Scholar Publishing Group
Academic Journal of Environmental Biology
https://doi.org/10.38007/AJEB.2020.010203
ISSN 2789-8407 Vol. 1, Issue 2: 18-25

Biological Monitoring System of Water Environment Based on Human-computer Interaction Technology

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Keywords: Human-computer Interaction, Aquatic Environment Biology, Biological Monitoring, Monitoring System

Abstract: With the continuous development of the national economy and society, the concept of sustainable development also puts forward new requirements for the development of water conservancy, and the pollution of lakes hinders the development of water environment. It can be seen that the management of river and lake environment is particularly important. Monitoring and early warning of biological dynamics in the aquatic environment is particularly important. The purpose of this paper is to study the biological monitoring system of water environment based on human-computer interaction technology. It is proposed to combine computer human-computer interaction technology with water quality biological monitoring technology, and try to design a biological water quality monitoring system to realize comprehensive monitoring of water quality and early warning of water pollution. Through the research and analysis of the environmental monitoring system based on human-computer interaction, a set of client-side human-computer interaction scheme and UI scheme suitable for the system is designed and implemented, and the system is tested for biological monitoring of water environment.

1. Introduction

There are basically two ways to monitor pollutants in the ecological water environment. The former mainly detects the pollution of the water environment by measuring the water, sediment and sediment in the target water environment. However, this method has certain limitations. It can explain the ecological status of the waters in the short term, and cannot directly reflect the degree of damage to organisms in the water environment [1-2]. The latter mainly reflects the concentration of pollutants in the water environment by monitoring the content of pollutants in aquatic organisms. This method can directly help determine the impact and toxicity of pollutants in the water environment. The process of pollutant accumulation in organisms can reflect the long-term pollution of the water environment. Status, and has the role of early warning [3-4].

At present, it is urgent to improve the technical level of water quality biological monitoring in my country, and give full play to the application of biological monitoring in water environment management [5]. Jeong Y evaluated the balance and dynamics for monitoring a range of organic pollutants (Log K-OW from -0.03 to 6.26) in effluents from wastewater treatment plants, wastewater treatment plants on the receiving rivers Saar and Moselle Performance of passive samplers. The Organic Chemistry Integrated Sampler (POCIS) and the novel Mixed Polymer Sampler (MPS) were selected as kinetic and equilibrium passive samplers, respectively. Concentrations were described in terms of time-weighted average concentrations measured by POCIS (C-TWA) and equilibrium concentrations analyzed by MPS (CEquil-MPS) and POCIS membranes (CEquil-PES) [6]. As Human-Computer Interaction (HCI) strives to study and theorize how people behave and interact with evolving technologies, an important, emerging question is the ensemble of intrinsic qualities such as self-awareness and agency. To analyze this issue, some scholars draw on Michel Foucault's ethic of "caring for the self", which examines how the self is constituted through conscious and reflective work of self-transformation. and presents three case studies to illustrate how individuals practice themselves to reflect and negotiate their relationship with technology [7]. Therefore, the relevant information obtained on the basis of the establishment of a water environment biological monitoring system will play an important role in the development of other advanced water quality biological monitoring indicators in the future [8].

This paper proposes a design idea of applying human-computer interaction technology to the biological monitoring system of water environment. The purpose is to provide a design method to obtain various parameters for the early monitoring and early warning system technology of water quality. According to the essence and content of the project, this system is suitable for the monitoring of residents' drinking water outlets, as well as for the monitoring of water quality in rivers and lakes, and has a wide range of application value and prospects. Biological monitoring of water environment is a comprehensive research topic and a relatively innovative one.

2. Research on Biological Monitoring System of Water Environment Based on Human-computer Interaction Technology

2.1. Advantages of Biological Water Quality Monitoring

Some aquatic organisms in the water environment are very sensitive to the influence of some pollutants, and they can even react to some trace pollutants that cannot be detected by physical and chemical tests, and show corresponding symptoms of discomfort. Therefore, we know that the biological water quality monitoring method is a supplement and development of the physical and chemical monitoring method. By effectively combining the two, a better monitoring purpose can be achieved and a better preventive effect against hazards can be achieved [9-10] .

2.2. Human-computer Interaction Technology

Since its birth, computers have been an indispensable right-hand man for people, so how to interact with them efficiently and naturally has become an important research topic [11]. The process of human-computer interaction includes three important steps, which are in the order of the interaction:

(1) Transmission of information between people and computers (input and output of data). Computers can process a large amount of data, and the first step for people to use a computer is to transmit data to it, or obtain data through a computer (such as saving the calculation results to a mobile hard disk, downloading music from the Internet through a computer) [12].

(2) Manipulation of computers. Computers can only exchange information with other machines through low-level electrical signals, and their internal data are stored in physical forms such as high and low levels and magnetic states. It is impossible for people to directly control the computer through electrical signals, nor to read and write data directly through the physical state, so the computer needs to provide abstract concepts that people can understand to help people control it [13].

(3) Computer feedback on manipulation. In the process of manipulation, when a person sends a command to the system or takes a manipulation action, the computer needs to generate corresponding feedback to inform the user of the current state of the system. For example, the user provides a picture, and the system searches for similar pictures on the Internet. When the system obtains the search results, it needs to display the feedback results according to the settings of how many pictures are displayed on each page and the size of each picture [14] .

2.3. Water Environment Biological Monitoring System

(1) System construction

The system mainly analyzes the ecological status of live fish in the water body (selection behavior, wild swimming behavior, floating head behavior, slow swimming behavior) to achieve the purpose of evaluating water quality [15-16]. The system converts the movement of live fish into video image data for target detection, tracking, understanding and analysis, and effectively realizes early detection and evaluation of water pollution through real-time monitoring of the movement behavior of live fish [17-18]. The system hierarchy diagram is shown in Figure 1:

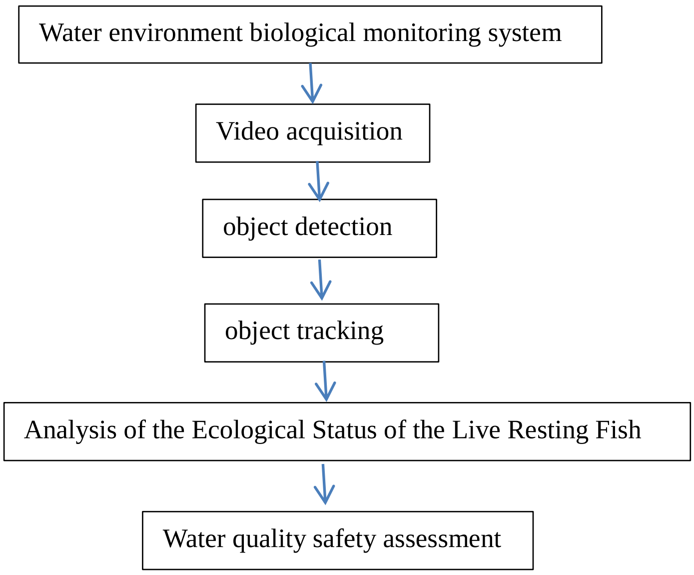

Figure 1. System hierarchy diagram

(1) Human-computer interaction design

The system mainly includes three main parts: client, server and Web. The server is responsible for collecting the data uploaded by the user, receiving and providing services, and storing the data; the web side mainly performs part of the data visualization display work and user management work, which is mainly used by the internal personnel of the system; the mobile client is mainly used by the user To use it, users can obtain and browse various environmental data by using the mobile client, and perform photo uploading operations through the client [19].

The main work of this paper includes client-side human-computer interaction design and user UI design, and the design scheme is implemented through code [20].

The real scene function interface displays the real-time picture of the water environment in the area selected by the user, so that the user can understand the water environment and biological conditions of a certain area more specifically. In the form of waterfalls, a large number of photos are displayed beautifully, and users can easily browse the photos quickly. Users can also load more photos by sliding up and down the interface, which is convenient for users to view more photos. Photos of the same size show a more uniform interface, while photos of different heights highlight the lively style of the interface [21].

3. Experiments on Biological Monitoring of Water Environment

3.1. Experimental Environment

In order to compare the real simulation of real aquatic organisms, live fish are used as the experimental environment for water quality monitoring test organisms. The experimental process in the laboratory is as follows: through the camera, the activity state of the creatures cultured in the cubic fish tank is photographed horizontally. Then the obtained video is transmitted to the water environment biological monitoring system for real-time online processing and analysis. During the experiment, we adopted the experimental environment with constant light and water temperature of 20-26 ℃, the number of live fish in the initial state was 6, and sodium ascorbate was used for dechlorination of water quality. The experimental environment is divided into 3, and the average swimming speed, average swimming height and survival of fish in the three environments are extracted respectively, and the analysis of the experimental data is given accordingly.

3.2. Object Behavior Parameter Extraction and Analysis

This paper proposes to use the average swimming speed of all fish within the monitoring range as the object characteristic parameter in water quality monitoring.

In the tracking process, the center of gravity of the object is selected for tracking, and the two frames before and after the coordinates of the center of gravity of object i are respectively Pi1(xi1, yi1) and Pi2(xi2, yi2), the time interval is s, and the unit is seconds. If the biological indicator The number of fishes is predetermined as M, then the average swimming speed of M live fish can be expressed as formula (1).

$$\bar{v} = \frac{\sum_{i=1}^{M} v_i}{M} \tag{1}$$

To a large extent, its selection behavior is presented. In this experiment, we choose the bottom line as the baseline to measure the position of the subject. If the coordinates of the object i are (x, yi), the height of the video image is H, and the width is W, and if the number of fishes is predetermined to be M, then the average swimming height of M can be expressed as Equation (2).

$$\bar{h} = \frac{\sum_{i=1}^{M} h_i}{M} \tag{2}$$

4. Experimental Data Analysis of Biological Monitoring of Water Environment

The following is to obtain some experimental data on the behavior of live fish according to the above experimental environment settings, and analyze the experimental data.

Experiment 1: Normal unpolluted drinking water quality. The statistics of average swimming speed, average swimming height and surviving number of live fish were extracted. The statistical method is as follows: the experimental period is 6 hours, random sampling is performed once every 10 minutes, and the average value of 6 times is obtained as a record. The distribution law of a total of 6 points is shown in Figure 2.

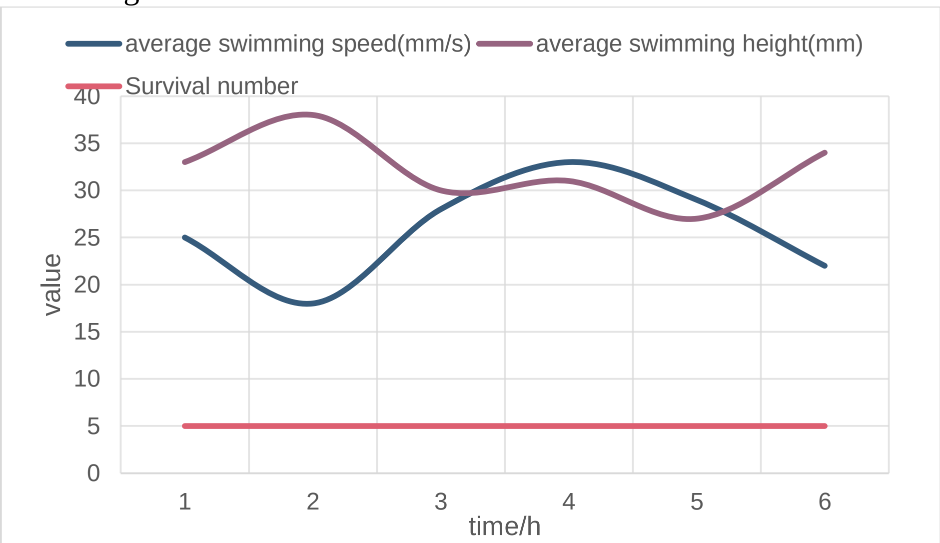

Figure 2. Distribution law of 6 points

Table 1. Behavioral parameters of fish under normal water quality

Time/h	Average swimming speed(mm/s)	Average swimming height(mm)	Survival number
1	25	33	5
2	18	38	5
3	28	30	5
4	33	31	5
5	29	27	5
6	22	34	5

Experimental data analysis: Behavioral understanding of the living fish of the test organisms living in a normal unpolluted water environment. The average swimming speed is evenly distributed at 25mm/s, and the distribution range is mainly 18~33mm/s. The peaks (peaks or troughs) of the short-term average swimming speed do not appear for a long time. The average swimming height is distributed in the middle and upper layers for a long time, the average swimming height is about 32mm, and the distribution range is mainly 27~38mm, as shown in Table 1. The peaks (peaks or troughs) of the average swimming height in the short term do not appear for a long time. The number of surviving fish is obtained according to whether the swimming speed is zero. Experiments show that the number of surviving fish monitored under normal water quality is stable, and most of the time is the number of experimental fish.

Experiment 2: In normal unpolluted drinking water, add a small amount of solid NaOH agent, about 0.1g. Statistical curves of the average swimming speed, average swimming height and surviving number of live fish were extracted. The statistical method is as follows: the experimental period is 30 minutes, random sampling is performed once every 10 minutes, and the average value of 3 times is obtained as a record, and the distribution law of a total of 3 points is obtained. The number of surviving fish in the early and late stages is shown in Table 2.

Table 2. Number of surviving fish in early and late stages

Time/minute	Initial survival	Late survivors
10	5	5
20	5	3
30	5	0

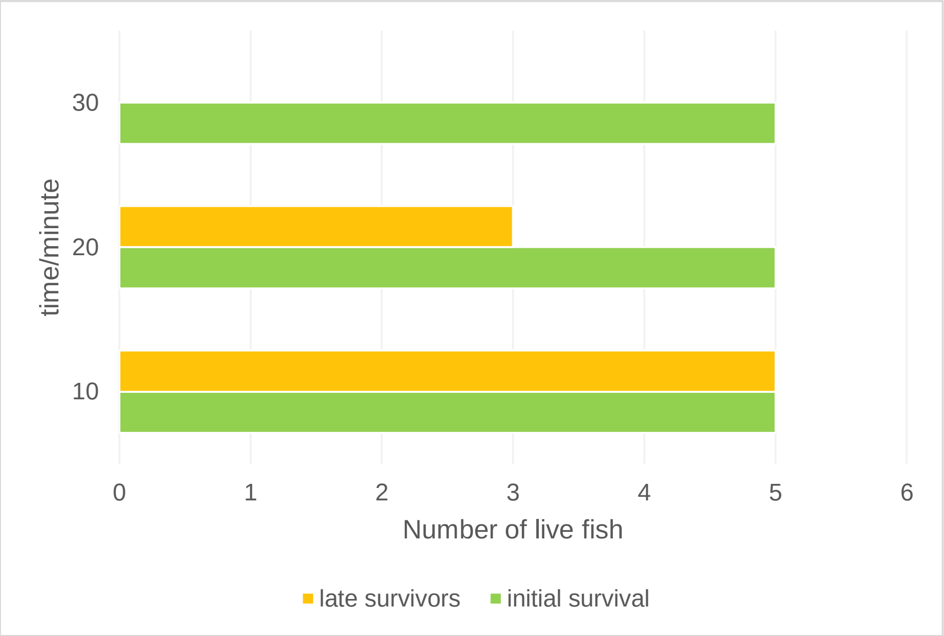

Figure 3. Behavioral parameters of fish in the early and late stages of NaOH contamination

Experimental data analysis: NaOH reagent was added under normal water quality to understand the behavior of living fish. The average swimming speed, in the first 10 minutes, did not change significantly. After 10 minutes, due to the influence of the polluted water quality, the swimming speed of the fish increased significantly, and the behavior of swimming frantically appeared, and the wave band continued to be in a relatively high range. Subsequently, due to the dissolution of pollutants, the polluted water became relatively uniform, and the swimming ability of the fish gradually decreased. After 20 minutes, the swimming speed slowly approached zero. For the average swimming height, in the first 10 minutes, due to the injection of chemical reagents, the innate evasion behavior of fish makes it have the ability to escape danger, and the swimming height has an obvious rising state. After 10 minutes, the polluted water became more uniform, and the average swimming height of the fish slowly returned to a lower height. The number of surviving fish also decreased significantly after 20 minutes of water pollution. After 30 minutes, almost all the fish died, as shown in Figure 3.

5. Conclusion

Human-computer interaction is a technology that studies people and computers and their interaction, and uses some information to communicate between humans and computers to make the interaction more natural and efficient. Based on the research on the water environment monitoring system, this paper analyzes the needs of the client, and draws a client-side human-computer interaction scheme and UI scheme that are more suitable for this system, but there are many areas worth improving. In the process of generating the time-lapse photography video, due to insufficient processing of the original photo data, the generated time-lapse photography video will have jitter phenomenon, and sometimes the video effect cannot meet expectations. It is necessary to perform more processing and operations on the original data of the generated video to avoid jitter in the video as much as possible. In addition, the water environment can be further evaluated and studied.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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