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Keyword

Ultrasound

Ultrasound is high-frequency sound that humans cannot hear. Its properties include poor transmission in gas, but good transmission in substances like water and metal. The lower the frequency, the longer the wavelength, and the higher the frequency, the shorter the wavelength.

Development of ultrasonic technology triggered by the sinking of the Titanic

Sound that reaches our ears consists of waves (sound waves) that propagate by vibrating the air. Sound emitted from musical instruments, etc., travels through the air and vibrates our eardrums, which makes it audible. The number of times a sound wave repeats per second is called its frequency. The lower the tone, the lower its frequency, and the higher the tone, the higher its frequency.

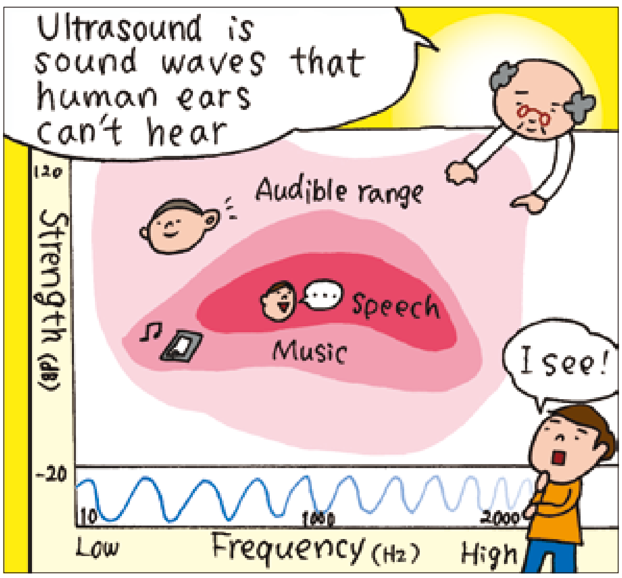
The range of sound that can be perceived by the human ear (audible sound) extends from 20 Hz (a wave repeated 20 times per second) to 20 kHz (20,000 times per second). Sound with frequencies higher than 20 kHz are called ultrasonic waves because they exceed the range of sound that we can hear.

Ultrasound has higher directivity than audible sound, meaning that it is easier for it to travel in a straight direction. It is more easily transmitted in water or solids than in air, and in water it can travel a considerable distance. This enables dolphins and whales to communicate the location of food in the water or understand the contours of the surrounding terrain. Also, sound is reflected when it hits an object, and ultrasonic waves with their high directivity are reflected in a narrower range. Bats use this mechanism. They cannot see well even in bright places, but they can fly without seeing because they can check for obstacles by listening to the reflection of the ultrasonic waves that they emit.

Today, ultrasonic technology is used in various places in the world, but the major event that triggered its development was the sinking of the Titanic in 1912 after it collided with an iceberg. It is said that this accident triggered research on technology for detecting obstacles in water. The application of ultrasonic waves was very important for the development of marine navigation technology. Starting with German U-boats in World War I, countries have worked to develop submarines, and the research and development of technology to detect other countries' submarines has also accelerated. French physicist Paul Langevin developed a piezoelectric element that converted electrical energy to ultrasonic vibration, inspired by the piezoelectric effect by which pressure is converted to electricity. His piezoelectric element could be used not only as an ultrasonic transducer that generates ultrasonic waves, but also as a sensor that detects ultrasonic waves. This invention triggered the development of sonar, which is used in fish finders.

Ultrasound used widely, from medical to industrial applications

Ultrasound is also used in the field of medicine. One example is the ultrasonic diagnostic device used to observe a baby in its mother's womb. The ultrasonic waves used in fish finders vary in frequency from 15 to 200 kHz, depending on the depth of the target fish, but for medical ultrasonic diagnostic devices, high-frequency ultrasound from 3 to 15 MHz is used, depending on the depth of the body part. These ultrasonic waves do not damage the body and there is no risk of radiation, unlike an X-ray or CT scan.



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Ultrasonic cleaners are used to clean eyeglasses and precious metals by removing dirt with the fine bubbles generated when water is vibrated with ultrasonic waves. It may not be well known to the general public, but this mechanism is also used in industry. For example, in semiconductor manufacturing processes, where even minute amounts of contaminant cannot be permitted, ultrasonic cleaners are used. Another example is the ultrasonic machines that process metal with powerful ultrasonic waves.

Flowmeters, too, can use ultrasonic waves to measure the flow rate of a liquid

In factory equipment, ultrasonic waves are used to detect failures in equipment and damage in pipes, etc., that cannot be found with the human ear or eye. For example, in the case of an air leak, when gas escapes from minute cracks or joints in pipes, it makes a sound that we cannot hear. But with an ultrasonic detector, it is possible to detect the leak from a distance and repair it.

Ultrasound is also used by flowmeters for measuring liquid flow rate. A widely used type of ultrasonic flowmeter has an ultrasonic sensor that can be clamped onto a pipe.

Unlike electromagnetic flowmeters, ultrasonic models can measure liquids and gases that are not conductive, and the clamp-on type can be used on various types of pipe (metal, plastic, etc.). With the advantages of versatility and high accuracy, ultrasonic wave technology is once again attracting the world's attention.

Since ultrasonic waves can be used to measure position without contact, they may be used in the future as an alternative to radio technology. Although ultrasound is a simple physical phenomenon, it has a wide range of applications and much potential.

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