use a separate port to cascade the radar. Compared with the serial port, the communication rate of the CAN protocol is faster and more convenient. Different from other obstacle avoidance radars, it has strong robustness, high measurement accuracy, all-weather work, and small size, which has great advantages for UAV obstacle avoidance.

II. Precautions for product use

1. For initial use, please ensure that the radar is powered separately, with a range of + 5V ~ 28VDC.
2. The firmware of this radar only supports ArduPliot firmware version 4.5.0 and above.
(Ardupilot Firmware Address:https://ardupilot.org/ardupilot/docs/common-downloads_firmware.html)
3. For the flight controller used, its flash memory needs to be 2Mb or more, and it supports burning ArduPliot firmware.
4. Please keep no other obstructions in front of the radar antenna during the use of the radar.
5. Use and test in an open area without interfering radar signals.
6. When the radar is installed, it is necessary to ensure that the module is vertically forward. The customer can recommend to raise the inclination angle by 5 ° ~ 7 ° according to his own flight speed (if the flight speed inclination angle is too large, the recommended range is 5 ° ~ 25 °), so as to maintain the accuracy of the data.
7. When the power supply of 5V is used to supply power to the radar, it is recommended to provide a stable current of 0.5A for the radar, otherwise the radar cannot be used normally.

III. Function Highlights

Support for Ardupilot: Perfect compatibility with open source flight control, easy to use, plug and play, no need to calibrate radar.
High protection level: radar IP66 protection, high waterproof and dustproof level, shock resistance and fall resistance, to ensure the safety of UAV.
Anti-jamming: low sidelobe synthesis of antenna pattern by Taylor algorithm is adopted for receiving and transmitting antennas, which can make the radar not easily affected by ground clutter.
Light weight: The weight with the shell is 90 G, which greatly reduces the load of the UAV and increases the endurance of the UAV.

IV. List of articles

MR72 obstacle avoidance radar × 1 (complete machine with line)


V. Connection between flight controller and radar

The following installation takes UAV and radar as models for example; PIXhawk 2.4.8 flight controller and MR72 radar obstacle avoidance module are taken as examples.

5.1 Installation

1. Use screws to fix MR72 radar and mounting bracket.

2. Forward obstacle avoidance: Install the MR72 radar and mounting bracket on the UAV base with screws.

3. The antenna faces forward, and the outgoing line is in the left front of the UAV.

4. MR72 radar rises 5 ° ~ 7 ° according to the flight inclination of UAV (plant protection).

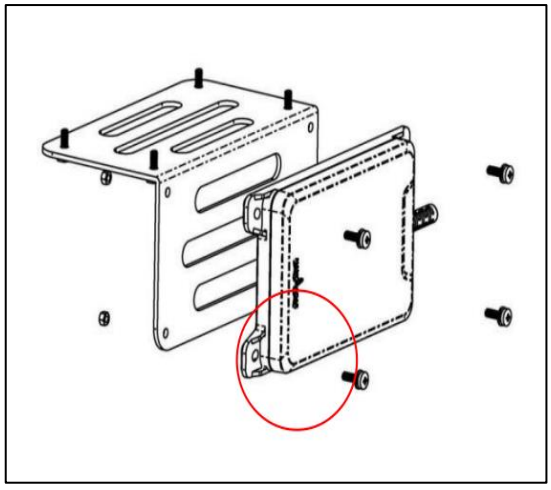


Figure 1 UAV access radar map

Figure 2 Installation of radar and base

5.2 Connection

1. Connect the harness of MR72 radar to PIXhawk 2.4.8.

2. Note the RX and TX cross connections in the harness to the RX and TX of the CAN port in PIXhawk 2.4.8.

3. The MR72 radar is powered by an independent power supply of 12V.

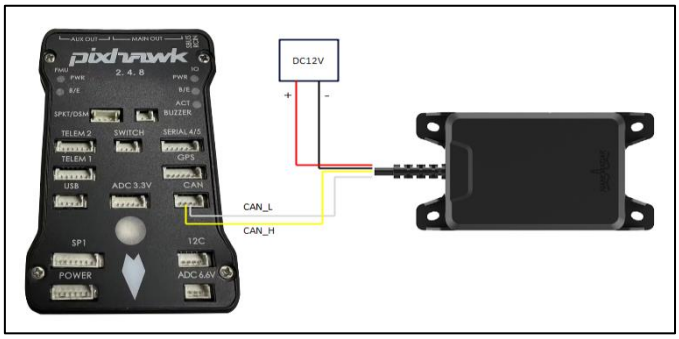


Figure 3 Connection between flight control and radar

VI. Usage

The produced MR72 radar has compiled the open source version firmware (MR72 _ NR _ CAN3 _ 40M _ V3.0.0). Nanoradar Company provides the supporting upper computer debugging software, which can upgrade and debug the radar and support the remote debugging of technicians. The software adopts Mission Planner ground station software to debug obstacle avoidance and CAN protocol parameters. The official download address is https://ardupilot.org/planner/docs/mission-planner-installation.html。

6.1 Parameter setting of ground station

1. Open the Misson Planner ground station, and connect the USB cable connected to the flight control to the USB port of the computer.

2. Go to My Computer Desktop and click Manage to view the ports you are currently connected to.

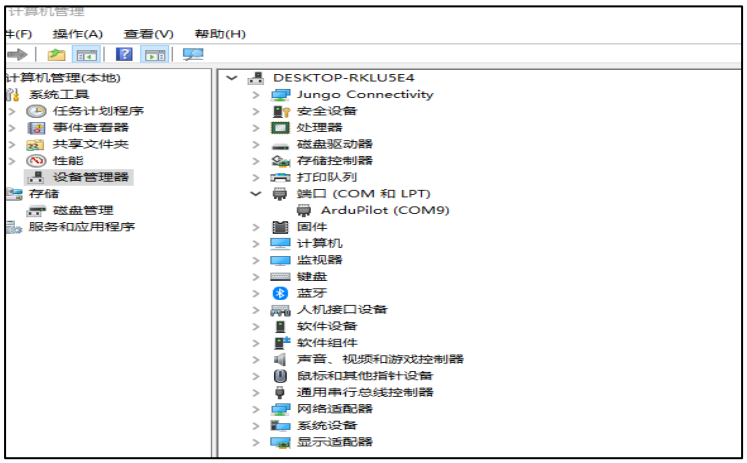


Figure 4 Port view

3. Click the upper right corner of the ground station, configure the port number and baud rate, and set the baud rate to the 115200.

Figure 5 Connection mode selection

4. Click the "Configuration/Debugging" interface to find all the parameter trees, and find the search on the right side to search for the parameters you need to modify.

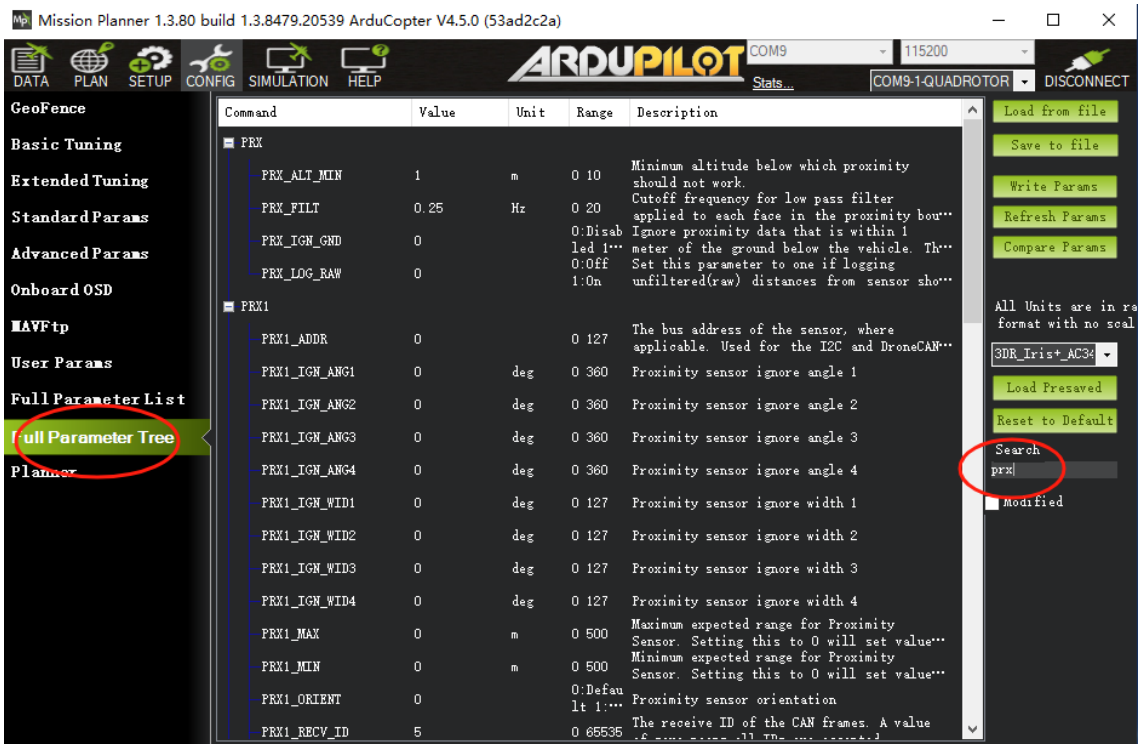


Figure 6 Parameter query

5. According to Table 1 and Table 2 below, we search for keywords, such as "AVOID" and "CAN", find the parameters in the table, and modify them one by one.

Table 1 Configuration of CAN1 interface parameters

Parameter name	Value	Parameter introduction
CAN_D1_PROTOCOL	14	Allows the use of the MR72 CAN communication protocol on the CAN1 port
CAN_P1_DRIVER	1	Enable CAN1 bus
CAN_P1_BITRATE	500000	The code rate of CAN1 interface is 500kb/s.

Note: When configuring CAN parameters, you need to modify PROTOCOL and DRIVER first, a nd then write the parameters and refresh them before configuring BITRATE parameters; To use CAN2, change "D1" and "P1" in the above parameters to "D2" and "P2", for example, change "C AN _ D1 _ PROTOCOL" "to" CAN _ D2 _ PROTOCOL "".

Table 2 Configuration of Obstacle Avoidance Parameters

Parameter name	Value	Parameter introduction
AVOID_ENABLE	2	Enable proximity sensor avoidance
AVOID_ANGLE_MAX	1000	The maximum angle for obstacle avoidance in non-GPS mode is 10 °
AVOID_BEHAVE	1	When avoiding obstacles, the action made by the UAV is stop.
AVOID_MARGIN	5	Obstacle avoidance distance of 5 meters in GPS mode
AVOID_DIST_MAX	10	Obstacle avoidance distance of 10 meters in non-GPS mode

Note: We only provide the appropriate recommended parameters for the above parameter values, and the actual values can be modified according to the customer's requirements.

6. As shown in the figure, we configure the basic parameters in Table 1 and Table 2 to meet the conditions for opening obstacle avoidance.

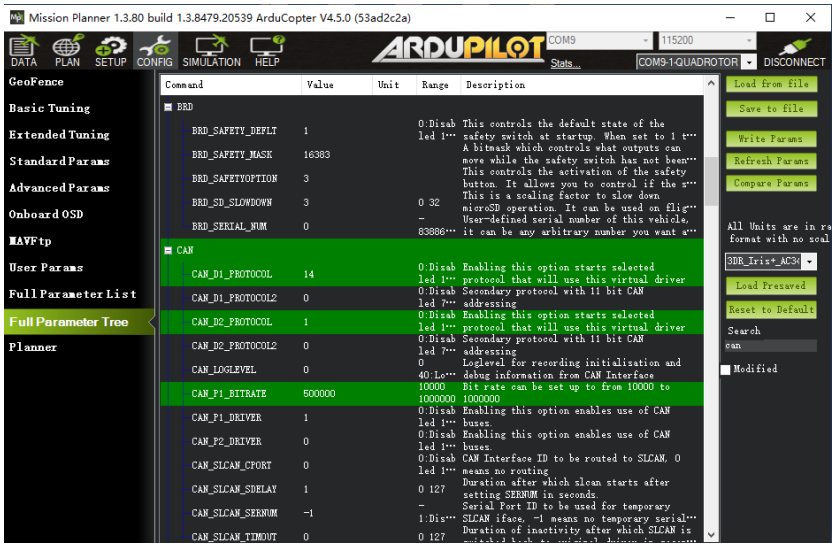


Figure 7 CAN1 parameter configuration

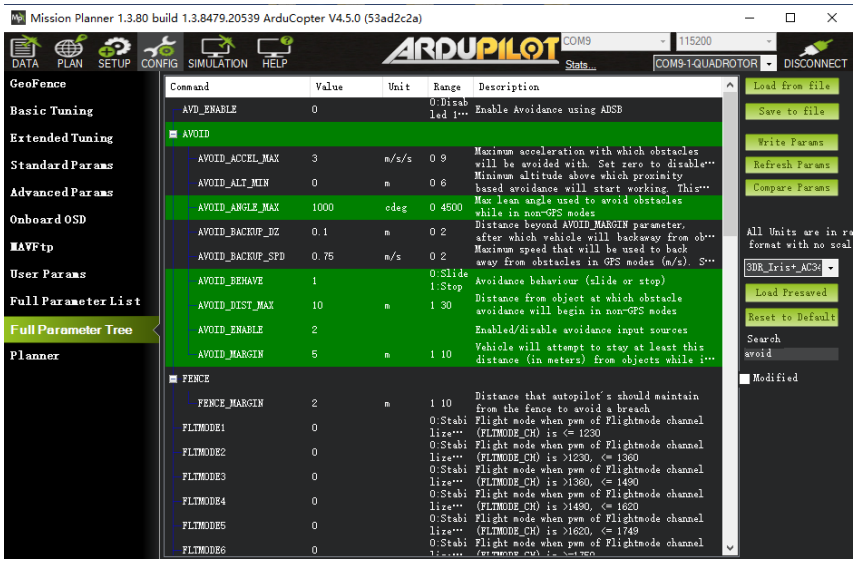


Figure 8 Obstacle avoidance parameter configuration

6.2 Sensor parameters

Table 3 Configuration of One-way Obstacle Avoidance Sensor 1

Parameter name	Value	Parameter introduction
PRX1_TYPE	17	Connect MR72 Proximity Sensor
PRX1_RECV_ID	0	The ID of radar allowed to receive is 0
PRX1_YAW_CORR	0	Radar shows the sector position is straight ahead.

Note: When configuring PRX parameters in the default parameters, you need to set PRX1 _ TYPE first, write the parameters and refresh the parameters.

Configure the subsequent parameters. When modifying the PRX _ RECV _ ID, the flight control needs to be powered off once before the modification of this parameter will be displayed.

1. Configure sensor 1 according to the above table, as shown in the figure:

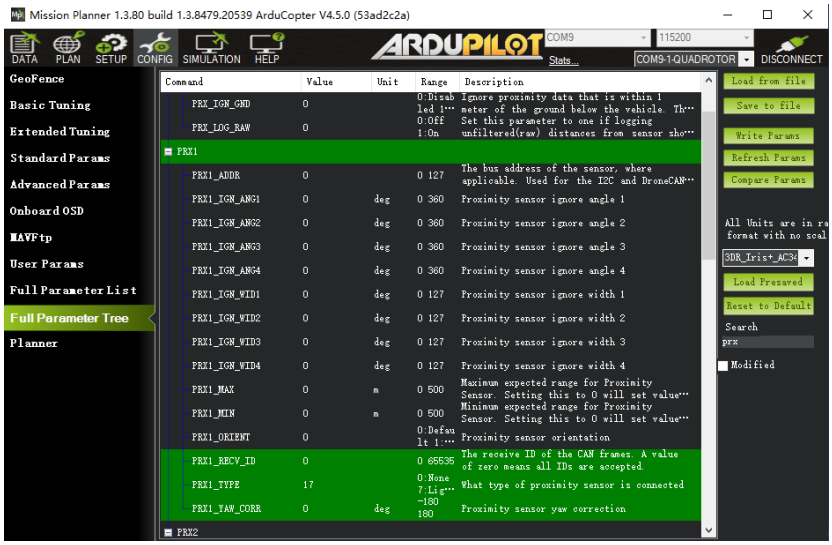


Figure 9 PRX parameter configuration

2. After configuring the sensor parameters, click "Flight Data" to return to the main interface, and open the interface "Temp" through "Ctrl + F".

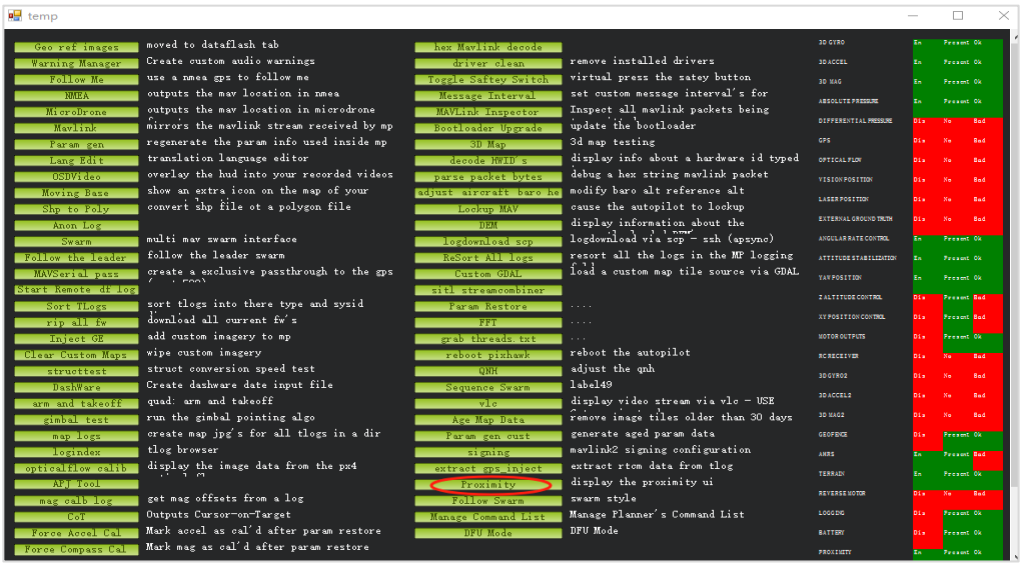


Figure 10 "Temp" interface

3. In the range of 315 ° to 45 ° in the figure, red lines will be displayed. Each red line represents a target obstacle. A maximum of three targets will be displayed in one range.

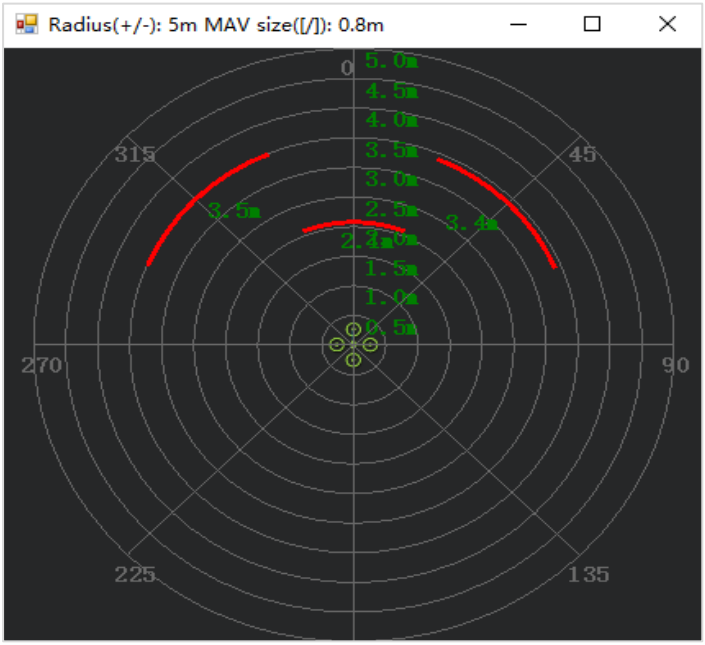


Figure 11 Real-time display of radar interface

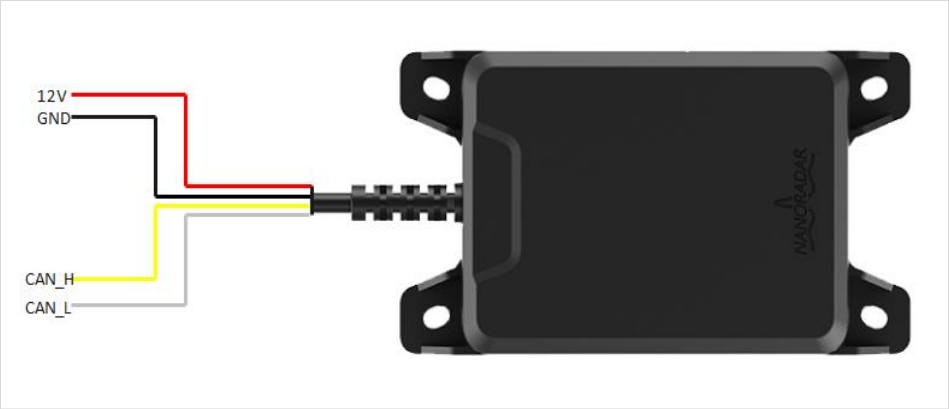
七、 Radar parameters

Modulation mode		FMCW
Test distance		0.2~40m/80m
Angular range		±56°@6dB
Speed range		-100km/h… + 100km/H (-means far from the target, + means close to the target)
Elevation beam		14°
Azimuth beam		112°
Radar transmitting frequency	Follow ETSI & FCC	76…77GHz
Power source		+5V…28VDC
Interface type		UART, CAN (high speed 500Kbit/s)
Power consumption		2.5W
Operating temperature		-40℃…+70℃
Storage temperature		-40℃…+90℃
Weight		90g
Size	W*L*H	100×57×16.5mm
Degree of protection		IP66

VIII. Appendix

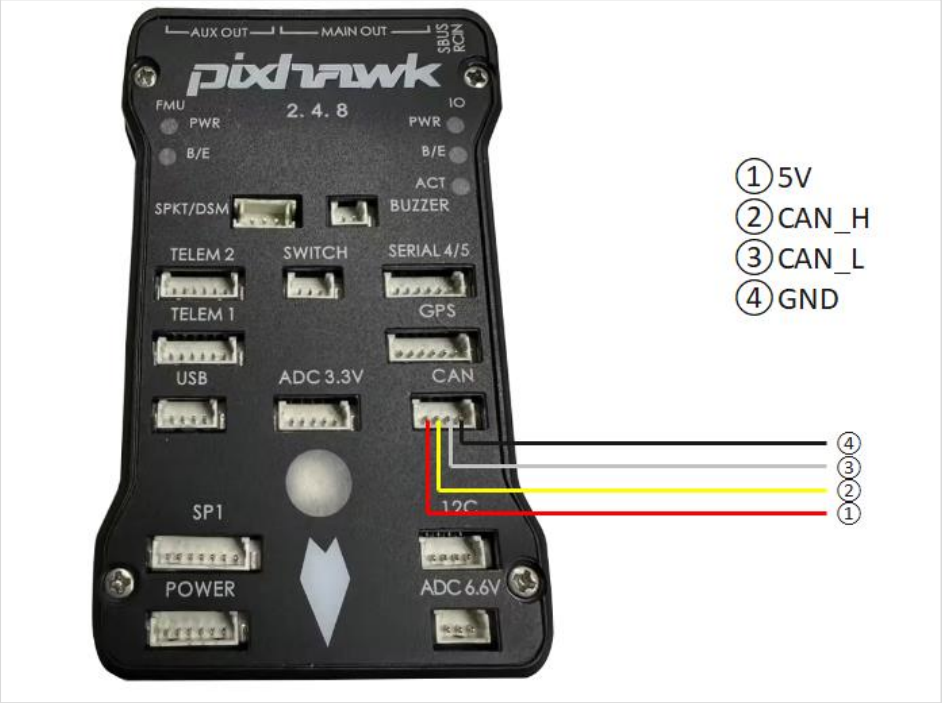
8.1 Definition of radar harness

Pin	Color	Interface description	Remarks
1	Red	DC12V	Power supply positive
2	-	-	-
3	Black	GND	Negative pole of power supply
4	-	-	-
5	White	CAN_L	Low level CAN port
6	Yellow	CAN_H	High level CAN port
7	-	-	-
8	-	-	-



8.2 Definition of flight controller harness

Color	Interface description	Remarks
Red	DC5V	5V power supply (not used temporarily)
Yellow	CAN_H	High level CAN port
White	CAN_L	Low level CAN port
Black	GND	Ground wire (not used temporarily)



8.3 FAQ

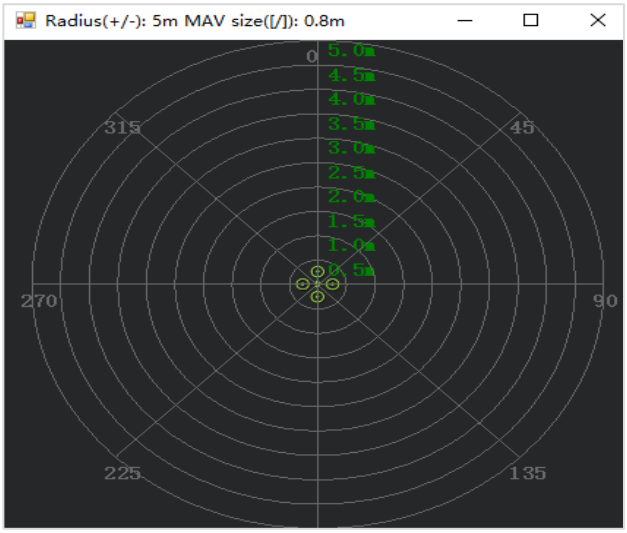
Q: In which modes can the obstacle avoidance of MR72CAN protocol be used?

A: Radar obstacle avoidance is divided into simple obstacle avoidance and algorithm obstacle avoidance. MR72 adopts simple obstacle avoidance, so it only supports LOITER mode and ALT _ HOLD mode at present. If you want to use obstacle avoidance in AUTO or RTL mode, please modify the parameters OA _ TYPE = 1 (BendyRuler obstacle avoidance algorithm), OA _ MARGIN _ MAX = 5 (obstacle avoidance distance is 5 meters).

Q: Can the radar ID number be modified arbitrarily to match the CAN protocol of flight control?

A: The PRX _ RECV _ ID of the parameters at the flight control end changes with the ID of the radar itself. For example, if the ID of the radar I got is 5, then the parameters at the flight control end are changed to PRX _ RECV _ ID = 5; If the parameter PRX _ RECV _ ID of the flight control end is set as 9, the ID of the radar itself needs to be changed to 9 before it can be used according to the CAN protocol.

Q: How does Mission Planner divide the range of radar display interface?



A: As shown in the above figure, the radar display interface is composed of 360 ° circular interface, and the circular interface is divided into a sector by 45 °, and the two sectors are divided into an interval, that is, the first interval is from 315 ° to 45 °, the second interval is from 45 ° to 135 °, the third interval is from 135 ° to 225 °, and the fourth interval is from 225 ° to 315 °. That is, the first section is the front, the second section is the right, the third section is the rear, and the fourth section is the left.

Q: Can the open source MR72CAN protocol connect multiple radars to achieve multi-directional obstacle avoidance?

A: Yes, we support up to three MR72 radars cascading for obstacle avoidance in three directions. If necessary, you can go to the user manual for multi-radar cascading of the open source CAN protocol.

Q: MR72 obstacle avoidance distance and installation issues?

A: MR72 obstacle avoidance distance can be modified at the ground station. The installation of radar needs to consider the angle change caused by navigation obstacle avoidance and hovering obstacle avoidance of UAV. Considering the characteristics of radar visual angle range, and due to the delay of UAV braking in radar data transmission, it is necessary to control the extension of braking distance caused by flight speed and delay in order to ensure UAV flight installation.

Q: Standard test data flow?

A: After the configuration parameters are completed, the radar and flight control need to be powered on again to ensure that the data is valid. At the same time, the radar test is affected by the indoor multipath of millimeter wave, and the indoor data is inaccurate. When the hardware connection and parameter configuration are verified to be normal, the radar test needs to be carried out in the outdoor open field.