Research on Intelligent Remote Operated Vehicle Technology

Jinyu Ren[a], Jing Xu[b]

Wuhan Technical College of Communications, Wuhan 430065, China.

[a]308810953@qq.com, [b]1015852411@qq.com

Abstract

Intelligent remote operated vehicle combines the functions of artificial intelligence, underwater target detection and recognition, data fusion, intelligent control and so on; it is an intelligent platform that can conduct tasks in the water. Because remote operated vehicle has a good prospect in the ocean development, remote operated vehicle technology is a hot technology concerned by many countries in the world. This paper is based on practice and related technical problems, explains the development status and prospect of intelligent remote operated vehicle, and puts forward some suggestions on the solutions to these problems.

Keywords

Remote operated vehicle (ROV); Artificial intelligence.

1. Introduction

Ocean is a strategic development base of biological resources, energy, water resources and metal resources, it is the most realistic and potential space for development, and plays a direct and huge supporting role in China's economic and social development. Therefore, the extensive and in-depth development of ocean will become one of the development themes of China in the 21st century. As an assistant for human exploration and development of the ocean, remote operated vehicle, especially intelligent remote operated vehicle, will show their various uses in this field. Intelligent remote operated vehicle is robot that applies artificial intelligence, automatic control, pattern recognition, information fusion and understanding, system integration and other technologies to traditional carriers, and independently complete tasks in complex marine environment without driving by human, it is also a kind of system with artificial intelligence, which has high autonomous ability, memory ability and learning ability, and adapts itself to the changes of the external environment. The operator only needs to give the mission to the remote operated vehicle, and the tasks related to tactics and even strategy; they are completed by the remote operated vehicle. The intelligent remote operated vehicle represents the current development direction of the remote operated vehicle technology.

2. Prospect of Key Technologies of Remote Operated Vehicle

The development of intelligent remote operated vehicle technology has made exciting progress, but it still faces a lot of technical problems to be solved, and it will take a long time to meet the goal of marine research and development or weapon equipment. The key technologies of intelligent remote operated vehicle are as follows.

2.1 Design technology of intelligent underwater remote operated vehicle

The intelligent remote operated vehicle needs to adapt to the complex marine environment, its carrier not only has the ability to withstand pressure, watertight and bear load, but also has the ability of low resistance, high propulsion efficiency and space movement. In addition, in a very limited space, it needs to configure a variety of sensors with different performance to meet the needs of environmental detection, target recognition, autonomous navigation and autonomous completion of tasks. The system integration design of these devices should ensure the normal operation of information flow and control flow of the system, so the EMC and integration design of each part of the system is very important.

In order to adapt to a wide range of navigation, from the perspective of hydrodynamics, the basic shape of the intelligent remote operated vehicle should be a rotating slender body, similar to a torpedo, and new light composite materials should be used as far as possible, these materials have the characteristics of light weight, large buoyancy, high strength, corrosion resistance and strong biological adhesion resistance, which can make the intelligent remote operated vehicle have a large positive buoyancy, In addition, the noise of the composite material is low, which will reduce the background noise of the sensor.

2.1.1 Possibility and reality of application of bionic technology in intelligent remote operated vehicle

In recent years, many scholars at home and abroad attach great importance to the study of bionics and try to apply it into the design of intelligent remote operated vehicle carrier. Because fish tail swinging has high efficiency, low noise, flexible manipulation and small wake, it is a very ideal way of underwater propulsion and manipulation from the perspective of hydrodynamics and acoustics. If we master the principle of fish swimming, we can use it in intelligent remote operated vehicle, even if it is used on ships, it will cause technological revolution of ships

At present, different prototypes have been built for different bionic objects at home and abroad, and many research results have been obtained. Harbin Engineering University has studied and developed the "bionic I" prototype system since 2000, as shown in Fig.1, which is 2.4 inches long, 10 meters deep, the tests in the pool and sea have been completed, and the underwater navigation speed is up to 1.2 m / s, and it can carry out flexible rotation.

Fig.1 Bionic remote operated vehicle "bionic-1"

It must be pointed out that the bionic research of fish swing is still in the stage of mechanism research at present, in order to realize the real bionic and configurable multi degree and freedom closed-loop control, meet the requirements of various detection and identification sensors, and turn the potential advantages into the real remote operated vehicle, it is a long way to go.

2.1.2 Prospect of miniaturization technology application in intelligent remote operated vehicle

Because the miniaturization technology make the remote operated vehicle have the characteristics of small volume, low resistance, flexible mobility, good stealth performance, strong shock capability, low cost, mass production and easy carrying, which makes the micro remote operated vehicle very suitable for developing into an unmanned and intelligent underwater operation system. Because of the small volume of the micro remote operated vehicle, especially in the case of very complex seabed topography, the maneuverability and intelligence of the micro-remote operated vehicle is the key to the successful completion of the task.

Due to the wide application prospect of micro remote operated vehicle in the future, developed countries have invested a lot of human and material resources in the research and development of this kind of intelligent carrier, and have developed a variety of system prototypes. At the same time, great progress has been made in the navigation, control, environmental perception, energy and power and other key common technologies of micro remote operated vehicle, the autonomous level of micro underwater vehicles is constantly improving, and the endurance has been greatly increased. At present, Harbin Engineering University develops the experimental prototype of micro remote operated vehicles, as shown in Fig.2; it has completed the pool test and lake test, the total length of the

experimental prototype is 0.95 m, the displacement is 80 kg, the submergence is 50 m, it can conduct directional navigation, its endurance is more than 15 km, and has autonomous navigation and detection capabilities.
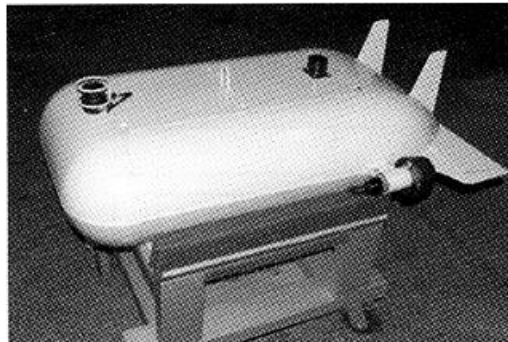

Fig.2 Micro and small remote operated vehicle "micro dragon 1"

2.2 System architecture

How to improve the autonomy of the remote operated vehicle, adapt to the complex marine environment and complete various tasks is an important manifestation of the intelligent system. The purpose of studying system architecture is to continuously improve and improve the existing architecture, strengthen the prediction and prediction ability for the future, and make the system more forward-looking and have autonomous learning ability, which is the same as the research task of the intelligent remote operated vehicle, it is also one of the key technologies to improve the level of intelligence (autonomy and adaptability).

Artificial intelligence technology is the foundation of autonomous ability of intelligent remote operated vehicle. The integration technology of architecture technology including artificial intelligence technology and various control technologies, they are equivalent to human brain and nervous system. The software system is responsible for the overall integration and system scheduling of intelligent remote operated vehicle, which directly affects its intelligence level, it involves the selection of basic modules, the relationship among modules, protocol specification of data (information) and control flow, communication and interface, global information resource management and overall scheduling organization.

In the research of artificial intelligence, symbol-based reasoning and artificial neural network technology are two main methods. For the research of intelligent remote operated vehicle technology, symbol-based reasoning ability is necessary at the high level, but it has some limitations in knowledge acquisition, system, learning ability and real-time performance. However, artificial neural network has strong learning, association, self-organization and self-adaptive ability, especially in dealing with some imprecise and incomplete information, it shows superiority. It adopts parallel and distributed storage and processing mechanism, which makes the system have fault tolerance and robustness. These characteristics make up for the lack of knowledge based on symbolic reasoning in some aspects. Therefore, the combination of logical reasoning and artificial neural network technology is very important.

2.3 Motion control technology of remote operated vehicle

The motion of the remote operated vehicle has obvious nonlinearity and cross coupling. In order to accomplish different tasks, the remote operated vehicle is required to have high control accuracy in multiple degrees of freedom. Therefore, it is necessary to establish a perfect integrated motion control system, so that it can avoid obstacles (based on behavior reflection) and describe the control information in a unified way. Moreover, information fusion, fault diagnosis and fault tolerant control strategy are integrated.

Considering the time-varying motion, the complexity and uncertainty of the environment, it is difficult to establish an accurate motion model of the remote operated vehicle. Most researchers focus on neural network and fuzzy logic control technology. The advantage of neural network control is to

fully consider the strong nonlinearity of the remote operated vehicle and the coupling between various degrees of freedom, the disadvantage is that the structure and parameters are not easy to determine. At the same time, when the amplitude and period of external interference are similar to the motion amplitude and period of remote operated vehicle itself, the learning of neural network will have obvious lag phenomenon, which makes the control have oscillation phenomenon. The design of fuzzy controller is relatively simple, and its stability is also good, the selection of many fuzzy variables and membership functions needs rich experience in manipulation. In the actual sea test, the debugging time is often limited, and the too complex parameter adjustment restricts the application of fuzzy control technology in the motion control of remote operated vehicle.

3. Application Prospect

The application fields of remote operated vehicles in the world have been expanding, such as marine research, marine development and underwater engineering. The military powers represented by the United States attach great importance to the application of remote operated vehicles in the future war. Intelligent remote operated vehicle will become one of the important means of underwater war in the future. Therefore, this technology is a research field that many countries attach great importance to, and it is in a critical stage of rapid development.

3.1 Research and development of marine resources

The ocean is the cradle of life, the treasure house of resources, the main road of transportation, and the battlefield of war. In the 21st century, human beings will face three challenges: the contradiction between population expansion and limited living space, the contradiction between the limited land resources and the growth of social production needs, and the contradiction between the deterioration of ecological environment and human development. The ocean, which accounts for 71% of the earth's surface area, is treasure far from being developed. If human beings want to maintain their own survival, reproduction and development, they must make full use of marine resources, which is also an inevitable choice for human beings. For China, which has a low per capita resource share, marine development is of more special significance. In the process of marine development, the intelligent remote operated vehicle will play an important role in the research of ocean environment detection and modeling, ocean target detection and recognition, positioning and transmission.

3.2 Effect in future wars

The western developed countries, represented by the United States, increasingly emphasize the zero casualties in the war, which makes the importance of the unmanned weapon system in the future war increase rapidly, and its potential combat effectiveness become more and more obvious. As an important part of the unmanned weapon system, the intelligent remote operated vehicle can be based on surface ships or submarines, complete environmental detection, target identification, intelligence collection and data communication in tens or hundreds of miles of underwater space, thus greatly expanding the battle space of surface ship or the submarine.

4. Conclusion

With the development of science and technology, the intelligent remote operated vehicle technology has made many encouraging progress, which makes people find that this multi-disciplinary technology will have a wide application prospect, so it is highly valued by many countries, especially developed countries, and has formulated various plans. On the one hand, they organize all aspects of technical force to study relevant key technologies; on the other hand, The research results obtained have been applied to various fields as soon as possible, which has played a role that existing equipment cannot play. However, the general technical level of the intelligent remote operated vehicle is still in the stage of research, test and development. There is still a long way to go before it can reach the application with real significance.

References

[1]Wan Lei, Zhang Yinghao, Sun Yushan, Li Yueming, He Bin. AUV's Depth Control Based on Reconstructive Fault-tolerant Control [J], ActaArmamentarii, 2015, 36(4), 723-730.

[2]Pang Shuo, JiuHaifeng. Current Status of Autonomous Underwater Vehicles Research and Development, Science & Technology Review, 2015, 33(23), 66-71.

[3]Liu Xuemin. Control of Automatic Underwater Vehicles [J]. Ocean Engineering, 2001, 19(3): 81-84.

[4]Liu Jianeheng, YU Huanan, Improved S Plane Control Algorithm For Underwater Vehicles [J]. Journal of Harbin Engineering University, 2002, 23(1): 33-36.

[5]Wang Xingce. Zhang Rubo. GuGuochang. Potential Grid Based Global Path Planning For Robots [J]. Journal of Harbin Engineering University, 2003, 24(2): 170-174.