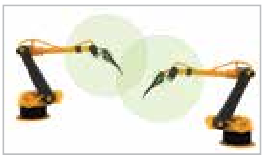
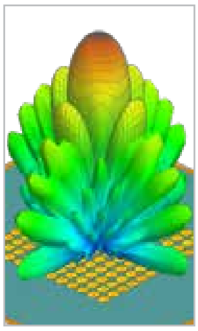
Radar Applications in Everyday Life




When thinking about radar application, for most people, the first thing that comes to mind are the radar systems checking traffic speed, used by the police to reduce speeding on public streets. The use of radar applications, previously limited to official users and the military, has recently entered new application areas, resulting in greater general use. In addition to traditional use cases such as for aerospace security, weather services and military appliances, radar applications today can be found in areas and machines used by everybody. New areas for radar applications are the automotive sector, building security, medical devices, civil engineering, or geophysics, to name only a few.

Since electronic components have become a lot smaller, the market has opened up for mass consumption. Today's radar systems are easy to handle, more precise, and affordable. For these reasons it can be expected that this market will keep on growing massively in the years to come. The developers of new radar systems have to face the challenges i.e. that each device has to be adapted to and optimized for each use case. To reduce the development time and costs of modern radar systems for everyday use the engineers often use simulation tools that help to visualize the system's behavior and to optimize the system even before a physical prototype is built.

RADAR stands for RAdio Detection And Ranging and these systems are, as the name indicates, used to handle wireless detection and to measure distances. As early as in the 19th century Heinrich Hertz could prove the reflection of metallic objects and the Scottish physicist Sir Robert Alexander Watson-Watt, generally know as the inventor of radar, had a method patented to locate objects via radio waves in 1919. We mainly distinguish between two kinds of radar systems: the pulse radar - sending out a short electromagnetic pulse, calculating the distance to an object based on the reflection of the signal and continuous wave radar, which sends a continuous frequency from an antenna, which is reflected by the target und received again with a Doppler shift. Based on the Doppler shift it is possible to calculate the speed of an object. Modern radar systems often gain a lot more information from the echo signal of a target, but the calculation of distance and speed based on a runtime and Doppler measurement are the most important characteristics of radar systems.

Since a few years and thanks to new technologies such as the Ultra-Wideband-Technology (UWB), we see new radar application coming into use, especially for sensor techniques. UWB has enabled new, more compact and less expensive radars, which can be seen in many areas of our everyday life.

Using UWB sensors environmental information such as geometrical size, material characteristics and its derivable data can be received with a high resolution and without having to destroy or touch the object. UWB-radar sensors are used for position detection of an object in a close-up range, as geo-radars and to analyze material (impedance spectroscopy). These sensors come to use in civil engineering, building materials, food and agricultural industries, bio technology, medicine, environment protection, production monitoring, monitoring and security techniques and in traffic and vehicle technology.

Everyday Use of Radar Systems

When looking into automotive engineering, anti-collision systems can be found in almost every modern vehicle. This radar type is a combination of UWB-radars and common Doppler-radars. They can be used to detect obstacles in a distance of around 30 meters and measure their speed. They are placed in bumpers or on the sides of a vehicle and warn about possible collisions with objects or persons. In addition, they can be used to support the parking process. Up to now they are only used passively, but in the future they might also be used actively, i. e. they could actively trigger the breaks of a vehicle. These systems are the next step in the development of autonomous vehicles.

Radar anti-collision systeme

UWB systems are also used to monitor buildings or other close-up areas. They create a monitoring shield above a sensible area that needs surveillance. These systems, not much bigger than a tin can, include a mini-UWB-radar that is able to cover an area of approximately 10 meters, and a wireless system that can trigger an alarm when this area is entered. In this case, the everyday use application is, building security and the monitoring of bigger or smaller objects such as a train or a painting in a museum. This system can also be used as a burglar alarm for private buildings or to monitor public and private swimming pools.

Radar area survveillance

In geophysics radars, so called GPR-Systems, are used to analyze the ground to create soil profiles. These systems are also UWB-radars, and to analyze the ground, the system is moved along the ground surface sending electromagnetic pulses into the ground. The analysis of the echo results in a very detailed soil profile. GPR-systems are also used in civil engineering to create the profile of an excavation area. This is particularly helpful for street and tunnel constructions but can also be used for any other construction project to create profiles of the soil or rock underneath and to detect pipelines or tubes, to eventually avoid them. In climate and earthquake research they can be used to create a profile of the permafrost i. e. in glacier areas.

UWB-Radar for ground analysis

In crime fighting, military projects and civil protection GPR-systems are used to find hidden weapons, mines or corps respectively trapped persons. With so called „UWB Through Wall Imaging" radars it is also possible to see through walls or other obstacles. These systems are often used in military applications and material engineering. Among other use cases these systems are used i. e. in security checks at airports to find weapons made of non metallic materials.

Another technology deriving from this is often used in construction and is therefore well suited for everyday life applications. In this case the radar is used to detect struts, power cables or water supply lines in walls. Why this is helpful becomes immediately evident to every person who ever tried to drill a hole into the wall of an old building without knowing where the former inhabitant or electrician had placed those supply lines.


Radar wall scanner

Systems to differentiate and identify different materials are also applied in handicraft. They can for example be used on buzz saws to stop the saw blade in case a finger or any other body part enters the danger zone.

In medical technology two application cases come immediately to mind: monitoring systems and systems for imaging diagnostic procedures. The monitoring systems are used to monitor vital functions of a patient, such as breathing or the heart beat. These systems are non invasive and can, if placed i.e. in a ceiling corner of a room, even monitor more than one patient at a time. In case of apnea or cardiac arrest these systems trigger an alarm. In addition, high risk pregnancies profit from these systems as they enable the monitoring of fetus' vital functions. UWB-systems for imaging diagnostic procedures are used in clinical diagnostics and don't expose the patient to nuclear magnetic resonance or X-rays, which is beneficial for the patient when doing prevention as well as for examinations in case of illness.

Summery

With new technologies such as the Ultra-Wideband-Technology (UWB), the development of new radar applications is not limited anymore. These systems are more frequently used in everyday applications and offer many advantages. They protect the health of people, guaranty safety and help to prevent accidents. To develop these kinds of systems electromagnetic simulation is applied. By introducing simulation into the development process engineers can predict and analyze i.e. the ideal position and radiation characteristics of antenna components or bidirectional influences of different components.

One of the leading provider of simulation tools, Altair Engineering offers, with its EM product suite FEKO, solutions that can be used to virtually design and optimize radar systems. The application of these simulation solutions helps to optimize development processes, reduce development time and the number of prototypes needed. Hence systems can be developed faster and less expensive and the risk of aberrations can be reduced. In the end the user will benefit from better and less expensive products for everyday use.

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