

# White Paper on MR72-UAV

## Millimeter Wave Radar



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## Version history

Date	Version	Version description
2018-11-9	1.0	The 1 <sup>st</sup> version of white paper on MR72-uav
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# Contents

MR72-UAV millimeter wave radar white paper.....	错误！未定义书签。
1 Application requirements for unmanned aerial vehicles obstacle avoidance.....	错误！未定义书签。
1.1 Challenges of obstacle avoidance for unmanned aerial vehicles obstacle avoidance	错误！未定义书签。
1.2 Differences obstacle avoidance way between mmv radar and other methods	错误！未定义书签。
2 MR72-UAV millimeter wave radar introduction.....	错误！未定义书签。
2.1 Features.....	3
2.2 Parameters.....	3
2.3 Applications.....	7
3 Application cases.....	7
3.1 Unmanned aerial vehicles active obstacle avoidance.....	7
4 Conclusion.....	10

# White paper on MR72-UAV millimeter wave radar

**Abstract:** MR72-UAV is a compact 77GHz distance measurement radar developed by Hunan Nanoradar Science and Technology Co., Ltd. It adopts double beam design, 0.2~40m measurement distance, small size, high sensitivity, stable performance, light weight, easy to integrate, and it can meet the application needs of unmanned flight platform (uav /UAS), helicopter, small airship and other fields, product performance has been recognized by many partners.

**Key words:** MR72-UAV , 77GHz millimeter wave radar , double beam design , accurate measurement.

## 1 Application requirements for unmanned aerial vehicles obstacle avoidance

### 1.1 Challenges of obstacle avoidance for unmanned aerial vehicles obstacle avoidance

With the rapid growth of the market of agricultural, electric power, industrial and other industry-level unmanned aerial vehicles (uavs), the key technologies of uavs are also making rapid progress. Real-time image transmission, target recognition, terrain following and other technologies make uavs more and more intelligent. Among many technical trends, the ability of automatic obstacle avoidance is the key to realize the safety of uav. The accurate active obstacle avoidance system of uav can greatly reduce the damage of uav/ personal accident and building accident caused by human operation error.

### 1.2 Differences obstacle avoidance way between mmv radar and other methods

The common technology used for unmanned aerial vehicles obstacle avoidance is millimeter wave radar, infrared sensor, ultrasonic sensor, laser sensor, and visual sensor. The detail comparison is as below table 1.

Different from other obstacle avoidance methods, 77GHz millimeter-wave radar has strong robustness, high measurement accuracy and all-weather working ability, and is favored by more and more uav manufacturers. It has many excellent characteristics such as small size, low

power consumption, high precision and anti-interference. At the same time, it can output the distance, speed, angle and other information of up to 50 targets, which is suitable for autonomous flight and automatic obstacle avoidance in the course of all-weather, all-day and all-terrain uav and fixed-point cruise.

Table 1 comparison of unmanned aerial vehicles obstacle avoidance technology

Obstacle avoidance way	Realize principle	Distance	Accuracy	Advantages	Disadvantages
Infrared	TOF	0.1~35M	±0.5m	Mature application Low cost	Easy to be absorbed Susceptible to other infrared interference
Visual	Visual positioning	0.3~10M	±0.1m	High accuracy Relative low cost	High power consumption, Complex algorithm Poor effect under haze condition
Ultrasonic	TOF	0.3~6M	±0.1m	Low cost	Short detection range, unable to work under the high wind
Lidar	TOF	Less than 200M	±0.02m	High accuracy under a good measurement condition	Expensive, big size, high power consumption
Millimeter wave radar	FMCW	0-40M	±0.18m	High accuracy, full day, all weather	Medium cost

Compared with other kinds of obstacle avoidance methods, 77GHz millimeter-wave radar has irreplaceable advantages in the application of uav obstacle avoidance. It can help uav work in various environments and assure the safety working of unmanned aerial vehicles.

## 2 MR72-UAV millimeter wave radar introduction

### 2.1 Features

It can guide the uav to avoid obstacles accurately in flight by transmitting two-beam fan-shaped microwaves to the front, detecting the reflection of microwaves, judging whether there are obstacles in front, and feedback the relative distance between obstacles and radar.

- Moving objects
- Velocity
- Distance
- Direction
- Direction

MR72-UAV adopts high integration density MMIC solution, very low power consumption(2.5W), small size (100×57×16.5mm), double beam design, max detect range 40m, light weight design, which can meet the distance measurement requirements for unmanned sweeper, unmanned logistics vehicle, engineering vehicle, mining vehicle and so on. MR72-UAV is the only mass production 77GHz millimeter wave radar for unmanned aerial vehicles obstacle avoidance, its excellent performance is highly recognized by many partners.



Figure 1 MR72T-UAV 77GHz millimeter wave radar real picture

For

customer's convenient to develop and test, MR72-UAV mmv radar provides CAN interface, the communication rate of 500Kb/s, target update rate 17GHZ, universal external communication interface makes it easy to integrate with PC or other MCU modules, it will

save user configuration time.

## 2.2 Parameters

MR72-UAV parameters as below:

Figure2 MR72-UAV Radar Performance Parameter

<b>Measuring performance to natural targets (non-reflector targets)</b>		
Modulation		FMCW
Distance Range		0.20-40m (short、middle mode, $\pm 56^\circ$ )
Distance Resolution	spot target, none tracking	0.17m, ability to separate targets and objects 1.5...2 x resolution
Distance Accuracy	spot target, none tracking	$\pm 0.10\text{m}$
FOV		$\pm 56^\circ @ 6\text{dB}$
Angle Resolution	spot target, none tracking	$\pm 2^\circ$
Velocity Range		-111km/h...+111km/h (-leaving object, +approximation)
Velocity Resolution	spot target, none tracking	2.06km/h
Velocity Resolution	spot target, none tracking	1.03km/h
Antenna Channels		2TX/4RX=8 channels=1TX/4RX(middle)、1TX/4RX(short)
Cycle Time		app. 30 ms for each mid and short range mode, total 60ms
Elevation beam		$14^\circ$
Azimuth beam		$112^\circ$
MR72 Dual beams (mid-range and short-range) work simultaneously and can not be switched. The detected targets are output in order of distance or RCS. By default, they are output by distance from near to far.		
<b>Operation Condition</b>		
Transmit frequency	ETSI&FCC	76...77 GHz
Transmit capacity	average/peak EIRP	29.8dBm
Power		+5.0V...32V DC
Consumption		2.5W
Working Temp		$-40^\circ\text{C} \dots +85^\circ\text{C}$
Storage Temp		$-40^\circ\text{C} \dots +90^\circ\text{C}$
Protection class		IP66
<b>Interface</b>		
Interface		1xCAN- High speed 500kbit/s
<b>Cover</b>		
Dimension	W*L*H	100×57×16.5 mm
Weight		90g
Material	front/back	PC

MR72-UAV mmv radar adopts advanced 2T4R integrated planar micro strip array antenna, each transceiver antenna contains 40 vertical polarization radiation units. The radar receive



and transmit antenna for wide beam in azimuth angle design, the bearing surface beam width is about  $112^\circ$ , which can increase the radar detection range; the pitch plane is designed as a narrow beam width is about  $15.6^\circ$ , which can reduce ground clutter at low speeds.

The transceiver antenna adopts Taylor algorithm to synthesize the antenna pattern with low lobe synthesis. The antenna low lobe synthesis design makes the radar not easy to be interfered by ground clutter and the target outside the main beam, and can significantly improve the SNR when radar detect target.

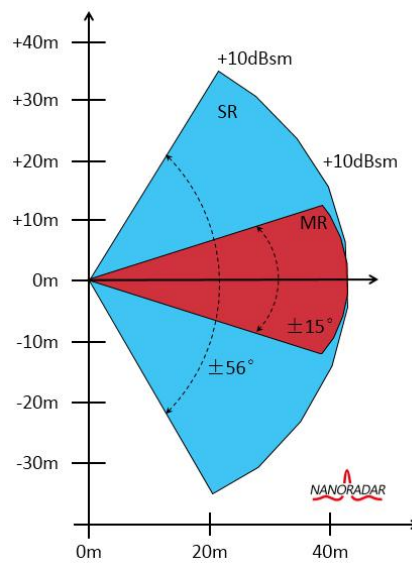


Figure2 MR72-UAV mmv radar FOV picture

Product outline as below:

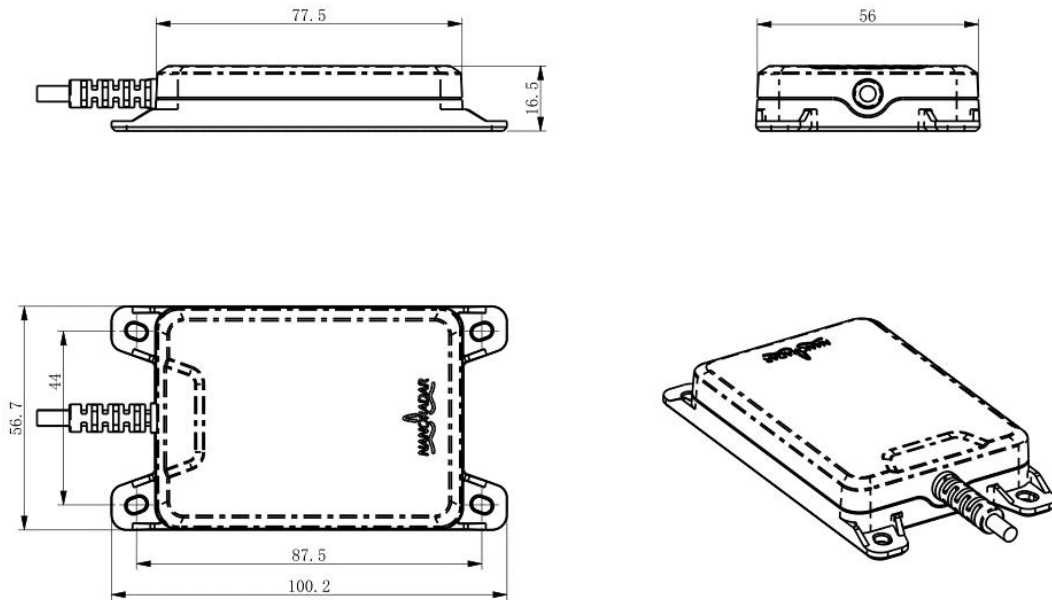


Figure 3 MR72-UAV outline

## 2.3 Application

- UAVs safety ranging and obstacle avoidance
- Production

## 3 Application cases

### 3.1 Unmanned aerial vehicles active obstacle avoidance

In recent years, with the rapid growth of consumption level of unmanned aerial vehicle (uav) market and its related technology is undergoing rapid change, also in the consumption level of drone technology trends, obstacle avoidance ability is the key link to realize automatic and intelligent, and improve the active obstacle avoidance system will be able to greatly reduce the damage of uav/ personal accident and building accident caused by human operation error. From every consumer product and technology development direction of unmanned aerial vehicle (uav) manufacturers, obstacle avoidance technology will be perfected in the next few years and become a high-end consumer in unmanned aerial vehicle (uav) standard system.

According to the current development of uav obstacle avoidance technology and its future research situation, uav obstacle avoidance technology can be divided into three stages. The first stage is perception of obstacles. The second stage is to bypass obstacles. The third stage is scene modeling and path searching. These three stages are actually the function process of

obstacle avoidance technology of uav. The process from the detection of obstacles by uav to the automatic avoidance of obstacles and the self-planning of paths.

Uav obstacle avoidance can be operated by remote control or automatically planned route operation by uav. Generally, it can be used in plant protection, power maintenance, industrial exploration and other fields to achieve efficient and rapid operation and save a lot of manpower and material resources. In the process of construction, the uav is not limited by the terrain and height, and can automatically set the height according to the terrain and avoid obstacles when encountering obstacles.

Existing uav obstacle avoidance mainly adopts visual obstacle avoidance, but due to the problems of single/binocular camera volume, weight, power consumption and algorithm calculation, the requirements for the existing uav platform are very high under the condition of ensuring the endurance of uav. At the same time, the effect of the single/binocular camera will be greatly reduced under the haze, dust environment. There is no such problem for 77GHz millimeter-wave radar.

MR72-UAV 77GHz millimeter wave radar is an unmanned aerial vehicle (UAV) obstacle avoidance radar, flexible installation position, applicable to all kinds unmanned aerial vehicle (UAV) platform, which can accurately detect the distance between obstacles and unmanned aerial vehicle (UAV), and the detection range, speed and angle data can transmit to the UAV flight control system through the CAN interface real-time transmission, realizes the unmanned aerial vehicle (UAV) keeps a proper distance flight or bypass obstacles, as shown in the figure below.



Figure 4 MR72-UAV outline

MR72-UAV advantages in unmanned aerial vehicles collision avoidance application:

- 1、 Accurate measurement;
- 2、 Small size, low power;
- 3、 High anti-interference ability, easy to be integrated;
- 4、 Advanced performance and durable.

## 4 Conclude

MR72-UAV is currently the best performance millimeter wave radar for unmanned aerial vehicles distance measurement, it can ensure the safe and stable work of the uav and realize the completion of plant protection, power maintenance, industrial exploration and other operations by the uavs under the complex working environment, especially in the case of non-empty space, many obstacles and interlaced wires, the performance is recognized by many factories, and it will soon become the standard equipment for unmanned aerial vehicles collision avoidance system.

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