The Design and Research of Intelligent Search and Rescue Device Based on Sonar Detection and Marine Battery

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***Abstract*—With the increasing number of Marine accidents, the task of maritime search and rescue is increasingly difficult. This paper studies a fast, accurate and scientifically valid intelligent equipment which breakthrough maritime search and rescue capability and level for maritime search and rescue. Using sonar detection technology combined with GPS navigation systems and Marine battery energy technology, intelligent search and rescue devices which we designed can quickly search for victims of life information. When the sonar equipment is searched for feedback, the GPS provides precise positioning to achieve accurate rescue. The search and rescue device is powered by Marine batteries, which is environmentally friendly and can be supplied for a long period of time. The Marine intelligent search and rescue equipment is equipped with fast speed and strong resistance to wind and waves, which have a long working characteristic and can reach the marine perils area quickly and realize efficient unmanned search and rescue.**

Keywords-Sonar Detection; Marine; Battery; Intelligent; Search and Rescue Device; Laser gyroscope; product design

I. INTRODUCTION

Maritime search and rescue is refers to the search and rescue operations taken by any maritime rescue force after obtaining maritime distress information in addition to the ship, which consists of two parts: maritime search and maritime rescue. Maritime search is refers to actions coordinated by the rescue coordination center or the rescue sub-center to utilize existing personnel and facilities to determine the position of the person in distress. Maritime rescue is refers to the rescue of any person in distress by any salvage force that can be used to provide initial medical care or other required services and to brought to safety place[1].Due to the continuity of sea search and maritime assistance in working hours and content, these two tasks are often referred to as sea search and rescue or referred to as maritime search and rescue.

II. THE PRESENT SITUATION OF THE TECHNICAL EQUIPMENT OF MARINE SEARCH AND RESCUE AT HOME AND ABROAD

The experience of the developed countries in the world shows that the perfect maritime search and rescue system and advanced equipment and facilities have a decisive role in ensuring maritime safety. After years of efforts, China's maritime search and rescue system construction has made great achievements, equipment level and search and rescue capabilities have been strengthened, China's maritime traffic safety situation improved significantly, the number and extent of ship traffic accidents were continue to decline[2]. However, we should also clearly see that the current situation of China's maritime traffic safety improved, mainly rely on administrative orders, insistent prevention and other measures to obtain. Management and rescue methods are extensive and costly.

Intensive, scientific and advanced, long-term maritime search and rescue system has not established yet, the maritime traffic safety situation is still preliminary and unstable. The number and quality of maritime search and rescue infrastructure and equipment, the ability to rescue the accident, especially the fast and effective rescue ability in the case of big waves, are also far from being able to adapt the development of social and economic and the demand of people's quality of life to improve, and there is a huge gap with the developed countries. Due to the gap in economic development, there is still a large gap between the technical equipment for maritime search and rescue and the developed countries. Of course, there are significant gaps in the number of search and rescue facilities due to the different functions of search and rescue organizations. The Search and rescue equipment quantity Contrast is shown in table 1.

TABLE I. SEARCH AND RESCUE EQUIPMENT QUANTITY CONTRAST FIGURE

country	Search and rescue equipment quantity			
	Wing plane	*Helicopter*	*small ship*	*Large ships*
China	2	6	28	12
Japan	29	46	350	169
America	150	62	1800	235

China's north sea, the east China sea and the south China sea rescue bureau have 40 existing professional rescue vessels, 18 emergency rescue teams and eight rescue helicopters including fixed wing aircraft. The U.S. coast guard is equipped with 13 large and medium-sized boats with a total of about 1,800 boats, with a total of about 1, 800, and a total of 212 aircraft with 5 fixed wing aircraft and helicopters. Japan's coast guard has 514 boat and 75 aircraft, with 29 fixed-wing aircraft and 46 helicopters. Therefore, the researching on intelligent rescue equipment can be applied to the complex situation and improving our maritime search and rescue capabilities has become the urgent needs to solve a big problem.

III. THE DESIGN AND RESEARCH OF INTELLIGENT SEARCH AND RESCUE DEVICE

In view of these problems， the nobody search and rescue machine has been researched and developed, which is high-performance, high-efficiency, low-cost, fast-to-reach area and long-time work. In this study, the maritime intelligent rescue device, the hull is a three-body structure, including the two wings and the main body. The wings and the main body make up the ocean battery, providing the system with electric energy. The rear of the main body set the propeller to provide propulsion for the rescue device. The storage space in front of the main body placed high calorie compressed food and fresh water. The storage space at the rear of the main body and the storage space of the wings store the life-saving supplies. A sonar detector is arranged above the main body for detecting survivors of the surrounding waters. The main body is also set up a GPS module to provide positioning information for the console. The middle of the main body is also equipped with warning lights. When the sonar detector detects the survivor, the UAV ejects life-saving supplies through the wings of the catapult and open the front of the front cover, and warning lights open at the same time. This intelligent search and rescue device is small, easy to transport, easy to use. The UAV can be used directly into the maritime area for work. This search and rescue device is mainly composed of detector, positioning lights, balance wings, power device, storage space and other structures. The structure and performance of each part will be described in detail below[3-5].Intelligent Search and Rescue Device Structure Chart is shown in Fig. 1.

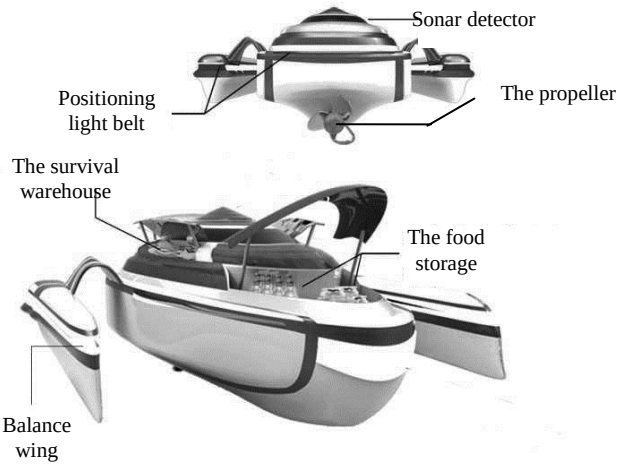

Figure 1. Intelligent Search and Rescue Device Structure Chart

A. *Detector*

Detector is located above the main body. Its role is mainly to detect a range of maritime survivors. The detector uses the active sonar technology to detect the underwater target. The detector can detect the range within one kilometer. It provides broad coverage in order to facilitate the first time rescue. Active sonar technology is refers to the sonar active launch acoustic "irradiation" target, and then receive the water reflection of the target to determine the target parameters. Active sonar technology is most of the use of pulse system, but also the use of continuous wave system[6-7]. It evolved from a simple echo detection instrument, which actively emits ultrasonic waves and then calculates echoes for the detection of survivors of sea floating when a shipwreck occurs. Sonar detection works is shown in Fig. 2.

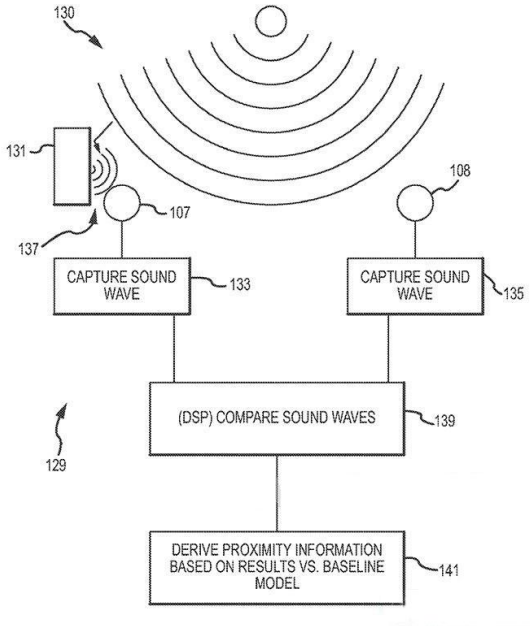

Figure 2. Sonar detection works

B. Positioning light belt

Positioning light belt is based on GPS technical. When the sonar get search feedback, the GPS provide real-time accurate positioning, so as to achieve accurate rescue by the search and rescue device[8]. As the scene of marine perils may be fog, big waves or search and rescue in the evening, as well as wind, flow and other natural factors affect the positioning accuracy will be affected, which led to the scene search is often very difficult. In order to find survivors, distress boats or lifeboats as soon as possible, then it need to locate the exact location to determine the target. The higher the positioning accuracy, the less the search time for the distress, the ship or the aircraft, and the search and rescue device as soon as possible to reach the exact location of distress and carry out search and rescue missions. The initiative rescue terminal of the search and rescue automatically open when the victims were found.

The process of micro-controller(MCU) active help terminal shown in Fig. 3.When the reed pipe conducts, the power supply begins to power the system[9].With MCU electricity self-inspection and the GPS unit power supply, It goes into the running state. After the GPS is on, it start to locate. At the time of the launch, MCU checks the GPS position. If GPS is invalid, it will select the location information stored in the MCU. If the GPS location is valid, it will select the location information of the current GPS. The MCU initiates the RF emission program. With Radio frequency emission module power supply, the MCU provides location data for launch after the modulation of radio frequency emission module. When the data is launched, the system is in low power and prepares for the next time[10].

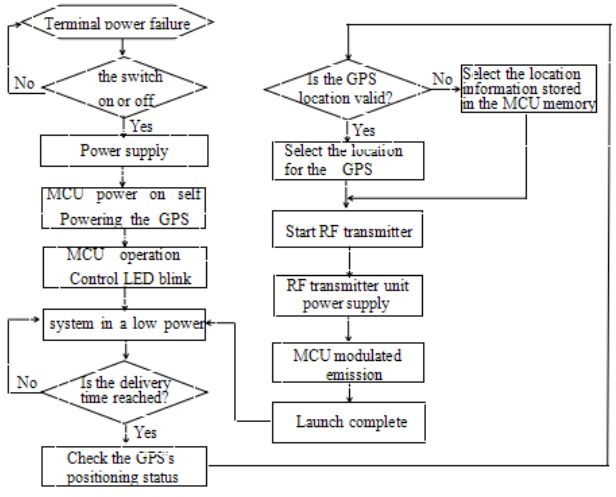

Figure 3. The process of micro-controller(MCU) active help terminal

The terminal positions through the GPS and sends the distress information including their own location coordinates to the nearby rescue ship or maritime rescue center through the maritime emergency rescue channel. Rescue ship quickly arrived at the waters of the waters to search and rescue after receiving the distress information or received the command of the shore command and control center. Under the guidance of the electronic chart, the rescuers can quickly find the staff and rescue them.

C. Balance wing

The balance of the rescuers depends on the wings. It is critical that the search and rescue machine balance on the surface of the water which is adjusted by the precise weight of the design and assembly. The center of buoyancy is above the center of gravity, and they are on the same vertical line. When the pitch and the horizontal, the force will form the recovery moment for the body. Maximizing the distance between the two hearts as much as possible, Its center of gravity is as close as possible to the bottom of the rescuers. The propeller on both sides of the rescuers are responsible for controlling the speed of surface navigation. The rudder plane is responsible for controlling the direction of the rescuers. According to the floating principle of the ship and the principle of the laser gyroscope, the search and rescue devices are always balanced on the surface of the water. The center of gravity and the center of buoyancy are on the same vertical line.

The laser gyroscope is designed to measure the angular velocity of the rotation by using the optical path difference. In a closed light path, two beams of light and light interference from the same source are sent clockwise and counterclockwise[11].By measuring the difference in the phase difference or interference pattern, the rotation angular velocity of the closed light path can be measured. The basic element of a laser gyroscope is a ring laser which made of triangular or square quartz closed optical path. there is one or a few with mixed gas pipe, two opaque mirror and one and a half. A monochromatic laser is produced by a high-frequency power source or a dc power source to excite the mixture. In order to keep the circuit resonant, the perimeter of the loop should be an integer multiple of the wavelength of light wave. A semi-transparent mirror is used to export the laser circuit, which is transmitted by a reflector to the two beams. The digital signal is formed from the Angle of the photoelectric detector and the input and output of the circuit. Because at high speed, the gyroscope's axis is stabilized in the fixed direction. Comparing this direction with the axis of the search and rescue device, the right direction of the search and rescue is accurate. Figure 4. The principle of laser gyroscope works is shown in Fig. 4.

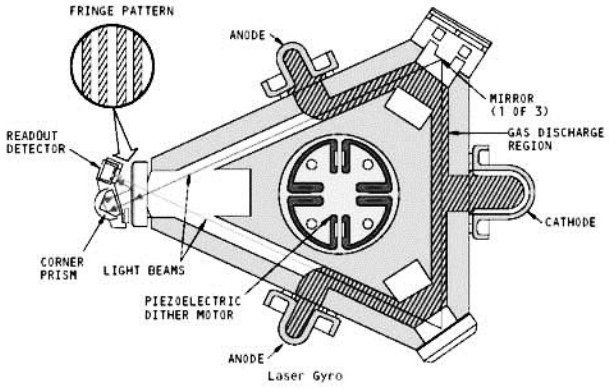

Figure 4. The principle of laser gyroscope works

D. Power plant

The energy for search and rescue devices use Marine batteries. The aluminum plate is negative, platinum is positive, water is electrolyte solution. Oxygen in the air reacts with aluminum that generates electricity. The Marine battery itself contains no electrolyte solution and positive active substance , which doesn't oxidize in the air and can be stored for a long time when the battery doesn't go into the ocean. When it is used, the battery can be turned into water, which is 20 to 50 times higher than the dry battery[12].The battery design cycle can last more than one year, avoiding frequent replacement of the battery. Even if you change it, you just replace a piece of aluminum. The size of the aluminum plate can be determined according to the actual needs.

E. Storage warehouse

The storage warehouse is divided into two parts---the survival warehouse and the food storage. The survival warehouse's position is located on both sides of the search and rescue device, which is stored in a life-saving appliance such as a compressed life jacket and waterproof glasses. The food storage is in the front space of the search and rescue unit, which stores high calorie compression food and fresh water[13].When Search and rescue device searched victims who is living , the survival warehouse was catapulted a life buoy through a catapult which keep the survivors afloat on the surface of the sea. After, the rescuers quickly ran to the survivors which opens storage automatically, and provides basic food and fresh water for survivors. Survivors can wait for ships or planes to rescue them.

IV. THE SEARCH AND RESCUE CAPABILITIES CONTRAST

The search and rescue capability of the ships, planes and ships that are currently available is determined by the search and rescue capability of the country. Search and rescue ability by the current location of the search and rescue individuals, ready to departure time, running speed, battery life, ability to resist the wind and waves, on-scene near and flow velocity, wave, wind speed and direction, air temperature, visibility, and so on factors .Search and rescue command center according to the above information is required, and the location of the object changes, determine the search area, select search and rescue individuals, choose the appropriate search pattern, make a search and rescue plan[14]. The Search and rescue equipment performance Contrast is shown in table 2.

TABLE II. SEARCH AND RESCUE EQUIPMENT QUANTITY CONTRAST FIGURE

	Search and rescue equipment performance		
items	***Rescue Aircraft***	***Rescue Ship***	***Intelligent Search and Rescue Device***
Sea area	Wide	Narrow	Wide
Sea limit	No	Yes	No
Wind and waves affect	No	Yes	No
Communication speed	Quick	Slow	Quick
Rescue speed	Quick	Slow	Quick
Rescue time	Long	Long	Short
accuracy	Common	Low	High
Emergency items provide	Not in time	Not in time	timely
Emergency speed	Quick	Slow	Quick
Cruising power	Weak	Common	powerful

As you can see from the analysis of the maritime search and rescue operations, a large amount of information is involved in the search and rescue mission and the search and rescue operations. The accuracy and rapid processing of this information will expedite the development of the search and rescue plan, improve the accuracy of the rescue plan, and coordinate the search and rescue work quickly and accurately.

A. Rescue Aircraft

The plane is flying fast, and be able to reach the disaster site quickly. This advantage is particularly acute in the case of a salvage mission at sea, when it is required to complete a rescue mission in a short period of time especially . In addition, the aircraft can search large areas of the sea and find the target in time. Also，it provides guidance for the accurate arrival of the salvage vessel. More importantly, the plane's involvement in the search and rescue operation was less affected by weather conditions such as wind waves. It is possible to use the Marine salvage facility when it is unable to sail to the area where the accident happened .The better aircraft have superior performance, have fast speed, long distance and good endurance ability. General aircraft have general performance , general speed , general voyage and general endurance ability. The poor plane has poor performance, slower speed , closer range and poor endurance[15] .

B. Rescue Ship

The ship referred here is a vessel that is specially used for salvage at sea or a professional salvage vessel. The salvage vessel is a special vessel, especially suitable for the field command. It is fast, resistant to wind and waves and can communicate with any distress vessel or boat on the maritime communication frequency. Professional salvage vessels are indispensable in maritime search and rescue operations. Search and rescue ship is excellent in performance, with fast speed and high wind resistance. General ship performance is general, with general speed, and general anti-wind grade . Poor ship have performance, slow speed, low wind resistance[16].

C. Intelligent Search and Rescue Device

The intelligent search and rescue device use sonar detector to detect underwater targets .The probe can detect a range within a kilometer. It can search for a wide range of areas and achieve the first time .It's supported by the GPS navigation system. When sonar is searched for feedback, the GPS provides precise positioning to achieve accurate rescue. Its main structure is aluminum and platinum with lightweight materials and small energy consumption .It can provide life-saving supplies, food and fresh water and can reach the

shipwrecks quickly, cost low, high efficiency. It uses Marine batteries and has a strong battery life and can work at sea for a long time.

V. CONCLUSION

Ship rescue and helicopter rescue are long and inflexible. This paper designs an intelligent search and rescue equipment which is able to accurately and accurately give the location of the drowning personnel. It combines GPS, sonar technology, Marine battery technology, database synchronization, wireless transmission, and so on, and implements three sets of equipment, such as active rescue terminal, receiving terminal and search and rescue display equipment. The active rescue terminal sends a distress signal containing its location information to the search and rescue vessel after the launch of the life jacket. Receiving terminal and search and rescue display equipment installed on search and rescue vessels. The search and rescue personnel can receive and display the position of the drowning personnel in real time and ensure the rapid implementation of the search and rescue work. The intelligent search and rescue devices which we designed is small, convenient to transport and convenient to use which needs to carry only some food and lifesaving goods. Intelligent search and rescue devices can be used directly to work in shipwrecks. Compared with the helicopter search and rescue, the intelligent search and rescue is low cost and high efficiency, which greatly reduces the search time. The intelligent search and rescue device uses a Marine battery to provide a steady stream of electricity for the search and rescue which has a long life and low cost and does not cause pollution. Using sonar detector, the search time was greatly reduced. The search and rescue vehicle uses sonar detector and GPS system, reduces the time of search and rescue greatly, and improves the search and rescue accuracy. Overall, the search and rescue with low cost, reasonable design, easy using, far signal range , accurate positioning and display high tracking performance, improve the efficiency of search and rescue work effectively.

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