

Research Progress and Application of Amphibious Bionic Robot

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Abstract

Based on the requirements of amphibious applications, the necessity of amphibious robots and the technical realization methods are discussed. Through technical comparison, it points out the performance advantages of amphibious bionic robots and the necessity of research, and introduces the current research status at home and abroad. Finally, according to the characteristics of the amphibious bionic robot, a new method of amphibious application is proposed.

Keywords

Amphibious; Bionic; Robot.

1. Introduction

Humans are animals that live on the ground. Any action in the water or in the air is, in the final analysis, a quasi-for attack on the land. Prepared. Therefore, the attack from water and air to land is an indispensable link. In recent years, China's biggest territorial issue has been the issue of island disputes. To resolve the Diaoyu Islands dispute, the South China Sea disputes, and Taiwan's reunification, a large amount of advanced amphibious equipment is urgently needed. At present, China is actively forming a landing force consisting of amphibious mechanical forces and transport ships, including the introduction and self-built, "Bison" hovercraft, the construction of large-scale landing ships of 10,000 tons, etc. On the other hand, the land, such as mountains, forests and rivers, should be avoided as much as possible in the army march, but at the same time they are also places where the opponent is easy to ignore the defense. Who has the ability to pass through complex terrain, Who can turn the useless land into a shortcut to the heart of the opponent. The all-terrain vehicle, which is currently being vigorously developed, has the ability to quickly transport troops through the swamp and muddy land. With the advancement of technology and the acceptance of casualties Unmanned will be the inevitable evolutionary form of future warfare. But at present, most robots can only move in a single environment. For example, land robots cannot perform underwater activities because they have no underwater propulsion mechanism or waterproof function. Most underwater robots do not have or do not have enough land motion capabilities. Therefore, in order to cooperate with special application scenarios such as landing and traversing complex terrain, it is urgent to develop high-performance amphibious robots.

2. Demand analysis

For a long time, landing operations have been initiated by surface ships, using surface/ground amphibious navigation vehicles such as hovercraft and amphibious tanks to transport equipment and personnel to the landing beach. The entire landing process is of a frontal battlefield style. Even if our side has control of the air and the sea, almost all of it is exposed to the opponent's line of sight. Before we touch the opponent's beach, we have already begun to suffer severe blows from the opponent's shore fire protection. Therefore, compared with surface and ground amphibious robots, amphibious robots with underwater and ground action capabilities are more popular with commanders. Due to the use of the natural barrier of the

water body to navigate underwater, even if it is detected, it will greatly increase the difficulty of the opponent's attack on us at sea. Only at the moment of landing will it float up from the water, which greatly enhances survival. ability. The bionic amphibious robot will have greater application value than the conventional driving robot. Changing the conventional propulsion method to the bionic propulsion method resulted in the following changes in amphibious applications.

2.1. Concealment

Using the underwater bionic propulsion method, the underwater noise can be lower than the background noise of the nearshore ocean, making our actions difficult to be detected by the other party, and achieving the goal of surprisingly winning tactics. Traditional landing methods require various tactics and even strategic deceptions before the entire landing operation to confuse the opponent to make a misjudgment and increase one's survivability. The underwater amphibious movement can make it easier for the commanders to make landing plans and launch more sudden landing actions, reducing the landing action from a nearly strategic behavior to a tactical behavior that can be used frequently.

2.2. Survivability

Navigating underwater with the help of the natural barrier function of the water body, even if it is detected, it will greatly increase the difficulty of the opponent's attack on us at sea. Even if the shore defense gun is used to shoot at us, the warhead will soon fall into the water. The loss of kinetic energy is unable to cause any damage to our amphibious robots moving underwater, which greatly reduces our casualties before the official landing.

2.3. Terrain adaptability

Conventional landing weapons are supported by air cushions or tracks, and require higher terrain at the landing site (for example, it needs to be leveled), making it easier for the opponent to predict our landing site and implement a siege on our side. Because the bionic platform is supported by legs, it has almost all-terrain adaptability, which turns any place except cliffs and other extremely special terrains into possible landing sites, making it impossible for the opponent to make predictions and increasing the difficulty of defense , Increase the freedom of our commanders and fighters, and make the situation develop in our favor.

3. Research status at home and abroad

Non-bionic amphibious robots use traditional propulsion methods, such as those used by traditional amphibious tanks and some special external propulsion methods.

Shapes, such as spherical robots, have the characteristics of good engineering and easy implementation, but usually also have the disadvantages of large propulsion noise, low efficiency, and poor adaptability to water and ground terrain. Most of them are more suitable for water and ground, rather than underwater With the ground.

There are multiple propulsion schemes for bionic amphibious robots:

(1) Single bionic advancement. Such as imitating real amphibians. The object imitated by a single bionic lives in environments such as watersides and tidal flats all year round, and has a good adaptation to both land and water environments, but neither the water nor the land propulsion method is optimal.

(2) Semi-bionic advancement. Only use the bionic propulsion method in the water or on the land, and use the traditional artificial propulsion method in another environment. Semi-bionics is usually based on the design principle of simply optimizing land performance while taking into account water performance (or vice versa).

(3) Composite bionic advancement. Combine the characteristics of multiple creatures to achieve stronger terrain adaptability or sports effects. The composite bionic propulsion can make the robot better take into account both underwater and ground environments.

Based on years of experience in amphibious robot design, the Lausanne Institute of Technology in Switzerland announced in 2015 the latest generation of salamander amphibious robot Pleurobot. Whether in water or on land, it uses the propulsion method of salamanders, which is an outstanding representative of a single bionic. Although it can be well adapted to both underwater and ground environments, the sports performance is not optimal.

ISRobotics and Rock-well International developed a six-legged crab-like robot in 1996. Each leg has two independent up and down and back and forth degrees of freedom, and can walk quickly on the ground. Harbin Engineering University produced an amphibious bionic robotic crab prototype in 2007, which weighs about 12 kilograms, is about 0.3 meters wide, and has a forward speed of 0.22 meters per second. 2016

The annual system has been improved. In 2010, Osaka University in Japan developed RT-I imitating tortoises, crawling on land with forelimbs crawling on sand, and paddling with hydrofoil in the water. The Marine Science Center of Northeastern Polytechnic University designed the lobster-like eight-legged walking robot for the task of removing mines in shallow water areas such as ocean currents and swells in the international sea area from 2.4 meters to 12 meters, which is 45.72 cm long (including antennae). It will alert when a mine is found. In 2012, the Korean Ocean System Engineering Research Department and the Korean Ocean Research Institute jointly developed the amphibious large-scale hexapod robot CR200, which weighs about 635 kilograms and has a diving depth of 200 meters. The pure-footed amphibious robot is also a single bionic amphibious robot. Its characteristic is that it can crawl on the bottom of the water, so that the function of ground walking can be directly applied to the underwater. The advantage is that it saves a set of underwater driving system. Unfortunately, it cannot move fast in the water. And the complex topography of the underwater has greater restrictions on it.

The Robotics Laboratory of Tokyo Institute of Technology developed a snake-shaped amphibious robot HELIX in 2002, and developed an improved version of ACM-R5 in 2005, which uses bellows to seal the joint rotation. There are passive wheels outside each joint to interact with each other in the water. The ground can reach a speed of 0.4 m/s. The Shenyang Institute of Automation developed the "Explorer III" amphibious snake-like robot in 2012. The robot has 9 joint modules with a diameter of 7.5 cm, a total length of 117 cm, and a total weight of 6.75 kg. Both of these two types of robots use a snake-like swing to move forward in the water, and use a swing and a roller on the ground. Both of these are typical representatives of semi-bionic propulsion.

4. Application scenarios

4.1. Landing operation

Using the low noise and high stealth of the bionic underwater propulsion, it can safely and concealedly approach the other side's beach; the use of bionic ground propulsion can adapt to more complex terrain and land in places that the other party did not expect. The landing action can be a one-time use type, that is, immediately after landing, discard all excess weight such as driving parts used only in the water, exhausted battery packs, and only carry the mission load and ground sensor system to attack the target on the shore at the highest speed. The amphibious robot can be released directly in the water by a submarine, or from a feint ship. The amphibious robot has entered a predetermined position without the opponent's awareness. The amphibious robot maintains a certain depth underwater, swims toward the target coast, and makes a landing on the selected coast at a predetermined time, launching a surprise attack

on the opponent. After the first round of strikes, other services and arms can take over the amphibious robots and quickly enter the battlefield to expand their results.

4.2. Special operations

Although there are currently advanced methods such as reconnaissance satellites and reconnaissance aircraft, for the concealed approach reconnaissance in coastal areas, especially when remote

When reconnaissance methods fail, there is currently no effective reconnaissance method except the use of frogmen and other special forces. But the use of special forces is extremely expensive and extremely risky. Therefore, the development of a small intelligent amphibious robot that can start from a long distance in the water, pass through the opponent's detection network, and land directly is an efficient reconnaissance method that realizes multiple batches, low cost, and low risk. It can even directly enter the inland river from the estuary of the sea to carry out close reconnaissance or even small-scale destruction. It can replace a large number of dangerous tasks that can only be performed by special forces in the past, greatly increase the frequency of reconnaissance of the opponent's intelligence, and obtain more real-time intelligence. Better support the decision-making process of large-scale landing operations. Special operations should adopt a reusable type, which can be repeatedly converted between the ground and underwater forms, and is suitable for safe evacuation by water after completing the mission. Especially for opponents with complete air defense systems, it is difficult to use unmanned aerial vehicles for reconnaissance, so ground reconnaissance equipment is needed to complete more detailed reconnaissance work. Amphibious robots can either accompany special forces members or independently carry out reconnaissance or sabotage activities. Compared with unmanned aerial vehicles, it can more effectively use topography as a cover, with low noise level, small infrared characteristics, higher survivability, and can follow

It is concealed when the machine stops, and it is not easy to attract the attention of the other party; it can carry more energy, and it can be latent with zero energy for a longer time, especially suitable for long-term surveillance and reconnaissance; it can contact water and ground more directly, and can use direct Sensors, rather than remote sensing sensors, obtain the most accurate information and are not easily confused by false targets.

4.3. Laser irradiation guidance

The amphibious robot can carry a laser irradiator to guide our laser-guided weapons to perform precise strikes on the opponent. Currently actively seeking

Guided weapons still have shortcomings in anti-jamming and anti-baiting capabilities, and they are costly. Therefore, the US military has used a large number of cheap weapons such as laser-guided bombs in recent wars, but it is still US soldiers who use laser irradiators. This is feasible when they have an advantage. However, before launching an attack, it is difficult for our personnel to reach the area occupied by the other side, thus restricting the use of cheap weapons. Using drones for guidance can easily be shot down, while using amphibious robots to pass through the warehouse secretly to reach the opponent's occupied area from the opponent's unexpected direction, and guide our cheap weapons to perform saturated and precise strikes, which can achieve a multiplier effect with less effort.

5. Conclusion

Due to its potential advantages of low noise and high environmental adaptability, amphibious bionic robots have been regarded as one of the important development directions by major research institutions. However, most of the robots are still proof-of-principle prototypes, and have not yet been engineered for actual use requirements. With the further upgrade of practical

application requirements and the continuous advancement of technology, amphibious bionic robots are bound to usher in broad development and application prospects.

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