MARITIME RESEARCH CENTER
FOUNDATION FOR UNDERWATER DOMAIN AWARENESS

Research Note

Underwater Search And Recovery & its present level of technology

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The Indian Ocean Region (IOR) is becoming the center of intense global attention for various reasons. It contains two thirds of the world's proven oil reserves, one third of the world's natural gas, 90% of the world's diamonds, 60% of the world's uranium and 40% of the world's gold, making it potentially the single largest area of exploitable wealth in the world[2]. Its waterways account for transportation of the highest tonnage of goods globally-one-half the world's crude oil container shipment and one third of the bulk cargo[3]. All this results in massive maritime build-up. This increase in maritime build-up, exposes us to vulnerabilities related to accidents and losses at sea. Underwater Search and Recovery (UWSAR), is becoming critical, thus effective & efficient capability and capacity building is inescapable.

No environment is more dangerous and extreme than the deep ocean/sea. Intense cold, tremendous pressures and the total absence of light combine to make the deep sea the most difficult region for mankind. Hence for effective and efficient capability and capacity building in the UWSAR domain technology plays a very important role. The entire process of UWSAR has multiple dimensions and the sequence of steps to be taken, needs to be understood.

Underwater search and recovery refers to the search, recovery, and salvage of objects with high value (e.g., aircraft black boxes, underwater vehicles, and crashed vehicles) that are lost on the seabed. In the search step, the underwater position of the salvage object needs to be accurately obtained as a prerequisite for underwater recovery. Depending on whether the salvage object carries acoustic beacons, the underwater search can be divided into two types: onboard acoustic signal search and near bottom sweep search and search. Once the underwater position of the salvage object is accurately known, it can be recovered and salvaged with a deep-sea recovery system in the recovery step.

Domains

1. Positioning

The process of location of the distressed vehicle can be done by the use of different technology depending on the type of the distressed object. Currently available underwater acoustic positioning systems can be divided into four classes: Long Baseline (LBL), Short Baseline (SBL), Ultra-Short Baseline (USBL) (also called Super-Short Baseline (SSBL)), and Combined Systems.[5]

An obvious advantage of conducting underwater searches for aircraft black boxes is that such objects are equipped with underwater positioning beacons, whose acoustic signals can be picked up by the shipboard acoustic positioning system. Various technologies that can be deployed to trace the last known location of the Aircraft can include Global Navigation Satellite System(GNSS) and tracing with the help of conventional radar systems. In the past, primary radar was used but now a more advanced Secondary Surveillance Radar (SSR) is in use.[6]

The predominant technology that can be deployed to trace the last known location of a non - military submersible is the use of Automatic Identification System (AIS) data.

2. Sensing

A shipboard sonar system can be used to search for the signals of underwater objects carrying acoustic beams. Once an aircraft black box enters the water, the water-sensitive switch on the carrying beacon activates the beacon to transmit a sound wave frequency of 37.5 kHz to the surrounding seawater through a metal shell. The sound source level is about 160 dB, the theoretical maximum action distance is 4000–6000 m, and the beacon can last for 30 days. Specialized search and recovery vessels are usually equipped with sonar systems capable of locating 37.5 kHz acoustic beacons.[1]

Side-scan sonar is a very efficient technique for getting acoustic images of sea bed. Side-scan sonar on an underwater vehicle can reach a distance of tens of meters from the sea bottom. At low speeds, high quality side-scan sonar images can be obtained, and even pipelines a dozen centimeters wide can be distinguished. Bathymetric side-scan sonar combines the side-sweep and multi-beam sounding technologies for synchronous measurement of the seafloor topography.(Sun et al., 2005)

3. Recovery / salvage

The existing deep-sea recovery and salvage system mainly depends on operational ROVs and HOVs. Remotely operated underwater vehicles (ROVs) and human-occupied vehicles (HOVs) have played an important role in accident recovery and salvage with significant social influence. A deep-sea ROV/HOV is used to hook the rope at the bottom. If the weight of the debris is not very large, a mechanical device like a television grab can be specifically designed to salvage it. If the salvage object is too heavy, then ropes or steel cables are required. In this case, the deepsea ROV/HOV mainly performs work such as traction and hooking. If an object weighing several tons needs to be recovered, then composite buoyant fiber ropes may be needed.[1]

Problems / challenges

a) Underwater positioning systems are subject to constraints imposed by the unique underwater environment. As a result, many of the common techniques used in land and space based positioning systems cannot be directly applied, including optical, radio frequency (RF) and inertial systems[5]. The fact that electromagnetic signals do not penetrate below the sea surface makes the GPS unsuitable for underwater positioning. Hence, an alternate solution is required.

b) Although a shipborne deep-sea multibeam sounding system can detect a wide range of deep seabed terrains, its detection accuracy is limited, and it cannot search for small objects on the seafloor.[7]

c) When underwater vehicles are lost at depths of several kilometers and even more than 10 km, there is usually a lack of corresponding recovery equipment.

d) In submarines there is a lack or failure of a positioning beacon, the exact position of the salvage object is unknown.

e) If the buoyancy material of the underwater vehicle has imploded and causes the entire buoyancy material system to fail, the gravity of the entire system of the underwater vehicle is much greater than the buoyancy. However, an operational ROV/HOV can provide a buoyancy load of around 200 kg, so using a deep-sea ROV/HOV to directly salvage underwater vehicles is not possible.[1]

f) If the beacon battery is dead, the beacon fails due to implosion, or the capabilities of USBL are exceeded, then this acoustic positioning method will also fail.

g) Gravity maps have low accuracy and cannot meet the needs of deep-sea search and recovery. Because of the vastness of oceans, shipborne deep-sea multi-beam measurement requires much time and money.[1]

h) The detection results need to wait until the AUV is recovered to the deck and the data are post-processed. In addition, because the AUV is battery-powered, its underwater operating time is limited.

i) Even when the location of the object has been obtained in advance, the deep-sea navigation accuracy is limited, and the underwater visible range is only 5–8 m. Thus, the operational ROV/HOV may take a long time to find the salvage object.[8]

Future scope

a) Satellite communication **-** ADS-B technology

The flights will be tracked using an industry-wide standard known as "automatic dependent surveillance – broadcast" or ADS-B. Automatic Dependent Surveillance-Broadcast (ADS-B) is a surveillance system placed in aircraft that periodically transmits state vector estimates and other information to air traffic control centers and other nearby aircraft (and may also receive traffic and weather information from various entities)[4].

b) If the weight of the wreck to be salvaged is very high, a neutral-buoyancy composite fiber rope may be needed. The breaking force of the rope is determined according to the weight of the salvage object, and the corresponding rope diameter is selected.[1]

c) If a 3D real-time imaging sonar is installed on the ROV/HOV, the search time can be greatly reduced.[1]

d) TV-grab is a visual grab sampler that combines the continuous observation of seabed images with a grab sampler (Zhang et al., 2005; Geng et al., 2009; Cheng et al., 2011)

e) Positioning system **-** U-GPS Technology

Acoustic techniques are well suited to the underwater environment, and can be used in combination with many standard positioning methodologies and algorithms such as those used in the Global Positioning System (GPS)[5].

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