TCM873 millimeter wave radar White paper

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Version history

Date	Version	Version description
2024-7-25	1.0	

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TCM873 80GHz Millimeter Wave Radar White Paper

Abstract: TCM873 is a compact 80GHz millimeter wave radar developed by Hunan NanoradarTechnology Co., Ltd. The TCM873 can detect and track the information of large and small vehicles and electric vehicles on the road in real time by transmitting dual-beam fan-shaped millimeter waves forward, detecting the reflection of millimeter waves, judging whether there are obstacles ahead, and feeding back the relative distance, speed and angle information between the obstacles and the radar. The product adopts a number of advanced technologies such as far and near beamforming to achieve a measurement distance of 1.2-500m, supporting the detection of 512 targets, compact size, high sensitivity, stable performance, light weight, easy integration, and the product performance has been recognized by many partners. The product can be applied to high-speed traffic monitoring, intersection monitoring, intersection detection, perimeter security and other application scenarios.

Keywords: TCM873, 80 GHz millimeter wave, 500 m detection range, 512 targets

1 Application requirements of traffic flow statistics

1.1 Opportunities and Challenges Faced by Intelligent Transportation

In recent years, with the promotion of social and economic development and national policies, China's urbanization process has developed rapidly. With the rapid growth of urbanization rate, there is a huge demand for urban transportation. China is not only one of the countries with the fastest construction speed of road and other transportation infrastructure in the world, but also one of the countries with the fastest growth of transportation demand.

According to the data, the investment in highway construction in 2019 was 2189.5 billion yuan, an increase of 2.6% over the previous year. Of this, 1150.4 billion yuan was invested in the construction of expressways, an increase of 15.4%; 492.4 billion yuan was invested in the construction of national and provincial highways, a decrease of 10.3%; Investment in rural highway construction was 466.3

billion yuan, down 6.5%.

With the gradual maturity of artificial intelligence technology and the promotion of a number of policies, intelligent and intelligent highway has become the main development direction of highway transportation. Through the construction of infrastructure, highway network construction will continue to increase, and highway freight capacity will continue to improve. With the further development of intelligent highway construction in China, the market scale will gradually increase. China Business Industry Research Institute predicts that the market scale of intelligent highway in China will exceed 60 billion yuan by 2020.

The increasingly complex road traffic environment urges our country to develop intelligent, comprehensive, accurate and real-time intelligent traffic management system, and to meet this requirement, we must rely on reliable real-time and accurate detection data, including large data, geomagnetism, video and radar detection means to provide multi-mode data. The technical advantages of millimeter wave radar can have extremely important applications in the field of intelligent transportation.

For example, it can be used for vehicle detection, traffic volume investigation, traffic incident detection, traffic guidance, speeding monitoring, electronic checkpoints, electronic police and traffic light control.

Intelligent traffic products such as traffic flow monitoring, intelligent control system of traffic lights at intersections, intelligent warning lights, intelligent parking navigation system and intelligent traffic guidance equipment began to emerge. Because of its powerful functions, this kind of intelligent transportation products effectively improve the efficiency of transportation and effectively solve the transportation problems in cities.

A variety of sensing technologies are currently used in traffic flow monitoring applications. They serve different markets, and each technology has unique advantages and disadvantages.

Inductive loop sensor. A cut in the road is crossed by an insulated and conductive wire. An electrical pulse passes through the wire. The change in inductance caused by the passage of a car indicates when the vehicle has passed or stopped. This solution is common, but inductive loop sensors have several disadvantages.

First, detection is limited to vehicles at dry loop installations, so the need to predict overall traffic conditions is difficult. Second, the system is expensive and complex to implement, requiring coils to be installed at intersections in every area and lane.

The biggest drawback is the need to excavate the road surface to install or repair the system. Considering the cost of installing this system and the short life cycle (one to two years), the overall cost of the induction loop system is very high.

Cameras and vision-based sensors. Video image processors, cameras, and vision-based sensors are used to capture image data from CMOS image sensors, which are then analyzed to determine traffic behavior.

Vision sensors can not only measure traffic behavior at intersections and highways, but also transmit real-time video to customers. However, changes in environmental conditions (day and night, light and bad weather) directly affect the detection ability of the system. Moreover, this visual challenge requires advanced signal processing and algorithms, which also increases the complexity of the system.

Compared with the disadvantages of the above sensors, millimeter-wave radar has many unique advantages, including its insensitivity to light or weather, its wider application range compared with vision-based technology, and its higher accuracy, which makes it perform better in traffic monitoring applications.

1.2 Difference between millimeter wave radar and other methods

Millimeter-wave radar can improve transportation efficiency and safety in various ways.

First, work in all-weather conditions. Radar is not sensitive to changing environmental conditions. Millimeter wave has the ability to penetrate and sense adverse weather conditions, such as night, smoke, rain. This capability makes millimeter-wave radar a superior solution for outdoor detection in uncontrolled and changing environments.

Secondly, high-speed objects are detected in the extended range. Millimeter-wave radars use fast frequency-modulated continuous-wave (FMCW) radars in the 80 GHz range, which offer several advantages over conventional radar systems. The combination of antenna design and RF configuration enables the 80GHz radar system to easily detect vehicle targets at speeds up to 300km/H within a range of 500m.

Finally, the object measurement accuracy is high. The fast FMCW radar with integrated processing can measure the range, radial velocity and angle of multiple target reflectors in a scene many times within 1 s. Traffic monitoring systems using millimeter-wave solutions can easily identify and track multiple vehicles in real time at high speed resolution over long distances.

80GHz millimeter-wave radar can also achieve traffic statistics, vehicle identification, congestion warning and other functions, with all-weather, all-day working characteristics, accurate detection and measurement, can play an important role in the traffic flow management system.

Table 1 Comparison of Traffic Flow Measurement Technologies

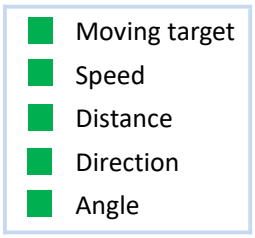
Measurement technology	Implementation principle	Distance	Precision	Advantage	Shortcoming
Vision camera	Visual positioning	0.3 ~ 200m	± 0.1 m	High precision and low cost	High power consumption, complex algorithm, poor effect under haze and other conditions
Ground	Electromagnet	/	/	Low cost, fast	Destroying the road

induction coil	ic induction			response and accurate measurement	surface, easy to damage, requiring a large number of deployments
TCM873 millimeter wave radar	FMCW	1.2 ~ 500m	± 0.6 m	High precision, all-weather	Difficult to distinguish object shapes

2.Overview of TCM873 80GHz Millimeter Wave Radar

2.1 Product features

The TCM873 millimeter wave radar detects the reflection of the microwave by emitting double-beam fan-shaped microwave to the front, judges whether there is an obstacle ahead, and feeds back the relative distance, relative speed and angle between the obstacle and the radar.



The TCM873 80GHz millimeter-wave radar adopts a highly integrated scheme, dual-beam design, and a lightweight design, which can detect up to 500 m, and can meet the requirements of ranging applications with high performance and environmental adaptability in the field of transportation. The excellent performance of TCM873 80GHz millimeter wave radar has been highly recognized by many partners.

Figure 2 Physical image of TCM873 millimeter wave radar

2.2 Product parameters

The TCM873 80GHz millimeter wave radar adopts the FMCW modulation mode with high complexity, which can accurately measure the distance from the front obstacle within the measurement range. Parameters of TCM873 are shown in the following table:

Table2 Performance Parameters of TCM873 80GHz Millimeter Wave Radar

Measurement Performance General Objectives		
Modulation mode		FMCW
Ranging range		1.2~500m@0°
Range measurement resolution	Point target, non-tracking	1m
Distance measurement accuracy	Point target, non-tracking	0.5m
Azimuth beam		± 40 ° @ Wide Beam ± 15 ° @ Narrow Beam
Elevation beam		± 13 ° @ Wide Beam ± 5.5 ° @ narrow beam
Angular accuracy	Point target,	0.6°

	non-tracking	
Speed range		-300km/H.. + 300km/H (+ means far from the target,-means close to the target)
Velocity resolution	Point target, non-tracking	0.05m/s
Speed accuracy	Point target, non-tracking	0.02m/s
Cycle period		About 80ms
Number of antenna channels		6TX/8RX = 48 channels
Operating conditions		
Radar transmitting frequency	Follow ETSI & FCC	80GHz
Transmission capacity	Average/Peak EIRP	29.8dBm
Power source		+9.0V…32VDC
Power consumption	At 12 V	12W
Operating temperature		-40℃…+70℃
Storage temperature		-40℃…+85℃
Degree of protection		IP67
Interface type		
Interface		RS485/Ethernet port
Structure		
Size	L * W (mm)	110*132
Weight	Harness is not included	/
Material	Enclosure Front/Rear Cover	/

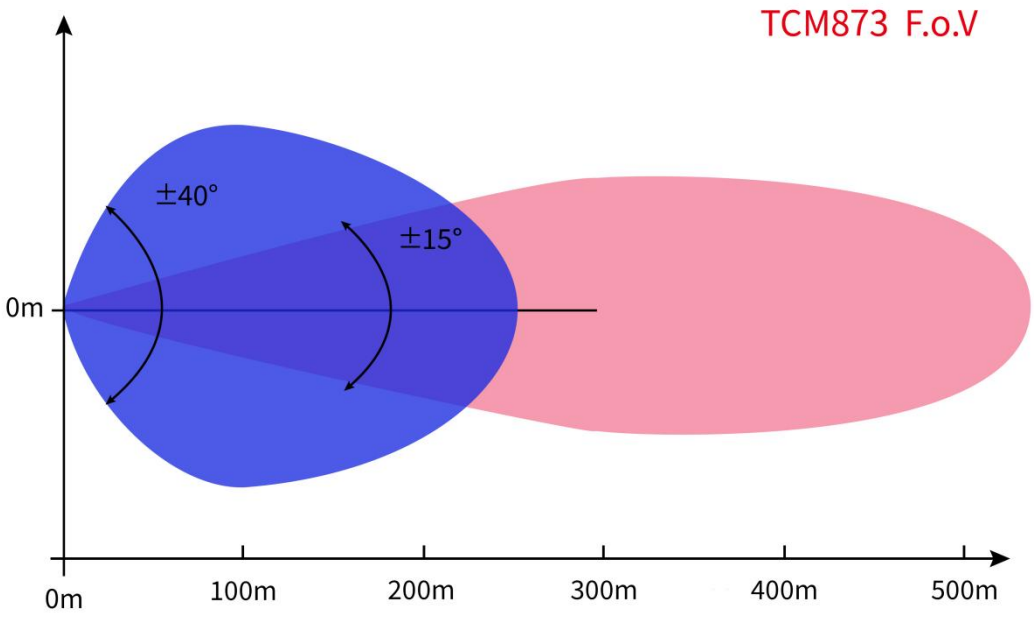


Figure 3 FoV Diagram of TCM873 Millimeter Wave Radar

PCB dimensions are as shown in the figure below:

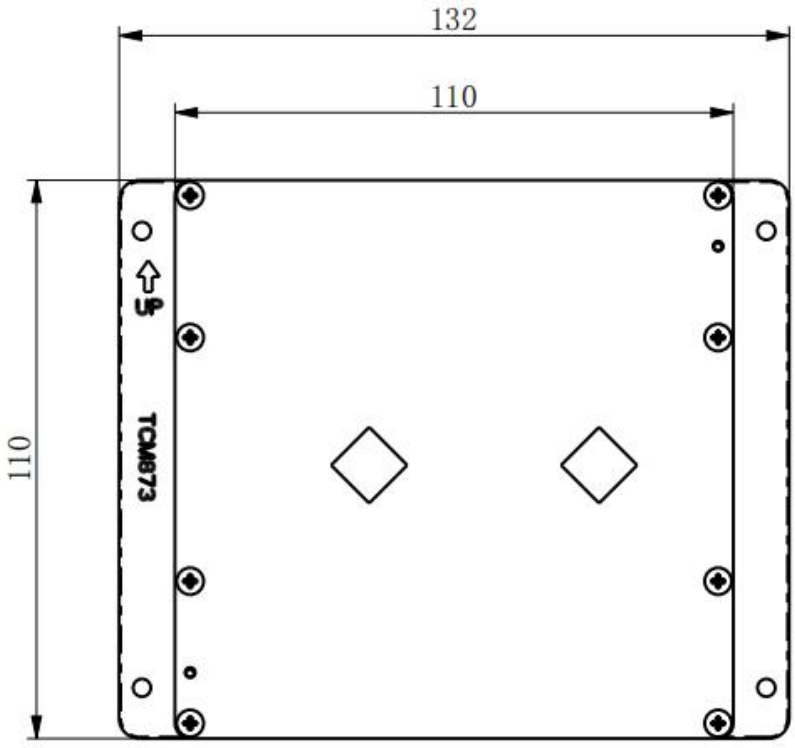


Figure 4 Dimensional diagram of TCM87 3 millimeter wave radar

2.3 Product application field

- Traffic flow statistics
- Traffic warning at the intersection
- Road safety warning
- Roadside parking violation monitoring

3 Typical application cases

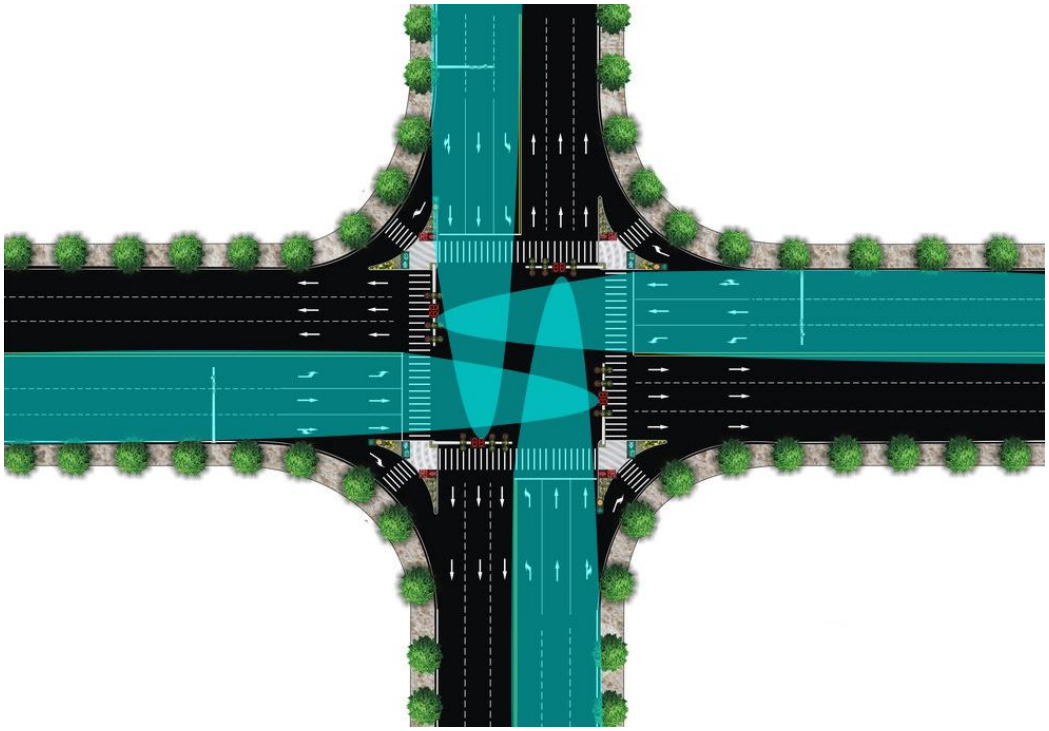
3.1 Traffic flow statistics

TCM873 80GHz millimeter wave radar can simultaneously detect the distance, speed and angle information of 10 lanes and 512 target vehicles, and the maximum detection range of the radar can reach 500 meters.

Based on the advantages of millimeter wave radar, TCM873 is not affected by light and dust, and can realize real-time monitoring of road sections all day and all weather. TCM873 effectively solves the problem of large vehicle target splitting, does not produce false alarm and omission when the target is running at low speed, and filters the false alarm caused by strong wind in the green belt of the highway. Through the fusion of cameras, the traditional traffic flow statistics scheme can be replaced with a very competitive cost advantage. Based on the above product features, customers can start their own traffic flow statistics and road congestion warning functions to achieve free flow traffic flow statistics and congestion warning system.

The main application scenarios are:

1）The traffic flow, queue length, speed and other information of the current road section are counted at the main road and intersection.



2）For expressways and expressways, the traffic flow, speed and other information of the current road section are counted.

4 Concluding remarks

TCM873 80GHz millimeter wave radar is the most cost-effective product in the field of traffic flow monitoring in China at present. It has the characteristics of high precision and high stability. The radar can detect the distance, speed and angle information of 512 target vehicles in 10 lanes at the same time. The longest detection range of the radar can reach 500 meters. The performance of this product has been verified by many manufacturers, and it can quickly replace foreign traffic flow monitoring radar.

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