GOVERNMENT POLYTECHNIC JALGAON

Academic Year (2020-21)

Microwave And Radar (MAR)

(22535)

EJ5I

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

GOVERNMENT POLYTECHNIC, JALGAON
(0018/1567)

Program Name and Code : ELECTRONICS &TELICOMMUNICATION

Course Name And Code : Microwave And Radar (22535)

Academic Year : (2020-21)

Semester : Fifth.

A MICRO PROJECT

On

To study the SONAR RADAR and make the detail report.

Submitted on ___/___/2021 by the group of 4 students.

Sr. No.	Roll No.	Name of student	Enrollment No.	Seat no.
1	11	Prathamesh Saraf	1800180265	
2	23	Mohit Bhangale	1800180288	
3	24	Mandar Patil	1800180290	
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Certificate

This is to certify that Master Mr/Ms. **Prathamesh, Mandar, Mohish, Mohit** Roll No.**11, 23, 24, 25** Of **5th** Semester of Diploma in **E&TC.** Of Institute, **Government Polytechnic, Jalgaon (Code:0018/1567)** has completed the **Micro Project** satisfactorily in the **Subject** Microwave And Radar (22535) for the Academic Year 2020- 2021 as prescribed in the curriculum.

Place**: Jalgaon**

Enrollment No:- **1800180265,1800180288,1800180290,1800180291**

Date:-

Exam. Seat No:-

Subject Teacher **Head of the Department** **Principal**

Seal of Institution

TITLE

To study the SONAR RADAR and make the detail report.

Submitted by-:

1. Prathamesh Saraf (11)
2. Mohit Bhangale (23)
3. Mandar Patil (24)
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Under the guidance of:
M.R.Umbarkar Sir

Index

Title

TITLE

To Study the SONAR RARAR and the make detailed report.

1. **Rational**

   Microwave communication is the backbone of terrestrial communication and also the sole of mobile communication to provide communication at difficult geographical locations and for specific task microwave links and RADAR are the establish telecommunication solution this course has been designed to develop skills in the diploma engineering to maintain microwave and RADAR based telecommunication system

2. **Aims and Benefits of Micro Project**

   Aims : To study the SONAR RADAR

   Benefits of micro project :

   1) It is simple RADAR System
   2) It is fast in response
   3) Best for sea level navigation

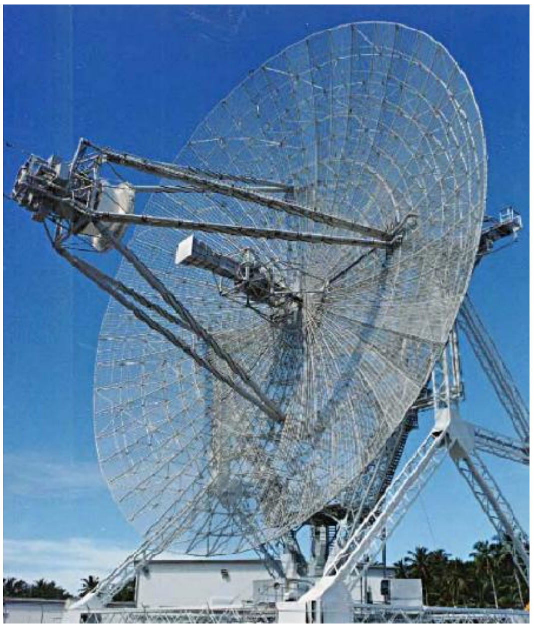
3. **Course outcomes (COs)**

   1) Interpret RADAR based system for range detection
   2) Maintain various types of RADAR system for the specified application

4. RADAR

Radar is a detection system that uses radio waves to determine the range, angle, or velocity of objects. It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain. A radar system consists of a transmitter producing electromagnetic waves in the radio or microwaves domain, a transmitting antenna, a receiving antenna (often the same antenna is used for transmitting and receiving) and a receiver and processor to determine properties of the object(s). Radio waves (pulsed or continuous) from the transmitter reflect off the object and return to the receiver, giving information about the object's location and speed.

Radar was developed secretly for military use by several nations in the period before and during World War II. A key development was the cavity magnetron in the United Kingdom, which allowed the creation of relatively small systems with sub-meter resolution. The term *RADAR* was coined in 1940 by the United States Navy as an acronym for "RAdio Detection And Ranging". The term *radar* has since entered English and other languages as a common noun, losing all capitalization. During RAF RADAR courses in 1954/5 at Yatesbury Training Camp "radio azimuth direction and ranging" was suggested. The modern uses of radar are highly diverse, including air and terrestrial traffic control, radar astronomy, air-defense systems, antimissile systems, marine radars to locate landmarks and other ships, aircraft anticollision systems, ocean surveillance systems, outer space surveillance and rendezvous systems, meteorological precipitation monitoring, altimetry and flight control systems, guided missile target locating systems, self-driving cars, and ground-penetrating radar for geological observations. High tech radar systems are associated with digital signal processing, machine learning and are capable of extracting useful information from very high noise levels.



RADAR system **What`s happen under the RADAR**

History of RADAR

As early as 1886, German physicist Heinrich Hertz showed that radio waves could be reflected from solid objects. In 1895, Alexander Popov, a physics instructor at the Imperial Russian

Navy school in Kronstadt, developed an apparatus using a coherer tube for detecting distant lightning strikes. The next year, he added a spark-gap transmitter. In 1897, while testing this equipment for communicating between two ships in the Baltic Sea, he took note of an interference beat caused by the passage of a third vessel. In his report, Popov wrote that this phenomenon might be used for detecting objects, but he did nothing more with this observation.

The German inventor Christian Hülsmeyer was the first to use radio waves to detect "the presence of distant metallic objects". In 1904, he demonstrated the feasibility of detecting a ship in dense fog, but not its distance from the transmitter. He obtained a patent for his detection device in April 1904 and later a patent for a related amendment for estimating the distance to the ship. He also obtained a British patent on September 23, 1904 for a full radar system, that he called a *telemobiloscope*. It operated on a 50 cm wavelength and the pulsed radar signal was created via a spark-gap. His system already used the classic antenna setup of horn antenna with parabolic reflector and was presented to German military officials in practical tests in Cologne and Rotterdam harbour but was rejected.

In 1915, Robert Watson-Watt used radio technology to provide advance warning to airmen and during the 1920s went on to lead the U.K. research establishment to make many advances using radio techniques, including the probing of the ionosphere and the detection of lightning at long distances. Through his lightning experiments, Watson-Watt became an expert on the use of radio direction finding before turning his inquiry to shortwave transmission. Requiring a suitable receiver for such studies, he told the "new boy" Arnold Frederic Wilkins to conduct an extensive review of available shortwave units. Wilkins would select a General Post Office model after noting its manual's description of a "fading" effect (the common term for interference at the time) when aircraft flew overhead.

5. Types Of RADAR

- CW Doppler RADAR
- Moving target indication (MTI) RADAR
- SONAR RADAR
- Ground Control Intercept (GCI) RADAR

6. SONAR RADAR

Sonar (sound navigation ranging) is a technique that uses sound propagation (usually underwater, as in submarine navigation) to navigate, communicate with or detect objects on or under the surface of the water, such as other vessels. Two types of technology share the name "sonar": passive sonar is essentially listening for the sound made by vessels; active sonar is emitting pulses of sounds and listening for echoes. Sonar may be used as a means of acoustic location and of measurement of the echo characteristics of "targets" in the water. Acoustic location in air was used before the introduction of radar. Sonar may also be used for robot navigation, and SONAR (an upward-looking in-air sonar) is used for atmospheric investigations. The term sonar is also used for the equipment used to generate and receive the sound. The acoustic frequencies used in sonar systems vary from very low (infrasonic) to extremely high (ultrasonic). The study of underwater sound is known as underwater acoustics or hydroacoustics.

The first recorded use of the technique was by Leonardo da Vinci in 1490 who used a tube inserted into the water to detect vessels by ear. It was developed during World War I to counter the growing threat of submarine warfare, with an operational passive SONAR system in use by 1918. Modern active sonar systems use an acoustic transducer to generate a sound wave which is reflected from target objects.

SONAR screen for ship and submarine **SONAR in World War 2**

7. History of SONAR RADAR

Although some animals (dolphins, bats, some shrews, and others) have used sound for communication and object detection for millions of years, use by humans in the water is initially recorded by Leonardo da Vinci in 1490: a tube inserted into the water was said to be used to detect vessels by placing an ear to the tube.

In the late 19th century an underwater bell was used as an ancillary to lighthouses or lightships to provide warning of hazards.

The use of sound to "echo-locate" underwater in the same way as bats use sound for aerial navigation seems to have been prompted by the Titanic disaster of 1912. The world's first patent for an underwater echo-ranging device was filed at the British Patent Office by English meteorologist Lewis Fry Richardson a month after the sinking of Titanic, and a German physicist Alexander Behm obtained a patent for an echo sounder in 1913.

The Canadian engineer Reginald Fessenden, while working for the Submarine Signal Company in Boston, Massachusetts, built an experimental system beginning in 1912, a system later tested in Boston Harbor, and finally in 1914 from the U.S. Revenue Cutter Miami on the Grand Banks off Newfoundland. In that test, Fessenden demonstrated depth sounding, underwater communications (Morse code) and echo ranging (detecting an iceberg at a 2-mile, 3.2 km range). The "Fessenden oscillator", operated at about 500 Hz frequency, was unable to determine the bearing of the iceberg due to the 3-metre wavelength and the small dimension of the transducer's radiating face (less than ⅓ wavelength in diameter). The ten Montreal-built British H-class submarines launched in 1915 were equipped with Fessenden oscillators.

During World War I the need to detect submarines prompted more research into the use of sound. The British made early use of underwater listening devices called hydrophones, while the French physicist Paul Langevin, working with a Russian immigrant electrical engineer Constantin Chilowsky, worked on the development of active sound devices for detecting submarines in 1915. Although piezoelectric and magnetostrictive transducers later superseded the electrostatic transducers they used, this work influenced future designs.

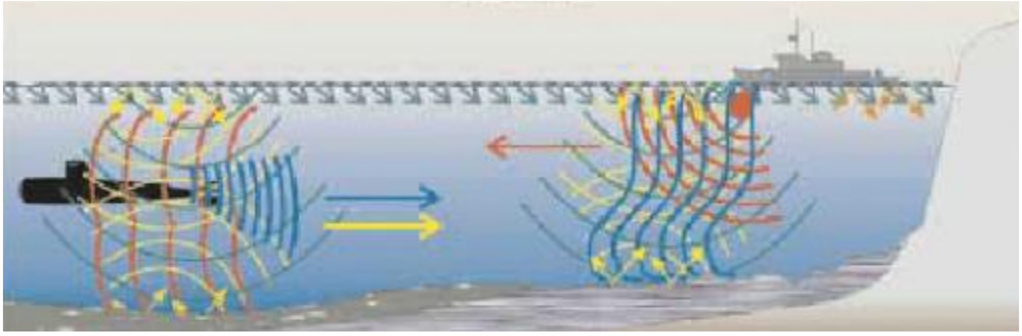
8. Types of SONAR RADAR

- Active SONAR RADAR
- Passive SONAR RADAR

Active SONAR RADAR

Active sonar uses a sound transmitter (or projector) and a receiver. When the two are in the same place it is monostatic operation. When the transmitter and receiver are separated it is bistatic operation. When more transmitters (or more receivers) are used, again spatially separated, it is multistatic operation. Most sonars are used monostatically with the same array often being used for transmission and reception. Active sonobuoy fields may be operated multistatically.Active sonar creates a pulse of sound, often called a "ping", and then listens for reflections (echo) of the pulse. This pulse of sound is generally created electronically using a sonar projector consisting of a signal generator, power amplifier and electro-acoustic transducer/array.

A transducer is a device that can transmit and receive acoustic signals ("pings"). A beamformer is usually employed to concentrate the acoustic power into a beam, which may be swept to cover the required search angles. Generally, the electro-acoustic transducers are of the Tonpilz type and their design may be optimised to achieve maximum efficiency over the widest bandwidth, in order to optimise performance of the overall system. Occasionally, the acoustic pulse may be created by other means, e.g. chemically using explosives, airguns or plasma sound sources. When active sonar is used to measure the distance from the transducer to the bottom, it is known as echo sounding. Similar methods may be used looking upward for wave measurement.



Principal of Active SONAR RADAR

Performance prediction

In noise-limited conditions at initial detection:

SL − 2PL + TS − (NL − AG) = DT,

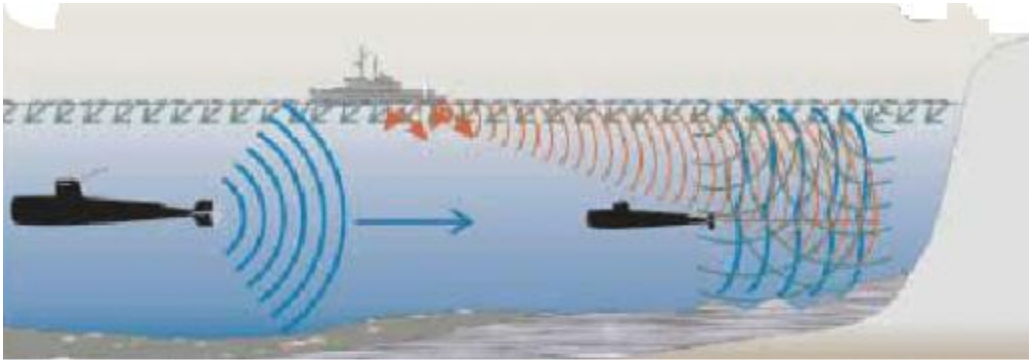
In reverberation-limited conditions at initial detection (neglecting array gain):

SL − 2PL + TS = RL + DT,

Passive SONAR RADAR

Passive sonar listens without transmitting. It is often employed in military settings, although it is also used in science applications, *e.g.*, detecting fish for presence/absence studies in various aquatic environments – see also passive acoustics and passive radar. In the very broadest usage, this term can encompass virtually any analytical technique involving remotely generated sound, though it is usually restricted to techniques applied in an aquatic environment.

Passive sonar has a wide variety of techniques for identifying the source of a detected sound. For example, U.S. vessels usually operate 60 Hz alternating current power systems. If transformers or generators are mounted without proper vibration insulation from the hull or become flooded, the 60 Hz sound from the windings can be emitted from the submarine or ship. This can help to identify its nationality, as all European submarines and nearly every other nation's submarine have 50 Hz power systems. Intermittent sound sources (such as a wrench being dropped), called "transients," may also be detectable to passive sonar. Until fairly recently, an experienced, trained operator identified signals, but now computers may do this.



Principal of passive SONAR RADAR

Noise limitations

Passive sonar on vehicles is usually severely limited because of noise generated by the vehicle. For this reason, many submarines operate nuclear reactors that can be cooled without pumps, using silent convection, or fuel cells or batteries, which can also run silently. Vehicles' propellers are also designed and precisely machined to emit minimal noise. High-speed propellers often create tiny bubbles in the water, and this cavitation has a distinct sound. The sonar hydrophones may be towed behind the ship or submarine in order to reduce the effect of noise generated by the watercraft itself. Towed units also combat the thermocline, as the unit may be towed above or below the thermocline.

Performance prediction

Unlike active sonar, only one-way propagation is involved. Because of the different signal processing used, the minimal detectable signal-to-noise ratio will be different. The equation for determining the performance of a passive sonar is

$SL - PL = NL - AG + DT$,

Where SL is the source level, PL is the propagation loss, NL is the noise level, AG is the array gain and DT is the detection threshold. The figure of merit of a passive sonar is

$FOM = SL + AG - (NL + DT)$

9. **Performance factors**

The detection, classification and localisation performance of a sonar depends on the environment and the receiving equipment, as well as the transmitting equipment in an active sonar or the target radiated noise in a passive sonar.

Sound propagation

Sonar operation is affected by variations in sound speed, particularly in the vertical plane. Sound travels more slowly in fresh water than in sea water, though the difference is small. The speed is determined by the water's bulk modulus and mass density. The bulk modulus is affected by temperature, dissolved impurities (usually salinity), and pressure. The density effect is small. The speed of sound (in feet per second) is approximately:

4388 + (11.25 × temperature (in °F)) + (0.0182 × depth (in feet)) + salinity (in parts-per-thousand).

This empirically derived approximation equation is reasonably accurate for normal temperatures, concentrations of salinity and the range of most ocean depths. Ocean temperature varies with depth, but at between 30 and 100 meters there is often a marked change, called the thermocline, dividing the warmer surface water from the cold, still waters that make up the rest of the ocean. This can frustrate sonar, because a sound originating on one side of the thermocline tends to be bent, or refracted, through the thermocline. The thermocline may be present in shallower coastal waters. However, wave action will often mix the water column and eliminate the thermocline. Water pressure also affects sound propagation: higher pressure increases the sound speed, which causes the sound waves to refract away from the area of higher sound speed. The mathematical model of refraction is called Snell's law. If the sound source is deep and the conditions are right, propagation may occur in the 'deep sound channel'. This provides extremely low propagation loss to a receiver in the channel. This is because of sound trapping in the channel with no losses at the boundaries. Similar propagation can occur in the 'surface duct' under suitable conditions. However, in this case there are reflection losses at the surface.

Scattering

When active sonar is used, scattering occurs from small objects in the sea as well as from the bottom and surface. This can be a major source of interference. This acoustic scattering is analogous to the scattering of the light from a car's headlights in fog: a high-intensity pencil beam will penetrate the fog to some extent, but broader-beam headlights emit much light in unwanted directions, much of which is scattered back to the observer, overwhelming that reflected from the target ("white-out"). For analogous reasons active sonar needs to transmit in a narrow beam to minimize scattering. The scattering of sonar from objects (mines, pipelines, zooplankton, geological features, fish etc.) is how active sonar detects them, but this ability can be masked by strong scattering from false targets, or 'clutter'. Where they occur (under breaking waves. in ship wakes; in gas emitted from seabed seeps and leaks etc.), gas bubbles are powerful sources of clutter, and can readily hide targets. TWIPS (Twin Inverted Pulse Sonar) is currently the only sonar that can overcome this clutter problem. Comparison of Standard Sonar and TWIPS in finding a target in bubbly water. Adapted from ref. This is important as many recent conflicts have occurred in coastal waters, and the inability to detect whether mines are present or not present hazards and delays to military vessels, and also to aid convoys and merchant shipping trying to support the region long after the conflict has ceased.

Target characteristics

The sound reflection characteristics of the target of an active sonar, such as a submarine, are known as its target strength. A complication is that echoes are also obtained from other objects in the sea such as whales, wakes, schools of fish and rocks.Passive sonar detects the target's radiated noise characteristics. The radiated spectrum comprises a continuous spectrum of noise with peaks at certain frequencies which can be used for classification.

Countermeasures

Active (powered) countermeasures may be launched by a submarine under attack to raise the noise level, provide a large false target, and obscure the signature of the submarine itself.

Passive (i.e., non-powered) countermeasures include:

- Mounting noise-generating devices on isolating devices.
- Sound-absorbent coatings on the hulls of submarines, for example anechoic tiles.

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10. Applications of SONAR RADAR

There are three types of Applications

- Military Applications
- Civilian Applications
- Scientific Applications

Military Applications

Modern naval warfare makes extensive use of both passive and active sonar from water-borne vessels, aircraft and fixed installations. Although active sonar was used by surface craft in World War II, submarines avoided the use of active sonar due to the potential for revealing their presence and position to enemy forces. However, the advent of modern signal-processing enabled the use of passive sonar as a primary means for search and detection operations. In 1987 a division of Japanese company Toshiba reportedly sold machinery to the Soviet Union that allowed their submarine propeller blades to be milled so that they became radically quieter, making the newer generation of submarines more difficult to detect.

The use of active sonar by a submarine to determine bearing is extremely rare and will not necessarily give high quality bearing or range information to the submarines fire control team. However, use of active sonar on surface ships is very common and is used by submarines when the tactical situation dictates it is more important to determine the position of a hostile submarine than conceal their own position. With surface ships, it might be assumed that the threat is already tracking the ship with satellite data as any vessel around the emitting sonar will detect the emission. Having heard the signal, it is easy to identify the sonar equipment used (usually with its frequency) and its position (with the sound wave's energy). Active sonar is similar to radar in that, while it allows detection of targets at a certain range, it also enables the emitter to be detected at a far greater range, which is undesirable.

Anti-submarine warfare

Until recently, ship sonars were usually with hull mounted arrays, either amidships or at the bow. It was soon found after their initial use that a means of reducing flow noise was required. The first were made of canvas on a framework, then steel ones were used. Now domes are usually made of reinforced plastic or pressurized rubber. Such sonars are primarily active in operation. An example of a conventional hull mounted sonar is the SQS-56. Because of the problems of ship noise, towed sonars are also used. These also have the advantage of being able to be placed deeper in the water. However, there are limitations on their use in shallow water. These are called towed arrays (linear) or variable depth sonars (VDS) with 2/3D arrays. A problem is that the winches required to deploy/recover these are large and expensive. VDS sets are primarily active in operation while towed arrays are passive.

An example of a modern active-passive ship towed sonar is Sonar 2087 made by Thales Underwater Systems.

Torpedoes

Modern torpedoes are generally fitted with an active/passive sonar. This may be used to home directly on the target, but wake homing torpedoes are also used. An early example of an acoustic homer was the Mark 37 torpedo.

Torpedo countermeasures can be towed or free. An early example was the German Sieglinde device while the Bold was a chemical device. A widely used US device was the towed AN/SLQ-25 Nixie while the mobile submarine simulator (MOSS) was a free device.

A modern alternative to the Nixie system is the UK Royal Navy S2170 Surface Ship Torpedo Defence system.

Mines

Mines may be fitted with a sonar to detect, localize and recognize the required target. An example is the CAPTOR mine.

Mine countermeasures

Mine countermeasure (MCM) sonar, sometimes called "mine and obstacle avoidance sonar (MOAS)", is a specialized type of sonar used for detecting small objects. Most MCM sonars are hull mounted but a few types are VDS design. An example of a hull mounted MCM sonar is the Type 2193 while the SQQ-32 mine-hunting sonar and Type 2093 systems are VDS designs.

Submarine navigation

Submarines rely on sonar to a greater extent than surface ships as they cannot use radar at depth. The sonar arrays may be hull mounted or towed. Information fitted on typical fits is given in Oyashio-class submarine and Swiftsure-class submarine.

Aircraft

Helicopters can be used for antisubmarine warfare by deploying fields of active-passive sonobuoys or can operate dipping sonar, such as the AQS-13. Fixed wing aircraft can also deploy sonobuoys and have greater endurance and capacity to deploy them. Processing from the sonobuoys or dipping sonar can be on the aircraft or on ship. Dipping sonar has the advantage of being deployable to depths appropriate to daily conditions. Helicopters have also been used for mine countermeasure missions using towed sonars such as the AQS-20A.

Underwater communications

Dedicated sonars can be fitted to ships and submarines for underwater communication.

Civilian Applications

Fisheries

Fishing is an important industry that is seeing growing demand, but world catch tonnage is falling as a result of serious resource problems. The industry faces a future of continuing worldwide consolidation until a point of sustainability can be reached. However, the consolidation of the fishing fleets are driving increased demands for sophisticated fish finding electronics such as sensors, sounders and sonars. Historically, fishermen have used many different techniques to find and harvest fish. However, acoustic technology has been one of the most important driving forces behind the development of the modern commercial fisheries.

Sound waves travel differently through fish than through water because a fish's air-filled swim bladder has a different density than seawater. This density difference allows the detection of schools of fish by using reflected sound. Acoustic technology is especially well suited for underwater applications since sound travels farther and faster underwater than in air. Today, commercial fishing vessels rely almost completely on acoustic sonar and sounders to detect fish. Fishermen also use active sonar and echo sounder technology to determine water depth, bottom contour, and bottom composition.

Echo sounding

Echo sounding is a process used to determine the depth of water beneath ships and boats. A type of active sonar, echo sounding is the transmission of an acoustic pulse directly downwards to the seabed, measuring the time between transmission and echo return, after having hit the bottom and bouncing back to its ship of origin. The acoustic pulse is emitted by a transducer which receives the return echo as well. The depth measurement is calculated by multiplying the speed of sound in water(averaging 1,500 meters per second) by the time between emission and echo return.

The value of underwater acoustics to the fishing industry has led to the development of other acoustic instruments that operate in a similar fashion to echo-sounders but, because their function is slightly different from the initial model of the echo-sounder, have been given different terms.

Net location

The net sounder is an echo sounder with a transducer mounted on the headline of the net rather than on the bottom of the vessel. Nevertheless, to accommodate the distance from the transducer to the display unit, which is much greater than in a normal echo-sounder, several refinements have to be made. Two main types are available. The first is the cable type in which the signals are sent along a cable. In this case there has to be the provision of a cable drum on which to haul, shoot and stow the cable during the different phases of the operation. The second type is the cable-less net-sounder – such as Marport's Trawl Explorer – in which the signals are sent acoustically between the net and hull mounted receiver-hydrophone on the vessel. In this case no cable drum is required but sophisticated electronics are needed at the transducer and receiver.

Modern versions of the net sounder, using multiple element transducers, function more like a sonar than an echo sounder and show slices of the area in front of the net and not merely the vertical view that the initial net sounders used.The sonar is an echo-sounder with a directional capability that can show fish or other objects around the vessel.

ROV and UUV

Small sonars have been fitted to remotely operated vehicles (ROVs) and unmanned underwater vehicles (UUVs) to allow their operation in murky conditions. These sonars are used for looking ahead of the vehicle. The Long-Term Mine Reconnaissance System is a UUV for MCM purposes.

Vehicle location

Sonars which act as beacons are fitted to aircraft to allow their location in the event of a crash in the sea. Short and long baseline sonars may be used for caring out the location, such as LBL.

Prosthesis for the visually impaired

In 2013 an inventor in the United States unveiled a "spider-sense" bodysuit, equipped with ultrasonic sensors and haptic feedback systems, which alerts the wearer of incoming threats; allowing them to respond to attackers even when blindfolded.

Scientific Applications

Biomass estimation

Detection of fish, and other marine and aquatic life, and estimation their individual sizes or total biomass using active sonar techniques. As the sound pulse travels through water it encounters objects that are of different density or acoustic characteristics than the surrounding medium, such as fish, that reflect sound back toward the sound source. These echoes provide information on fish size, location, abundance and behavior. Data is usually processed and analysed using a variety of software such as *Echoview*.

Wave measurement

An upward looking echo sounder mounted on the bottom or on a platform may be used to make measurements of wave height and period. From this statistics of the surface conditions at a location can be derived.

Bottom type assessment

Sonars have been developed that can be used to characterise the sea bottom into, for example, mud, sand, and gravel. Relatively simple sonars such as echo sounders can be promoted to seafloor classification systems via add-on modules, converting echo parameters into sediment type. Different algorithms exist, but they are all based on changes in the energy or shape of the reflected sounder pings. Advanced substrate classification analysis can be achieved using calibrated (scientific) echosounders and parametric or fuzzy-logic analysis of the acoustic data.

Bathymetric mapping

Side-scan sonars can be used to derive maps of seafloor topography (bathymetry) by moving the sonar across it just above the bottom. Low frequency sonars such as GLORIA have been used for continental shelf wide surveys while high frequency sonars are used for more detailed surveys of smaller areas.

Sub-bottom profiling

Powerful low frequency echo-sounders have been developed for providing profiles of the upper layers of the ocean bottom.

Gas leak detection from the seabed

Gas bubbles can leak from the seabed, or close to it, from multiple sources. These can be detected by both passive and active sonar (shown in schematic figure by yellow and red systems respectively).Active (red) and passive (yellow) sonar detection of bubbles from seabed (natural seeps and CCSF leaks) and gas pipelines, taken from ref.

Natural seeps of methane and carbon dioxide occur. Gas pipelines can leak, and it is important to be able to detect whether leakage occurs from Carbon Capture and Storage Facilities (CCSFs; e.g. depleted oil wells into which extracted atmospheric carbon is stored). Quantification of the amount of gas leaking is difficult, and although estimates can be made use active and passive sonar, it is important to question their accuracy because of the assumptions inherent in making such estimations from sonar data

Synthetic aperture sonar

Various synthetic aperture sonars have been built in the laboratory and some have entered use in mine-hunting and search systems. An explanation of their operation is given in synthetic aperture sonar.

Parametric sonar

Parametric sources use the non-linearity of water to generate the difference frequency between two high frequencies. A virtual end-fire array is formed. Such a projector has advantages of broad bandwidth, narrow beamwidth, and when fully developed and carefully measured it has no obvious sidelobes: see Parametric array. Its major disadvantage is very low efficiency of only a few percent. P.J. Westervelt summarizes the trends involved.

Sonar in extraterrestrial contexts

Use of both passive and active sonar has been proposed for various extraterrestrial uses,.An example of the use of active sonar is in determining the depth of hydrocarbon seas on Titan, An example of the use of passive sonar is in the detection of methanefalls on Titan,

It has been noted that those proposals which suggest use of sonar without taking proper account of the difference between the Earthly (atmosphere, ocean, mineral) environments and the extraterrestrial ones, can lead to erroneous values.

11. Effect of SONAR RADAR on marine life

Effect on marine mammals

Research has shown that use of active sonar can lead to mass strandings of marine mammals.Beaked whales, the most common casualty of the strandings, have been shown to be highly sensitive to mid-frequency active sonar.Other marine mammals such as the blue whale also flee away from the source of the sonar, while naval activity was suggested to be the most probable cause of a mass stranding of dolphins The US Navy, which part-funded some of the studies, said that the findings only showed behavioural responses to sonar, not actual harm, but they "will evaluate the effectiveness of [their] marine mammal protective measures in light of new research findings". A 2008 US Supreme Court ruling on the use of sonar by the US Navy noted that there had been no cases where sonar had been conclusively shown to have harmed or killed a marine mammal.

Some marine animals, such as whales and dolphins, use echolocation systems, sometimes called *biosonar* to locate predators and prey. Research on the effects of sonar on blue whales in the Southern California Bight shows that mid-frequency sonar use disrupts the whales' feeding behavior. This indicates that sonar-induced disruption of feeding and displacement from high-quality prey patches could have significant and previously undocumented impacts on baleen whale foraging ecology, individual fitness and population health.

A review of evidence on the mass strandings of beaked whale linked to naval exercises where sonar was used was published in 2019. It concluded that the effects of mid-frequency active sonar are strongest on Cuvier's beaked whales but vary among individuals or populations. The review suggested the strength of response of individual animals may depend on whether they had prior exposure to sonar, and that symptoms of decompression sickness have been found in stranded whales that may be a result of such response to sonar. It noted that in the Canary Islands where multiple strandings had been previously reported, no more mass strandings had occurred once naval exercises during which sonar was used were banned in the area, and recommended that the ban be extended to other areas where mass strandings continue to occur.

Effect on fish

High-intensity sonar sounds can create a small temporary shift in the hearing threshold of some fishes.

12. **Frequencies and resolutions**

The frequencies of sonars range from infrasonic to above a megahertz. Generally, the lower frequencies have longer range, while the higher frequencies offer better resolution, and smaller size for a given directionality. To achieve reasonable directionality, frequencies below 1 kHz generally require large size, usually achieved as towed arrays.

Low frequency sonars are loosely defined as 1–5 kHz, albeit some navies regard 5–7 kHz also as low frequency. Medium frequency is defined as 5–15 kHz. Another style of division considers low frequency to be under 1 kHz, and medium frequency at between 1–10 kHz.

American World War II era sonars operated at a relatively high frequency of 20–30 kHz, to achieve directionality with reasonably small transducers, with typical maximum operational range of 2500 yd. Postwar sonars used lower frequencies to achieve longer range; e.g. SQS-4 operated at 10 kHz with range up to 5000 yd. SQS-26 and SQS-53 operated at 3 kHz with range up to 20,000 yd; their domes had size of approx. a 60-ft personnel boat, an upper size limit for conventional hull sonars. Achieving larger sizes by conformal sonar array spread over the hull has not been effective so far, for lower frequencies linear or towed arrays are therefore used.

Japanese WW2 sonars operated at a range of frequencies. The Type 91, with 30 inch quartz projector, worked at 9 kHz. The Type 93, with smaller quartz projectors, operated at 17.5 kHz (model 5 at 16 or 19 kHz magnetostrictive) at powers between 1.7 and 2.5 kilowatts, with range of up to 6 km. The later Type 3, with German-design magnetostrictive transducers, operated at 13, 14.5, 16, or 20 kHz (by model), using twin transducers (except model 1 which had three single ones), at 0.2 to 2.5 kilowatts. The simple type used 14.5 kHz magnetostrictive transducers at 0.25 kW, driven by capacitive discharge instead of oscillators, with range up to 2.5 km.The sonar's resolution is angular; objects further apart are imaged with lower resolutions than nearby ones.

Another source lists ranges and resolutions vs frequencies for sidescan sonars. 30 kHz provides low resolution with range of 1000–6000 m, 100 kHz gives medium resolution at 500–1000 m, 300 kHz gives high resolution at 150–500 m, and 600 kHz gives high resolution at 75–150 m. Longer range sonars are more adversely affected by nonhomogenities of water. Some environments, typically shallow waters near the coasts, have complicated terrain with many features; higher frequencies become necessary there.

13.Benefits or advantages of SONAR RADAR

Following are the benefits or advantages of SONAR:

➡It is the only system used to find & identify objects in the water effectively. It is also used to determine depth of water.

➡It is used for various water based activities. This is due to the fact that sound waves used by SONAR do not attenuate much in the sea water scompare to radar waves and light waves.

➡It is very accurate system.

➡It is not too expensive.

14.Drawbacks or disadvantages of SONAR

Following are the drawbacks or disadvantages of SONAR:

➡The waves emitted by SONAR interfere with whales, dolphines, seals, turtles, sea lions etc. Hence it threatens marine life.

➡SONAR system generates lot of noise which depend on sound levels generated by SONAR.

➡The acoustic waves used in SONAR are affected by sound velocity variations over depth. This causes refraction of acoustic energy. Moreover ocean acts as lossy medium for acoustic waves. This requires use of high level sound waves to compensate for the losses which results into threat for humans (e.g. well divers and military) and sea animals.