FMCW Radar Sensors

Advantages and disadvantages of FMCW radar

Advantages

High resolution distance measurement

Mm-wave FMCW radars can have very high resolution for ranging, velocity and imaging application. A distance measurement resolution of 2 cm can be easily achieved over 20-30 meters. Accuracy for non-moving targets is better than for moving targets, and requires less processing power. Measurements of moving targets are of course possible, but requires more powerful algorithms and hardware. Other technologies such as infrared or ultrasonics cannot detect range or only over very limited distances.

Quick updating of measurement

Because FMCW mm-wave radars are continuously transmitting a signal, there is little delay in measurement updates, as can be the case with pulsed systems. Additionally, solid state electronics produce almost instantaneous start up times, as compared to pulsed systems often using magnetrons. Systems based on lasers, ultrasonics, or infrared will have similar update speeds to FMCW systems.

Functions well in many types of weather and atmospheric conditions

Due to the short wavelength of the electromagnetic radiation used, mm-wave systems have excellent performance in rain, humidity, fog and dusty conditions. The short wave-length means that raindrops, water vapor or dust particles do not block wave propagation easily. Heavy rain is generally required before a reduction in range or resolution occurs. mm-wave systems will function identically during day or night. FMCW radars are also immune to effects from temperature differences, or high temperatures.

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Better electrical and radiation safety

Sivers IMA modules are designed to be inherently safe, for use in an explosive atmosphere such as an oil tanker or LNG storage facility. They are completely sealed and tested, so there is no risk of sparking, resulting in fire or explosion.

Compared to pulsed radar systems, the peak emitted electromagnetic radiation is far lower in a FMCW radar system. This is important in applications where people are close to the antenna, as the peak emitted energy is far lower. This allows for more flexibility in selecting a mounting location for the antenna. The lower peak power requirements also allow for lower power consumption in the supporting electronics, resulting in lower costs and technology needs.

Infrared and video based systems are passive systems, and therefore do not emit a signal for measurement purposes. Most laser based ranging systems use low power emitters, and are considered eye-safe.

Good range compared to other non-radio technologies

Compared to systems operating in the visible or infrared light spectrum, or those using ultrasonic waves, FMCW radar sensors have excellent measurement range due to superior signal propagation.

Can be mounted invisibly (behind radome)

FMCW mm-wave radar systems can be mounted behind a wide variety of radio-transparent materials including most plastics and fiberglass. This allows for use in applications where the sensor must concealed for security, weather resistance or aesthetic reasons.

Can penetrate variety of materials

Mm-waves are capable of penetrating a variety of non-metallic materials. These can include wood, concrete, various polymers and composites. This allows mm-wave based systems to be easily concealed, or to be used for measurement or detection of concealed or covered targets. All other non-microwave based systems require an exposed sensor or window to functions, and can not penetrate a majority of materials.

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Better at detecting tangential motion than Doppler based systems

Since FMCW based systems do not require movement towards or away from the antenna to detect range, an 2D or 3D FMCW based system will be better at detecting tangential or orthogonal movement compared to Doppler-pulse systems when used in a scanning capacity.

Infrared and video based systems are also excellent at detecting movement, but may not be able to quantify the direction or magnitude of the movement.

Disadvantages

Reduced range compared to pulse radar

Due to the generally lower peak power output of FMCW radar systems, their long range performance can be lower than compared to pulsed systems. Since the transmitted signal is not as strong the received signal will be attenuated by atmospheric effects, interference, and distance. FMCW radars are however competitive or superior to other competing technologies in range.

More expensive than competing technologies

Similar economies of scale have not been achieved in FMCW systems compared to pulsed and Doppler radar systems, due to the maturity of the existing technologies in the marketplace. Sivers IMA FMCW radar modules are however price competitive, and can be produced in large, commodity-scale volumes. Additionally, the module uses a standard 3-wire interface for control functions, allowing for easier integration, and less expensive R&D. Compared to infrared and ultrasonic systems, FMCW systems will generally be far more expensive.

Susceptible to interference from other radio devices

Because they are continuously transmitting across a frequency band, FMCW systems may be more susceptible to interference from other electronic systems. This is due to the larger range of frequencies encountered and due to the lower “peak” power, resulting in the returned signal being overwhelmed by other emissions. Pulsed systems can generally overcome interference by increasing transmitted power or by switching frequencies. Distance measurement or detection systems using infrared, video, or lasers are generally immune to interference, given their operating principles.

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Can be jammed

When use in defense applications, FMCW radars can be at a disadvantage compared to pulsed systems. Due to the lower power and continuous transmissions of FMCW systems, they may be more easily jammed by electronic warfare systems. Pulsed systems have an advantage in this regard in that their transmissions are intermittent in nature, their transmission frequency can be varied, and their power output is generally higher.

Not passive

FMCW radar systems continuously transmit, meaning that they are easily detected by electronic warfare systems. Pulsed systems may be more difficult to detect as they are not continuously transmitting. This would make the location of an FMCW easier using detection and triangulation techniques. Additionally, pulsed systems may also more easily be adapted to operate as passive detectors of other transmitters. Their non-passive nature and use of microwaves also means that they are be subject to regulations regarding radio interference and licensing.

Can require more computing power than pulse-Doppler systems

FMCW radar systems, given the need for high-quality fast Fourier transform processing to achieve accurate measurements, can require more advanced and powerful hardware. Given the continued decrease in computing cost, this is becoming less of an issue. However the development and programming required can also be more complex, increasing costs.

May be subject to licensing and regulations

Because they are radio transceivers, these sensors may be subject to regulations regarding interference. As larger bandwidth increases the resolution of an FMCW system, restrictions of frequency use may impact the possible measurement resolution. Non-radio technologies generally avoid this regulatory or licensing requirement.

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