Design and analysis of field test of surface unmanned boat radio

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Abstract. Communication distance and real-time monitoring are important performances of surface USV radio stations, which can better play the role of smooth communication information between surface USV and shore-based platform and real-time monitoring of USV dynamics, usually in the field. Test verification. This article analyzes the main problems in the field communication distance and real-time monitoring test of the surface unmanned boat radio station, introduces the evaluation method of the field wireless electromagnetic environment monitoring, designs the network environment of the shore-based computer and the surface unmanned boat industrial control computer, and designs the surface Field test plan for man- ship radio station. The test analysis shows that the design scheme is feasible and the communication between the surface unmanned boat and the shore-based platform is smooth, which can better monitor the dynamics of the surface unmanned boat, thereby improving the operation quality of the surface unmanned boat.

1. Introduction
With the exploration of the ocean in recent years, the ocean has a very important position in transportation and military. The development and utilization of ocean resources has become a research hotspot in the ocean field of various countries. The marine environment is vast and the requirements for marine operations are complex and diverse. Various unmanned marine vehicles, including surface unmanned vehicles, have become the main choice for marine operations, The research work on surface unmanned boats has also become one of the research priorities in the marine field of various countries.[1-3]

The unmanned surface vehicle radio station field test, through the evaluation method of the field radio station environmental monitoring, establishes the communication network environment and test platform, and then carries out the surface unmanned boat radio station field test. Figure 1 shows the overall architecture of the radio station monitoring system, which mainly includes three parts: base station, unmanned boat industrial computer and shore-based computer. In the wireless monitoring system, there are base stations in the area to monitor the radio signal, which can meet the needs of the USV radio test monitoring coverage[4]. An omnidirectional antenna is used in the base station, which can receive radio signals from all directions. The antenna of the base station is connected to the input channel of the shore-based computer, and the collected radio signals can be transmitted to the shore-based computer to obtain the communication distance, and real-time monitoring details.
2. Test question
The USV radio station performance test includes technical performance test and service performance test. The technical performance test is carried out in accordance with relevant standards under laboratory conditions, and the use performance test is mainly carried out in a typical outdoor environment\[5\]. Compared with the laboratory technical performance test, the field communication distance and real-time monitoring test are affected by factors such as climate and electromagnetic environment. Therefore, it is necessary to conduct multiple tests and collect more test data to enable the communication between the surface USV and the shore-based platform to be smooth, better monitor the dynamics of the surface unmanned boat, ensure the accuracy of the test, and improve the operation quality of the surface unmanned boat.

Currently, radio station tests mainly use manual calls and subjective evaluation of communication quality. On the one hand, due to the lack of natural electromagnetic environment monitoring data, the occupied frequency points lack quantitative evidence, and there are many radio stations frequency points. Manually traverse all frequency points. Time length and low efficiency; on the other hand, communication quality is mainly based on human subjective evaluation, and evaluation results may vary from person to person, which is not conducive to the application of automatic test methods.

3. Wireless electromagnetic environment monitoring
The electromagnetic environment monitoring during the field test can be achieved through radio monitoring equipment \[6\]. The preparations for the radio station test are to allow the radio monitoring equipment to work for about one hour. Through the analysis of the spectrum occupancy and time occupancy, the frequency points occupied by the wireless environment interference in the field are excluded, and the radio station test can provide accurate usable frequency points. Ensure the accuracy of frequency point passability calculation. With the development of the radio station test, the radio monitoring equipment continues to work and records the processing results in the database as a reference for the evaluation of the wireless electromagnetic environment data and test results at the measurement time and location.

Therefore, in the process of wireless electromagnetic environment monitoring, the first step is to set electromagnetic environment monitoring parameters to display, distinguish, and record the electromagnetic environment background, interference signals and test signals; secondly, start the wireless electromagnetic environment monitoring scan and analysis, and save the scan results In the database; then according to the scanning results, when the communication plan is formulated in advance, the frequency points occupied by environmental interference shall be eliminated; finally, the number of frequency points occupied by environmental interference shall be counted, and the frequency points can be excluded to the greatest extent when calculating the passability of the frequency points The influence of electromagnetic environment interference on the evaluation of test results.

4. Web environment
The prerequisite for the data and information exchange between the USV control system and functional subsystems is to ensure network connectivity\[7\]. In this experiment, the shore-based computer and the industrial computer on the unmanned platform are connected to the same network.
segment. The computer enables the DHCP (Dynamic Host Configuration Protocol) protocol to obtain a specific IP address; use the ping command to verify the shore-based computer and the industrial computer. Whether the inter-network is unblocked, the execution process of the ping command is that the shore-based computer creates a data packet and sends it to the industrial computer. After receiving the data packet, the industrial computer replies to the shore-based computer with the same data packet. The two-way data packet can be successfully delivered. The representative completed a ping. The shore-based computer successfully pings the industrial computer, which means that the computers at both ends have successfully connected to the network.

Both the shore-based computer and the industrial computer on the unmanned platform are in the 192.168.1.0 network segment, and its IP address is 192.168.1.60, and the subnet mask is a 24-bit class C address. The shore-based computer and the industrial computer are pinged separately. The IP address of the opposite end, the result of executing the ping command is shown in Figure 2, indicating that the computer is connected to the same network and interconnected.

![Figure 2. The shore-based computer executes the ping command.](image)

5. Test results and analysis

The main radio station of the unmanned boat is built on a shore base 4 meters from the horizontal, as shown in Figure 3; the auxiliary radio station is set up on the highest point of the end bracket of the unmanned boat, as shown in Figure 4.

![Figure 3. Radio host build platform.](image)  ![Figure 4. Radio auxiliary machine building platform.](image)

After the master and slave of the radio station are set up, the computer connected to the radio station’s master set the wireless parameters on the network with a frequency band of 1.4G, a bandwidth of 10MHZ, an ID address of 192.168.1.20, and the frequency hopping is turned on. The unmanned boat moved away from the shore base and the test began. As shown in Figure 5, since the auxiliary engine installed on the unmanned boat at the beginning is closer to the main engine installed on the shore base, the SNR (SIGNAL NOISE RATIO) value is relatively large, indicating that the noise mixed in the signal is relatively small, and the sound quality of the sound playback is relatively small. High, the real-time monitoring location displayed at the shore monitoring point is very smooth. When the auxiliary engine installed on the unmanned boat is 400 meters away from the main engine installed on the shore, the SNR value is about 19, and the SNR value is within the range of (+15~+22). The test effect is very obvious, and the second error The bit rate and total bit error rate are both 0, the
signal is strong, and the real-time monitoring point displayed by the shore monitoring point has smooth image quality and achieves the expected effect, Real-time monitoring is shown in Figure 6.

As the unmanned boat sails on the water, the distance between the auxiliary aircraft installed on the unmanned boat and the main engine on the shore is getting farther and farther, As shown in Figure 7, the SNR value drops to about 15, the SNR value range drops to (-1~+21) Among them, the difference is relatively large, and the test effect is more obvious. But when the distance between the auxiliary machine installed on the unmanned boat and the main engine on the shore is 1690 meters, the second error rate rises to 24% at a certain moment and then drops to 0%. The shore monitoring point shows The picture quality of the three real-time monitoring stations is stuck for 2 seconds, indicating that at this moment, an unknown signal source interferes with the radio signal. As the secondary radio
follows the rotation of the drone or the unknown signal source disappears, the second bit error rate Reduce to 0%. The signal propagation of the radio station will be interfered by a strong signal source. During the test, the real-time monitoring point displayed by the shore monitoring point has a smoother picture quality, which can achieve the expected effect.

The unmanned boat starts to return when it sails to 2000 meters. The real-time data shows that the SNR value and the range of the SNR value will jump with the distance between the auxiliary aircraft and the main engine. When the auxiliary aircraft on the unmanned boat is farther from the main engine on the shore, the SNR value is lower, the range of the SNR value jumps, and the test effect is worse; on the contrary, when the auxiliary engine on the unmanned boat and the main engine on the shore The closer the host on the shore, the higher the SNR value, the smaller the range of the SNR value, the better the test effect. During the test, the bit error rate will increase due to interference from other signal sources, and overall it has little effect on the test effect. In Figure 9, the pictures of the three real-time monitoring points are relatively smooth and can meet the test performance indicators.
6. Conclusion

This article analyzes and introduces the evaluation method of the wireless electromagnetic environment monitoring in the field, designs the network environment connecting the shore-based computer and the surface unmanned boat industrial computer, and designs the outfield test plan of the surface unmanned boat radio station. The test analysis shows that the design scheme is feasible and the communication between the surface unmanned boat and the shore-based platform is smooth, which can better monitor the dynamics of the surface unmanned boat, thereby improving the operation quality of the surface unmanned boat.

Acknowledgments

This work was supported in part by National Key Research and Development Program of China, grant number 2018YFF01013402 and Major scientific and technological innovation projects of Shandong Province, grant number 13331.

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