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Technical-economic potential of a side-scan sonar

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Abstract
This paper presents technical-economic potential of a side-scan sonar. The side-scan sonar is used in many fields: research, topology, military, archaeology, offshore, etc. A side-scan sonar is an underwater device. This device is used in oceans, seas, lakes, etc. This article aims to study the side-scan sonar used only in the sea, in order to identify the shape of the seafloor. That is why in recent years, sales for side-scan sonar have increased. These devices are used especially in the Black Sea. One important thing is that side-scan sonars can be used in the Black Sea both, in summer and winter season, as well.

Keywords: Sonar, Vessel, Flowchart, Seafloor, Pipeline, Diagram

1. Introduction

The sonar (Sound Navigation and Ranging) is a device that uses propagation of sound waves in the underwater environment. Besides that, the main role of a sonar is to explore and map the sea.
In practice there are two types of sonar:

- Active sonars – emit an acustic signal or pulse of sound into the sea.
- Passive sonars – detect noise from marine object (ships, submarine, mine, etc.) and marine species (fish, whales, sharks, etc.).

Side-scan sonar is a type of active sonar use for detecting and imaging objects (targets) on the seafloor, [1].
The characteristics of a side-scan sonar used at the sea:

- Actual frequency..... 300/600 kHz;
- Max. range.....50 m;
- Max. length of cable..... 600 m;
- Max. depth rating..... 200 m;
- Horizontal beam width.....0.2^0;
- Vertical beam width.....50^0;
- Max. operating speed.....12 kn;
- Max. horizontal resolution..... $2 \cdot 10^{-2}$ m.

In this paper, we designed a side-scan sonar model in NX software from Siemens, as shown in Fig 1 below.

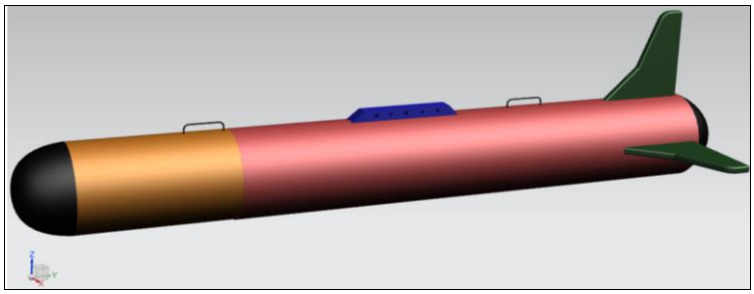

Fig 1: Side-scan sonar model

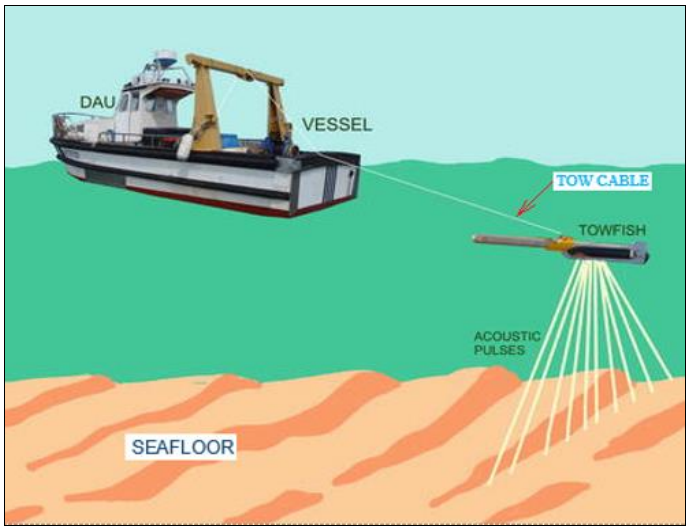

Fig 2: Vessel, tow cable and sonar towfish

The side-scan sonar travels through the sea with the help of a vessel with a tow cable, as shown in Fig 2 above.

For the study of a seafloor surface, the ship must tow a side-scan sonar using a tow cable.
The side-scan sonar in the sea transmits and receives acoustic pulses. This is done by transducers mounted on each side of the towfish. The types of vessels that carry side-scan sonar are: offshore vessel, research vessel, military ships, fishing vessel, etc. [2]

2. Efficiency of a side-scan sonar

Vessels transports side-scan sonars to areas where certain objects have to be placed (submarine pipeline, mine, habitats of marine animals, etc.). After that, the side-scan sonar is launched from the ship into the sea. Usually ALARS (Autonomous Launch and Recovery System) is used to launch the device, [3].
In fact, the ALARS system can be mounted/dismounted from a ship. The system for tracking side-scan sonar into the sea consists of the following devices: PC computer, printer, AC power supply, through-hull launcher, deck-monted launcher, hand-held launcher, tow cable and side-scan sonar, [4].
The side-scan sonar actually works at a certain height from the seafloor. Moreover, this device must get real time accurate information about the seabed as prior knowledge, otherwise it will produce false ground or lose the target (object). This will ultimately reduce the quality of the bathymetric image.

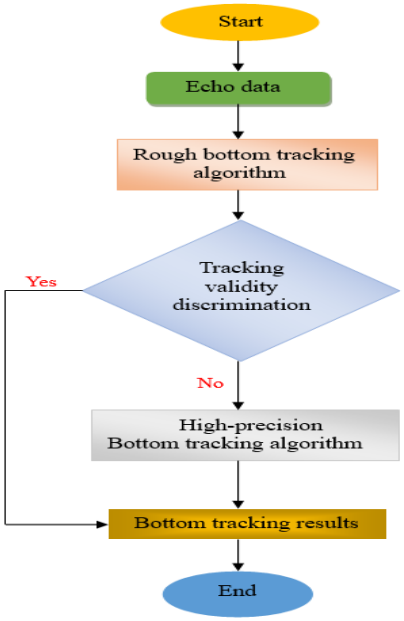

Fig 3: Real-time workflow diagram of side-scan sonar

Adapted method tracking the seafloor in real time with side-scan sonar, is shown in Fig 3 above.
Unfortunately, real-time seafloor extraction methods are limited by the following: transmission pulse, seafloor type and sea surface interference.

Case studies for side-scan sonar

a) Subsea pipeline

Subsea pipeline it is a special pipe that is placed on the bottom of the sea or under it, inside of a ditch, [6].
The main types of subsea pipeline are for oil, gas, water, etc.

Submarine pipelines are subjected to external and internal pressures. External pressures are higher than internal ones. Thus, external pressures can over time create cracks in the body of pipelines. That is why the pipeline must be checked periodically with the help of side-scan sonar.

In the case of the most numerous oil pipelines, offshore type ship transport side-scan sonar in the area of submarine pipeline is mounted. After this, side-scan sonar is launched from the offshore vessel into the sea.

All information obtained from the side-scan sonar is transmitted to a PC (personal calculator). Thereby, this information is stored in a database, [5].

In offshore, there are two special stages for the study of a submarine pipeline resistance, as shown in Fig 4 below.

1. Offshore vessel → side-scan sonar → subsea pipeline.
2. Offshore vessel→ PC computer → database.

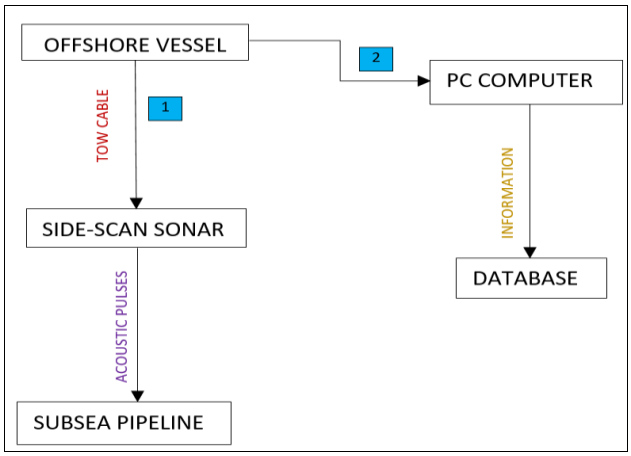

Fig 4: Flowchart of first study

b) Maritime archaeology

The information transmitted from the side-scan sonar helps the diving team. Because, the diving team can safely study a wreck on the seafloor, as shown in Fig 5 below.

In archaeology there are three special stages for the study of a shipwreck, [6].

1) Research vessel → side-scan sonar → shipwreck.
2) Research vessel→ PC computer → database.
3) Research vessel→ diving team → shipwreck.

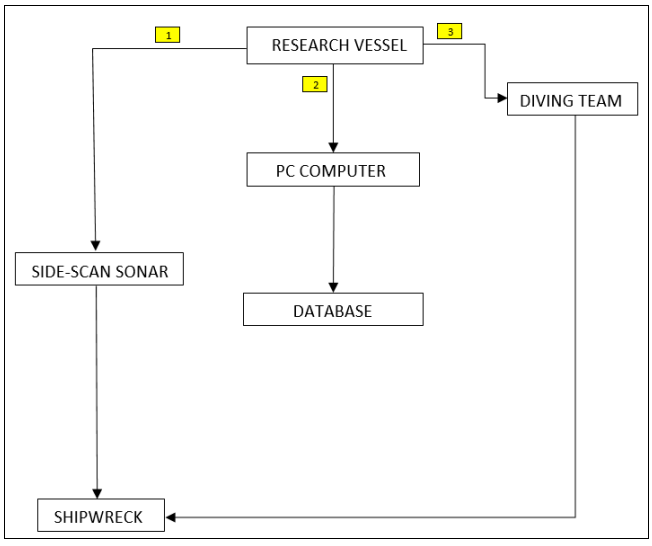

Fig 5: Flowchart of second study

This second study of paper shows a shipwreck located by the side-scan sonar, as it is shown in Fig 6 below.

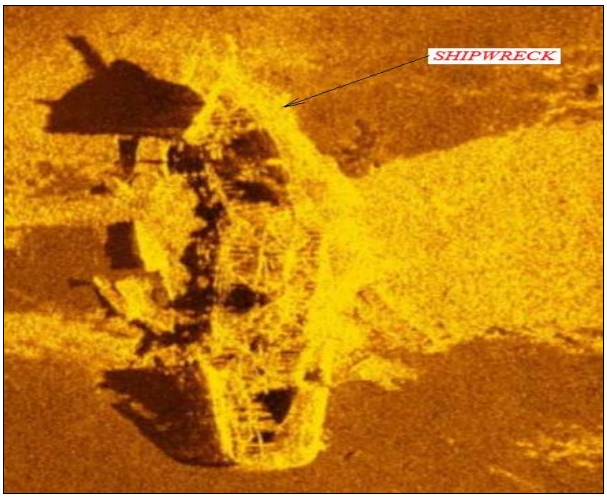

Fig 6: Side-scan sonar image with a shipwreck

Thus, depending on the specific missions, side-scan sonar sales have seriously increased in time.

The side-scan sonar sales have also increased depending on their specific missions, [7].

The chart below represents the situation of side-scan sonars acquired in 2021. These sonars are used for missions in the Black Sea, as shown in Fig 7 below.

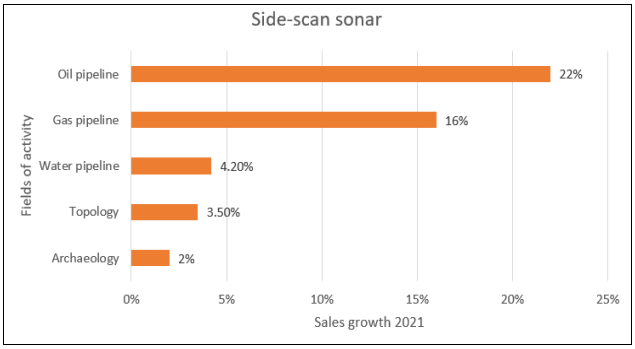

Fig 7: Increasing sales for side-scan sonar (2021)

3. Conclusions

Side-scan sonars are operated only by authorized operators. They have to be well prepared in use of the device. Therefore, operator must have:

- Abilities to operate the side-scan sonar.
- Abilities to effectively drive search patterns with the vessel.
- Abilities to understand what they are seeing on the side-scan sonar.

During complex missions, very good skills to operate different side-scan sonar systems and to drive the respective vessel are required.

The advantages of a side-scan sonar are:

- It is towed by a ship and does not consume energy.
- It is relatively cheap.
- Can be used for a long time under water.

It is also possible to use advanced side-scan sonar for deep sea. Developed side-scan sonar can be source of information for objects from seafloor.

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