

10.10: Ultrasound



Figure 12.6.1

What could this smiling dolphin and yawning bat possibly have in common? It's not just that both of them are mammals. Both of them also use ultrasound to find things in the dark.

What Is Ultrasound?

Ultrasound is sound that has a wave frequency higher than the human ear can detect. It includes all sound with wave frequencies higher than 20,000 waves per second, or 20,000 hertz (Hz). Although we can't hear ultrasound, it is very useful to humans and some other animals. Uses of ultrasound include echolocation, sonar, and ultrasonography.

Echolocation

Animals such as bats and dolphins send out ultrasound waves and use their echoes, or reflected waves, to identify the locations of objects they cannot see. This is called echolocation. Animals use echolocation to find prey and avoid running into objects in the dark. You can see in the Figure below how a bat uses echolocation to find insect prey.

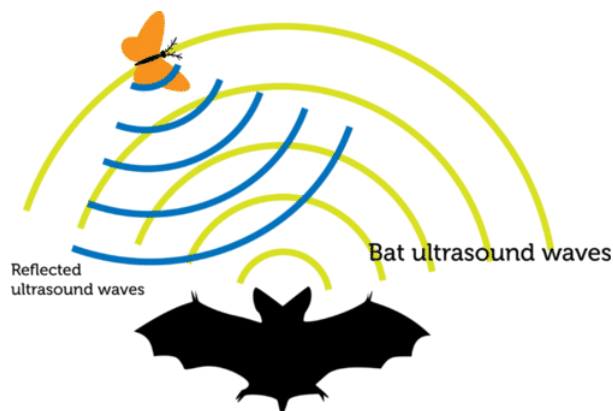


Figure 12.6.2

Sonar

Sonar uses ultrasound in a way that is similar to echolocation. **Sonar** stands for sound navigation and ranging. It is used to locate underwater objects such as submarines. That's how the ship pictured in the Figure below is using it. A sonar device is both a sender and a receiver. It sends out ultrasound waves and detects the waves after they reflect from underwater objects.

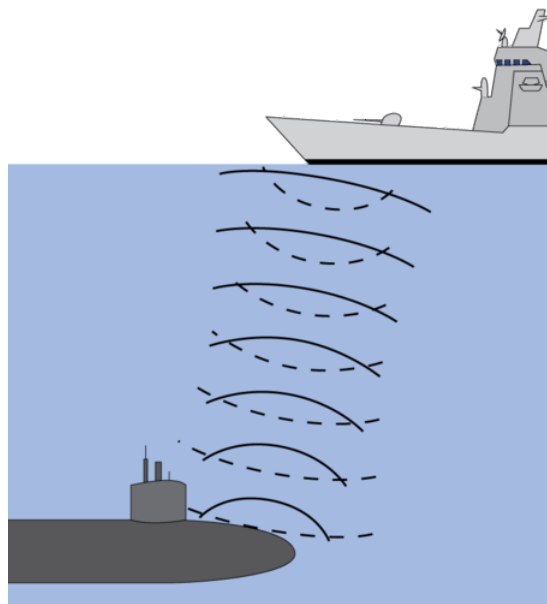


Figure 12.6.3

The distance to underwater objects can be calculated from the known speed of sound in water and the time it takes for the sound waves to travel to the object. The equation for distance traveled when speed and time are known is:

$$\text{Distance} = \text{Speed} \times \text{Time}$$

Consider the ship and submarine pictured in the Figure above. If an ultrasound wave travels from the ship to the submarine and back again in 2 seconds, what is the distance from the ship to the submarine? The sound wave travels from the ship to the submarine in just 1 second, or half the time it takes to make the round trip. The speed of sound waves through ocean water is 1437 m/s. Therefore, the distance from the ship to the submarine is:

$$\text{Distance} = 1437 \text{ m/s} \times 1 \text{ s} = 1437 \text{ m}$$

Q: Now assume that the sonar device on the ship sends an ultrasound wave to the bottom of the water. If the sound wave is reflected back to the device in 4 seconds, how deep is the water?

A: The time it takes the wave to reach the bottom is 2 seconds. So the distance from the ship to the bottom of the water is:

$$\text{Distance} = 1437 \text{ m/s} \times 2 \text{ s} = 2874 \text{ m}$$

Use the PLIX Interactive below to simulate how echolocation can be used to map the seafloor:

Ultrasonography

Another use of ultrasound is to “see” inside the human body. This use of ultrasound is called ultrasonography. Harmless ultrasound waves are sent inside the body, and the reflected waves are used to create an image on a screen. This technology is used to examine internal organs and unborn babies without risk to the patient. You can see a doctor using ultrasound in the Figure below.



Figure 12.6.4



Summary

- Ultrasound is sound that has a wave frequency higher than the human ear can detect. It includes all sounds with wave frequencies higher than 20,000 waves per second, or 20,000 hertz (Hz).
- Animals such as bats and dolphins send out ultrasound waves and use their echoes to identify the locations of objects they cannot see. This is called echolocation.
- Sonar stands for sound navigation and ranging. It is used to locate underwater objects such as submarines.
- Ultrasonography is the use of reflected ultrasound waves to “see” inside the body.

Review

1. Define ultrasound.
2. Explain how animals use echolocation to find things in the dark.
3. What does sonar stand for? How is it used to locate underwater objects?
4. A sonar device on a ship sends ultrasound waves under the water to locate a sunken ship. It takes the ultrasound wave 0.6 seconds to travel from the device to the sunken ship and back again. How far below the surface is the sunken ship?
5. How is ultrasonography like sonar?

Additional Resources

Study Guide: Waves Study Guide

Real World Application: Shipwreck!, Echolocation

PLIX: Play, Learn, Interact, eXplore: Seafloor: Sonar Boats

Video:



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