# Explore the Advantages and Find Improvements of the Underwater Robots Used in the Dynamic Environmental Monitoring of River Water Environment

Qingwei Chen, Hanwen Lu, Wenshan Huang*

Peking University Schools, 82 Daniwan huangzhuang, Haidian District, Beijing 100080, China

*huangwenshan@pkuschool.edu.cn

**Abstract.** Influenced by the very important environmental protection concept nowadays, this article is dedicated to studying the role that underwater robots play in environmental protection. To test this issue, this experiment used a modified wireless underwater robot to test the ph, turbidity, water temperature and oxygen consumption of the river through simple equipment. These are all very important indicators that can reflect the quality of water sources. After the data collection is completed, the research will compare the data collection effects of robots and humans, including collection efficiency and the degree of data fluctuation, so as to analyze the advantages of underwater robots in environmental protection. Challenges of these underwater robots will be analyzed. At the same time, we have proposed possible solutions to improve the original underwater robot.

**Keywords:** Environmental science, underwater robots, sensor technology, underwater communication technology

## 1 Introduction

### 1.1 Research Problem Restatement

"Ecological civilization construction is the inevitable choice of social development." Environmental protection is becoming more and more important in China[1]. Nowadays, water pollution, such as blooms, industrial pollutant discharge, and so on, is becoming a more serious problem which need to be solve. Industrial wastewater, domestic sewage, and agricultural runoff are the main sources of pollution[2]. Human industrial activities can cause a large amount of heavy metals to enter river sediments. These heavy metals are not only an important source of water pollution but also pose a potential risk to drinking water safety. Mining activities, especially abandoned pyrite mining areas, can cause severe pollution to the surrounding river basins. For example, the dam failure at the Aznalcóllar mining area in 1998 led to the contamination of the Agrio and Guadiamar rivers with large amounts of pyrite slurry and acidic water. Ag-


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ricultural subsidy policies may lead to an increase in fertilizer usage, thereby exacerbating the pollution of agricultural runoff on rivers. Additionally, the release of potential toxins and harmful compounds in cyanobacterial blooms poses a significant risk to public health. Chemical pollutants from factories and illegal discharges of substances like rivers deserve our attention. Propert detection means are currently lacking, and thus the detection of change of the distribution of pollutants in water is also lacking[3]. The distribution of pollutants is often closely related to the flow of water and the source of pollution. In the water body, the distribution of pollutants is often not balanced and realize these unbalance is difficult. However the trends in the quality of pollutants in water have rarely been studied. Due to the lack of reasonable, convenient and accurate monitoring means, it is very difficult to understand the pollution of the environment. Therefore, it is difficult to make an appropriate response in a timely manner and because of this reason cleaning up pollution is often costly. When environmental pollution becomes very serious, people need to use a large amount of funds to repair the loss of the environment. In addition, the destruction of the environment has seriously affected the life of the residents near the water source, and the pollution of the water source will also cause serious hidden dangers to the water supply of the city. The destruction of the environment has also had a serious impact on biodiversity. This research is hoping to solve this problem by using underwater robots as a tool to create a new, more comprehensive and dynamic detection method which allows for more comprehensive and accurate monitoring of the water environment, while also saving time and have a better effect. Furthermore, I also hope that through my own observations and tests, I can provide solutions for the subsequent design of the robots.

## 2 Literature Review

### 2.1 Overview of the Literature

The definition, history of development of Autonomous Underwater Vehicle (AUV), the structure of AUV, features of AUV, and its advantage for environment monitoring. The successful example of applying AUV in other areas. The importance and must of using AUV. The reason AUV is suitable for the requirement of technology in the environment monitoring process.

The development of environment monitoring. The traditional way of monitoring the environment and its disadvantages and limits. The importance and advantage of dynamic monitoring of water environment. The example of dynamic monitoring. How can AUV play a role in the environment monitoring process.

### 2.2 AUV's Importance

The advantage and need of using AUV which suits environment monitoring.

Automation underwater vehicle(AUV), one type of underwater robot means no human driving, relying on remote control or automatic control of underwater navigation equipment, mainly refers to those instead of divers or manned small submarine deep-sea detection, rescue, removal of mines and other high risk underwater intelligent system. Therefore, automation underwater vehicles are also called "submersible robots" or "underwater robots". Different from Remotely Operated Underwater Vehicle (ROV), which use cables to control the robot, AUV is completely automatic but at the same time requires more complete control. Underwater robots were first conducted in around 1970s and accelerated development after the 21st century. Even now the speed of development is still increasing.

Underwater robot boasting excellent concealment and high safety, have been widely applied in fields such as ocean exploration, environmental monitoring, and underwater rescue.AUV is also used in marine research. AUV’s advantage on water sample collecting was put in use in coral eDNA survey and helped researchers to collect water samples in deep sea which helped their study in the field of eDNA[4]. This provides a fine example of the application of AUV. AUV shows probability in archaeology as well. In 2005 Foley’s team use AUV as a technique to study shipwrecks and achieve a good effect which AUV play a great role inside the study. The importance of AUVs is growing over time.

Overall, AUV’s characters and advantage make it suitable for the requirement of technology in environment monitoring and has already recieve a wide and successful use and application in other areas.

“In the innovation of environmental monitoring methods for water pollution, the staff should first pay attention to building a modern monitoring system.” Create new way of monitoring is very important and AUV technology is perfectly suitable for this job. An AUV contains an upper computer (The computer controls the robot), lower computer robot) and we need to design routine for it[5]. These form a complete system. When underwater, AUV moves in a programmed way. They do not require a tethered cable and because of that, they can swim freely without restriction. AUV can also collect a large number of samples in one turn. They can carry such devices under water and activate them in the water. AUV’s advantage is that it can carry out large-scale detection independently. It can also carry some convenient detection tools, AUV’s advantage makes it possible for them to carry specific materials that can absorb other chemicals. The robot can move from upstream to downstream of the river and collect continuous data then analyze the diffusion trend of pollutants. “A variety of passive sampling devices at different stages of maturity regarding routine use in chemical monitoring are available for the sampling of contaminants with a wide range of physico-chemical properties.” [6].

AUV also have limits as well. It also has some notable points in their design. “It's disadvantage is that the robot itself carries limited energy, and the sailing time is also limited. ”It also require a high-level control system[7]. “Path planning and trajectory tracking are the indispensable components of AUV control systems to perform tasks effectively” AUV requires more detailed sequence design, and better ability to execute commands[8][9]. Thus, AUV requires efficient energy systems that can support long-term operation. The stress in the water environment ans AUV’s motion, speed, the ability to maintain integrity inside water is also of concern. Materials and water resistance ability are point of note as well.

Overall, AUV can collect samples in a wild range and are highly efficient, but we still need to realize their limits and design emphasis and at the same time provide more attention to this in the design process. Design limitations can have a significant impact on the sampling . AUV has already been put into use in various research fields and has achieved some good results. It is resonable to expect that it will play a role in river water environment monitoring and will achieve valuable outcomes.

### 2.3 Monitor Water Environment in a Dynamic Way

Dynamic monitoring is defined as continuous, real-time monitoring of an object. It is valuable to use dynamic monitoring as a method to monitor water environment.

With the development of technology, it is necessary to update the monitoring methods to fit the need of environment monitoring. “In the process of monitoring specific pollution sources, in order to achieve scientific and accurate monitoring of water pollution, relevant units and staff must conduct scientific research on the sampling location of wastewater, clarify the relative standard deviation of wastewater pollution monitoring data under different sampling conditions, and then rationally select the sampling location of wastewater based on this.” Obviously, these biases are of great concern[10]. Environment monitoring is becoming more and more important in the modern world and is also closely related to our lives. Therefore their accuracy is therefore increasingly important.We must consider the uneven distribution of pollutants in water. It is also worth considering how water flows and the different directions in which it flows. Changes in the distribution of pollutants in the water are also interesting information. Traditional methods do not have a comprehensive understanding of the water, the depth of the water and the direction of flow because traditional methods only take samples in few specific places. These specific places may not represent the whole stream and are incomplete which may cause large bias to the monitoring result. Traditional methods is disable to describe trend of the spread of pollutants.

Current environmental monitoring needs more extensive, comprehensive, dynamic and innovative technical testing means, and AUV, as a high-tech product, has high mobility and flexibility, and AUV can detect water areas in a comprehensive way, it can well meet the current needs and can lad to interesting results.

There are many innovative ways to monitor the environment. The research in 2022 demonstrated that the in-situ fluorescence method for monitoring chlorophyll a (f-Chl a) and phycocyanin (f-PC) in cases of biological pollution such as cyanobacterial blooms has become an effective real-time monitoring technique. This method can continuously and with high resolution monitor the dynamics of cyanobacterial populations, providing crucial data for early warning and risk assessment. However, the fluorescence signals are susceptible to both biological and non-biological factors, and appropriate calibration is necessary to enhance accuracy. Furthermore, the Internet of Things (IoT) and intelligent sensor networks have also been applied to water environment monitoring. The combination of IoT technology and intelligent sensors is the key to achieving real-time monitoring and management of river pollution. By deploying underwater sensor networks, various water quality parameters such as water temperature, pH, dissolved oxygen, conductivity, and turbidity can be continuously monitored. These data can be transmitted in real time to control centers or cloud platforms, enabling remote monitoring and early warnings, thereby providing support for timely remedial measures. A particular example is the use of drones to collect water samples of Shenbei ecological environment branch[11]. On July 10, 2024, drone technology was successfully used to complete the surface water sampling work of Yangshi Reservoir and Maoshan Reservoir within the jurisdiction in ShenYang city. This example successfully reduce resources required for environment protection and improve work efficiency and reduce safety hazards and significantly shows the benefit of technology in environment protection. AUV shows similarity with this example. The application of innovative technologies is becoming increasingly important. As mentioned before, underwater robots already play a role in many areas and fields, including Marine biology research, sampling and so on but no one has ever used underwater robots to monitor the environment. Also, the traditional methods of sampling water resources ignore the flow of water and the uneven distribution of pollutants in water. Such monitoring methods are not enough to fully monitor the water environment. Thus, new dynamic monitoring method which use high technology are strongly required by now.

Current environmental monitoring needs more extensive, comprehensive, dynamic and innovative technical testing means, and AUV, as a high-tech product, which develop fast in recent period and become wide applicate has high mobility and flexibility, and can detect water areas in a comprehensive way, can well meet the current needs and show great importance and can have advantage compair with traditional water monitoring and make great innovation.

## 2.4 Research Gap

Underwater robots already play a role in many areas, including Marine biology research, sampling, marine environment monitoring and so on but no one has ever used underwater robots to monitor the river environment. The conbnition of AUV and dynamic monitoring of environment is a brand new idea and is worth exploring. Also, the traditional methods of sampling water resources ignore the flow of water and the uneven distribution of pollutants in water in other words in has significant limits. Traditional detection methods are non-dynamic which means they ignore the the diffusion process of pollutants. At the same time, there are some limitations due to the limited sampling sites. Overall, these kinds of sampling lack complete detection to the environment and do not fit to the trend of development of environment protection. Such monitoring methods are not enough to fully monitor the water environment. We need more comprehensive, advanced and complete testing. We also need to track pollutants in rivers and build new, modern detection. Due to its own characteristics, AUV is able to solve this question and build a new system which is more efficient and complete. AUV shows probability to solve the limit of traditional water environment monitoring and the result of using AUV as a tool for water environment monitoring in river stream is worth expecting. AUV also shows the probability of fixing the problem of environment monitoring and making progress. Overall, the application of AUV shows the possible new direction of development in this field.

### 2.5 Research Questions

What is the overall advantage and benefit of using AUV to provide dynamic monitoring of water environment compared with traditional water environment monitoring and how can we compare them using data we found?

What kind of difficulties and challenges will AUV face in river water environment and in monitoring process and how to solve them?

In future research, how can we improve AUV design ?

## 3 Methodology

### 3.1 Data Collection Basic

This research is a quantitative research and it is going to collect various coefficients reflecting water quality and compair the effect of human and robot on data collection. For sample collection, I am going to choose river Chenghe (from Shangchengqiao to Chengheqiao section) and Wanquan River (from Haidian Park to Furongli). For data collection tools, I am going to collect water samples from the shore using simple water quality test kits as a comparison of underwater robot. The advantages and disadvantages of data accuracy, efficiency, coverage, will be measured and facts related to the performance of the robot will also be tested. This helps me compare the differences between the expected and actual effects of the robot and analyze what challanges robots are facing.

### 3.2 Underwater Robot & Detection Tool Introduction

For under-water robot, the base of the testing robot is based on Sea Perch kit, a type of under water robot with simple structure[12]. The experiment will use the propellers of the kit and the pipeline structure. Buoyancy materials will be applied as assist to control upward and downward functions of the robot. The weight on both sides of the robot is evenly distributed, so it can maintain a stable posture in water. As for controll chip we use LoRa (Long Range Radio), a kind of wireless communication module as the base to communicate. LoRa can achieve long-distance data transmission with low bandwidth, and is particularly suitable for scenarios that require low-rate and long-distance communication, such as intelligent agriculture, environmental monitoring, and underwater sensor networks. The robot was equipped with a timing chip and use wireless control method. Use the core motherboard Arduino UNO. First, burn the program written on the computer onto the chip. Then, connect the LoRa module to the USB to TTL module and the Arduino development board. Next, configure the parameters of the LoRa module. Finally, connect the LoRa module to the development board, modify the program and test the communication. Instruments capable of collecting data are also equipped on robots. The robot is connected to a ph detector, a turbidity detector, a digital thermometer, a oxygen content detector as monitoring instruments. They will be connected to main chip through wire. These components will be removed from the original instrument and connected to the existing chip through welding. As for the tridional water detecting method, all kinds of instruments still exist but the testing procedure was taken by human.

### 3.3 The Significance of the Detected Values

These four quality will be mainly tested: ph , turbidity, water temperature, oxygen content ad in water and the time required for testing. These data are of great significance for water quality testing. It reflects the acid-base balance of the water body, and this condition is directly related to the survival of aquatic organisms. Turbidity related to pollutants and heavy metals. Oxygen content in water affect dissolved oxygen, biological metabolism and pollutant degradation. The time consumed for the detection is directly related to the efficiency of task completion.

The weight is related to the buoyancy and stability of the robot in water, and at the same time, the weight of the underwater robot is associated with the ease of movement of the underwater robot.The speed of underwater robots is directly related to the efficiency of the robots and can help them counteract the flow of water.The signal delay directly reflects the control timeliness of the underwater robot and indicates the robot's ability to receive real-time feedback.

The simple structure of underwater robot contain: detection tool, control chip, motor and propeller. The body of robot is formed by plastic tube.

These quality will be analyzed by 4 types of device. ph detector, turbidity detector and temperature detector and underwater oxygen sensor. All four detection instruments are small-sized devices that can be carried by robots and connected to the main unit via wires. They collect data for monitoring purposes.

### 3.4 Cellect Data from River

Data of water will be collected from Ching river (from Shangchengqiao to Chengheqiao section) and Wanquan River (from Haidian Park to Furongli).

Qinghe River flows through Haidian, Chaoyang, Changping and other areas in Beijing, covering the urban core area, the urban-rural fringe and the suburbs. It is convenient for setting up sampling points. Wanquan River is located in Haidian District and passes through areas with a high concentration of universities. The sampling points are well-connected and convenient for transportation, making it very suitable for studying the impact of urban domestic sewage and rainwater and they could represent river in Haidian distinct.

### 3.5 Test Procedure

In order to solve the two problems of the experiment, different data were collected for each of the two issues.

For collecting data in water, use robots and manually place the sensors that measure the corresponding indicators into the water.When the sensor indicates that the measurement is complete, retrieve it and bring it ashore. Repeat this process for 30 times, conducting experiments at different locations and positions which was randomly selected within the lake.

To collect data from the underwater robot, first, the expected data is required, and second, the data needs to be obtained from the robot. The data references for the expected weight, speed and signal delay of the robot can be calculated through a mathematical model. In reality, the speed of underwater robots can be calculated by releasing them in a pool and measuring the distance they travel.

### 3.6 Step of Data Collection

To ensure the scientificity and rigor of the comparison, the experiment will be conducted in a fixed area within the lake (for example, a 100-meter radius), and data will be collected 3 meters below the water surface. For the three key water quality parameters - pH value, temperature, and dissolved oxygen - two data collection methods will be employed:

Robot collection method: Use underwater robots equipped with corresponding sensors for measurement. The robots will cruise and sample at random selected different locations within the lake. When the sensors indicate that the measurement is complete, the robots will be recalled to the shore and the data will be exported. This process will be repeated 30 times in each lake to ensure the representativeness and statistical significance of the data. For example, some self-powered sensing technologies utilize water flow energy collection systems, enabling long-term continuous monitoring.

Traditional manual collection method: Operators carry sensors of the same type and calibrated standards at the same locations and depths as the robots for manual sampling. After the data collection at each sampling point is completed, relevant parameters are manually recorded. This process is also repeated 30 times in each lake.

The experimental equipment will be in good condition and calibrated to ensure that the measurement benchmarks of the sensors used in both methods are consistent. During the monitoring process, the time points and geographical coordinates of each collection will be recorded in detail for subsequent spatio-temporal correlation analysis.

### 3.7 Data Analysis (Organization of of Data)

To conduct a comprehensive assessment of the robot's functions, the following expected indicators need to be set:

Measurement accuracy: The expected error for pH value is less than ±0.05 pH units. The expected error for temperature is less than ±0.1°C. The expected error for dissolved oxygen is less than ±0.1 mg/L. The expected battery life is that a single charge can enable continuous operation for 4-8 hours. The expected data integrity is that the data transmission success rate is above 95%.

Place the robot on a known-length track, measure the time it takes to pass through the track, and calculate the actual average speed.

Use precise weighing equipment to measure the actual weight of the robot.

Through data transmission tests conducted under different distances and environmental conditions, record the average time for data packets to travel from transmission to reception, to evaluate the actual signal delay. Continuously operate the robot until its battery runs out, and record the actual working time. Calculate the ratio of the number of successfully received data packets to the expected number of data packets within the given time period.

### 3.8 Specific Indicators for Measuring Efficiency and Accuracy

Efficiency indicators include task completion time, which is the time required to complete the same monitoring task. Energy consumption rate, which is the energy consumption per unit time or per unit task volume (such as per kilometer of cruise).

Data collection rate, which is the number of data points successfully collected per unit time.

Cost-effectiveness, which is the cost savings or efficiency improvement compared to traditional manual methods when achieving the same monitoring goals.

Compare the differences between the expected and actual functions of the robot. Use bar chart to show results.

## 4 Results

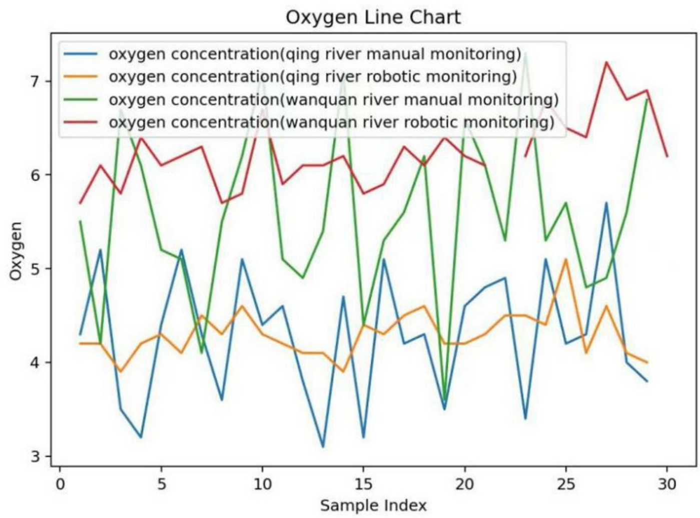


**Fig. 1.** The comparison of oxygen concentration trend from Qing river and Wanquan river using human and under water robot in 30 dection time.

As illustrated in Fig. 1, we compared the dissolved oxygen concentration trends in the Qing River and the Wanquan River based on both manual measurements and measurements collected by the underwater robot. In both rivers, the manually collected data exhibit pronounced overall fluctuations, whereas the robotic measurements, despite still showing certain variations, present a noticeably more stable temporal profile with reduced amplitude. Significant discrepancies between the two measurement methods are observed at the 3rd, 5th, 7th, 9th, 14th, 16th, 17th, 20th, 24th, and 28th detection times, during which the manual measurements deviate considerably from the robotic results. These divergences suggest that manual sampling may be more susceptible to environmental disturbances or human-induced errors, while the underwater robotic platform provides enhanced stability and repeatability during continuous monitoring.

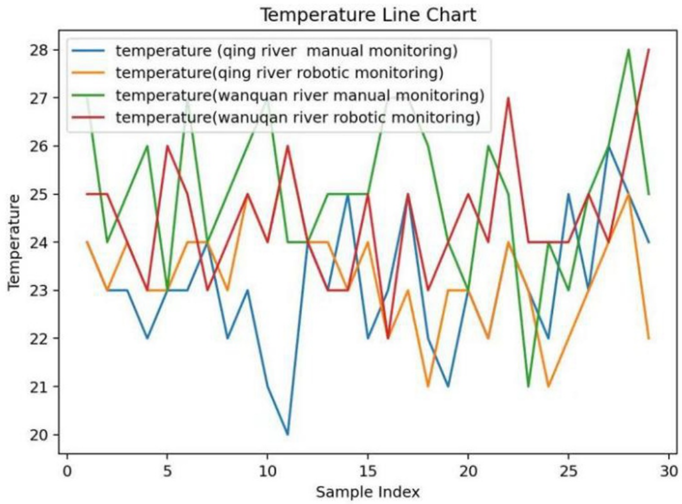


**Fig. 2.** The comparison of temperature detection trend from Qing river and Wanquan river using human and under water robot in 30 dection time.

As shown in Fig. 2, the temperature measurements from both the Qing River and the Wanquan River exhibit relatively small overall fluctuations; nevertheless, noticeable differences between manual and robotic measurements are still present. In the Qing River, significant discrepancies are observed at the 2nd, 6th, 7th, 11th, 17th, 22nd, and 29th detection times. In the Wanquan River, differences between the two measurement methods occur at the 5th, 6th, 11th, 17th, 19th, 24th, and 28th detection times. These divergence points indicate that, even under relatively stable temperature conditions, manual measurements may still be influenced by sampling variability, whereas robotic measurements maintain higher consistency during continuous monitoring.

As illustrated in Fig. 3, the pH detection trends collected from the Qing River and the Wanquan River reveal several points of divergence between manual measurements and those obtained using the underwater robot. In the Qing River, notable differences are observed at the 3rd, 18th, 19th, and 29th detection times, where the manual results deviate considerably from the robotic measurements. In the Wanquan River, significant discrepancies appear at the 12th, 20th, and 24th detection times. These results indicate that even for parameters such as pH—typically more stable than dissolved oxygen or temperature—manual sampling may still be prone to variability, whereas robotic detection provides more consistent readings across repeated measurements.

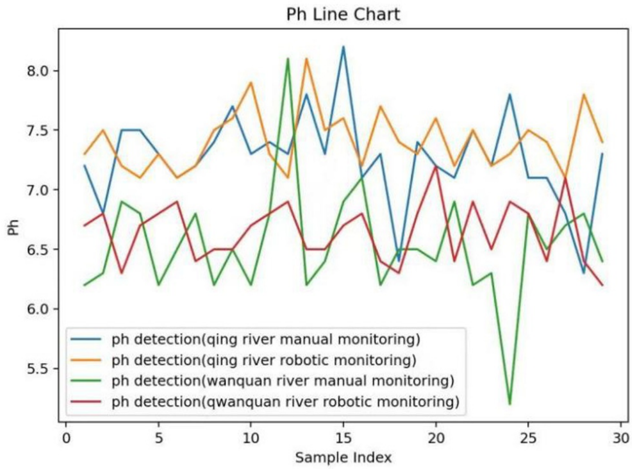


**Fig. 3.** The comparison of PH detection trend from Qing river and Wanquan river using human and under water robot in 6 dection.

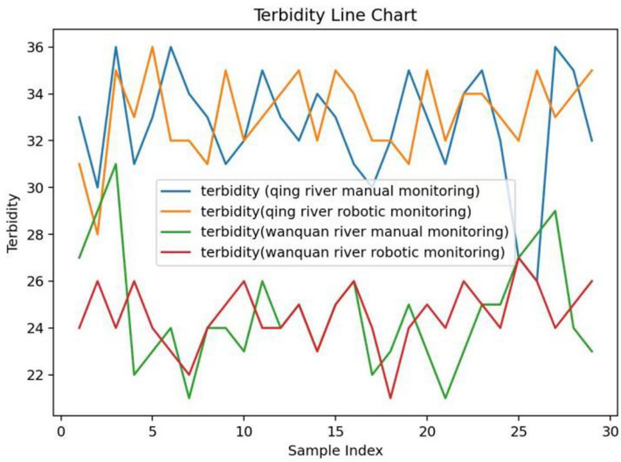


**Fig. 4.** The comparison of terbidity detection trend from Qing river and Wanquan river using human and under water robot in 30 detection.

As presented in Fig. 4, the turbidity detection trends for the Qing River and the Wanquan River further highlight the variability between manual and robotic measurements. In the Qing River, significant discrepancies are observed at the 6th, 9th, 19th, 25th, and 26th detection times, where manual measurements deviate noticeably from those obtained by the underwater robot. In the Wanquan River, marked differences occur at the 3rd, 10th, and 27th detection times. These divergence points suggest that turbidity measurements—often affected by localized disturbances, sediment movement, and sampling technique—may exhibit higher sensitivity to human-induced variability, while robotic measurements maintain greater stability across repeated observations.

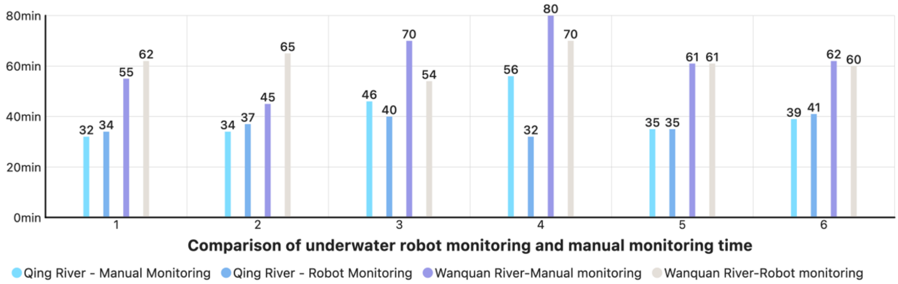


**Fig. 5.** The comparison of the monitoring time required by humans and underwater robots for obtaining data.

As shown in Fig. 5, the average monitoring time required by human operators and underwater robots was compared across three monitoring sessions. For both rivers, the monitoring duration for each method remained generally stable across repeated trials, and no abnormal values were detected. The results indicate that, within the same river, the underwater robot consistently required approximately 12%–15% less time to complete data acquisition compared with manual measurement. This pattern remained uniform across all three monitoring sessions, demonstrating the robot's higher operational efficiency and its capacity to streamline repetitive environmental monitoring tasks.

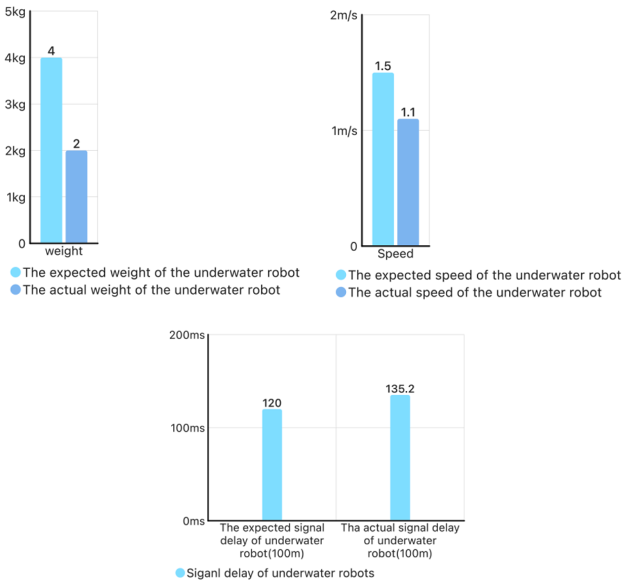


**Fig. 6.** Comparison between expected indicators and actual indicators of the robot Compair 3 aspects: weight, speed, and signal delay.

As illustrated in Fig. 6, the comparison between the expected performance indicators and the actual measurements of the underwater robot reveals noticeable gaps across all three dimensions—weight, speed, and signal delay. Although the degree of deviation differs among indicators, none of them fully meet the initial design expectations. The actual weight of the robot is approximately half of the anticipated value, while its operational speed reaches only about two-thirds of the expected speed. In terms of communication performance, the measured signal delay shows an additional 15.2 ms compared with the expected specification. These discrepancies highlight areas where further optimization of structural design, propulsion efficiency, and communication modules will be required to align the robot's performance with its original design goals.

There for 6 roles of data collection, each time an underwater robot is used for monitoring, the time spent is shorter than that of manual monitoring. The robots also demonstrated smaller fluctuations in data.

From the comparison of the expected and actual functions of the robot, many of its data fall short of expectations. This proves the future development potential of underwater robots. Also it must be noted that this is merely a sample robot. To obtain more comprehensive data, more similar robots need to be provided for reference. Standardized production steps for the robots used in the test should be sorted out to reduce experimental errors.

For similar low-priced robots in the future, after experiments, the following solutions have been devised.

Given that the weight distribution and resistance issues of the robot were not taken into account during the design process, it is necessary to optimize the structural design of the underwater robot to address the remaining instability problems. A 3D-printed polylactic acid shell was used, and a silicone layer was applied to its surface. The results of the fluid dynamics simulation show that the resistance coefficient has decreased by 21 percent. Meanwhile, when assembling the robot, finite element analysis (FEA) should be used to optimize the buoyancy distribution and weight configuration of the robot, so that it can have a compact structure. Meanwhile, since the monitoring equipment and instruments are independent of each other, the new robot integrates all modules into a unified control system based on the Arduino UNO architecture. The overall weight of the newly constructed robot is 1.8 kilograms and it can perform stable submersion at a depth of 2 to 3 meters. Preliminary tests show that the communication delay is less than 15.2 milliseconds, ensuring the stability of data collection. These improvements collectively ensure reliable operation and high data integrity, minimizing data fluctuations as much as possible, thus supporting dynamic water environment monitoring with minimal human intervention.

## 5 Discussion

Underwater robots could increase the efficiency of water environment monitoring and it also plays a certain role in the monitoring of water environments. The data collected by underwater robots are more stable, have fewer outliers, and also consume less time. In the 30 measurements, the turbidity of the water body measured by the underwater robot was consistently more stable than that measured by humans. Moreover, compared to the abnormal values measured by humans, althought outliers still exist, there were less significant difference in the underwater robot's measurements. The overall data is stable. Also, it can be seen that in the same river, the robot requires less measurement time than a human for about 12% to 15%.

After the initial improvements, we also discovered that before designing such relatively simple robots, it is necessary to optimize the structure, conduct fluid dynamics simulations, and optimize the internal buoyancy distribution to ensure the balance of the weight configuration. Additionally, before creating such simple robots, it is necessary to ensure that all the components are integrated into a single system and that the system is stable. The underwater robots used for monitoring the water environment of lakes still need to adjust the distribution of their weights, improve the performance of their engines, optimize the transmission of delayed information, and further deepen the research focus on overcoming technical obstacles.

It can be known from the experimental data that robot's expected weight, speed and signal delay did not meet the expectations. Meanwhile, it's worth noting that the current mainstream research is mainly focused on solving technical problems so adopting innovative technologies has become the mainstream trend in research. Here is one example "adopting appropriate technical means to reduce resistance has become one of the current hotspots in the design and research of underwater robots."More efforts should be devoted to solving similar functional problems, such as insufficient motor power and unstable propellers. This can maximize the efficiency of the robot[13].

At the same time, we should also be aware of the possible impact of weather and rainfall on the monitoring indicators. Precipitation can dilute the concentration of pollutants in water, and it can also cause changes in water temperature, which may interfere with the measurements made by the instruments. The terrain of Qinghe River and Wanquan River is relatively simple. Therefore, when going to more natural environments or conducting more complex environmental tests, the terrain that may cause communication disruptions needs to be considered.

## 6 Conclusion

Since the experiment still requires more test runs, this time the experiment is unstable. The conclusion of this experiment still needs to be verified through more repetitions to demonstrate its functionalityand need to be test more in depth. More data is needed. More tests are needed. Data should be obtained from a wider variety of sampling locations, and more detailed analytical methods should be employed for the analysis. However, based on the current data, it can be seen that underwater robots will play a more significant role in future environmental management. Due to their small size and high flexibility they could increase the efficiency of water environment monitoring through reducing time and can provide more stable data compair with triditional method of water sample collecting.Spending less time and creating more stable data will become underwater robots' unique advantages. However, at the same time, by comparing with the data I had expected, it can be observed that the underwater robots used for rivers have some room for improvement and are worthy of further exploration. This study found that by optimizing system control and structural control, it was demonstrated that even relatively low-cost autonomous underwater vehicle platforms can be technically improved, enabling high-precision environmental monitoring and opening up new possibilities for scalable dynamic monitoring networks. Efficiency of under water robot could still be improved via test type and power source. It is necessary to address the structural and functional issues that the robot might encounter. In the future, we should expect that more advanced technologies will be widely applied in the field of underwater robots.

In the future, efforts should be focused on expanding the potential application market for underwater robots. Interfaces that can be compatible with other measurement devices can be added to underwater robots, simplifying the operating system while optimizing the structure and materials to reduce the price of the robots. If improvements can be continuously made, underwater robots will surely be able to perform even more important functions.

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