

# ***Intelligent Aquarium Based on Android and Web Technology***

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**Keywords:** Intelligent control, Android, Web, Aquarium

**Abstract:** Aiming at the lack of intelligent control of aquariums sold in the market, the need for manual intervention, and the low survival rate of aquaculture, this paper designs an ecological control system for home intelligent fish tanks, including temperature detection control module, pH detection control module, water level detection control module, etc., to collect and control the living environment parameters of ornamental fish, develop android applications, realize real-time remote monitoring of aquariums through Internet of Things technology, ensure the high-quality ecological environment of fish, and transmit data to mobile APP terminals through WiFi technology to realize intelligent control and management. The design of this system is of great significance for improving the application level of smart home, greatly improving the ability of intelligent control, saving resources and manpower.

## **1. Introduction**

At the end of last century, China began to expand domestic demand and speed up infrastructure construction, which led to rapid economic development. Especially after entering the 21st century, under this background, more and more people began to join the ranks of aquarium lovers, and introduced ornamental fish and aquarium and supplies to families, which not only enriched their leisure life, but also improved the indoor landscape. Based on Android and web technology, this paper designs an aquarium environment monitoring system.

## **2. Overall System Design**

On the hardware side, STM32F103ZET6 is used as the core controller, and peripheral circuits such as environmental acquisition module, control module, power module and communication module are built to complete the system design [1]. Its structure is shown in the local hardware side structure diagram in Figure 1.

"Water rubik's cube" intelligent aquarium bottom tank equipment includes: water pump, protein separator, RO water purifier, trace element titration, etc. These equipment take STM32F103ZET6 as the core controller to realize the orderly work of the whole aquarium.

### 3. System Function Design

### 3.1. Web Server Function

The aquarium monitoring platform is mainly composed of four parts: user management, ornamental fish culture website, environmental monitoring and adjustment and data management, and its overall functional structure is shown in Figure 2.

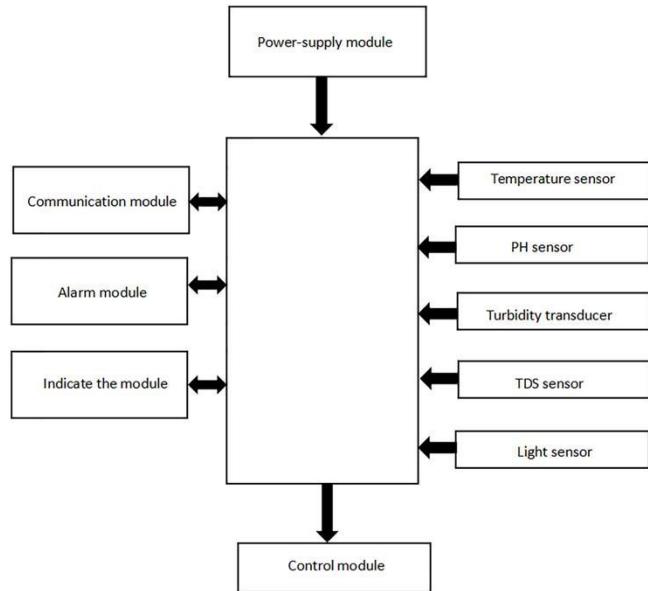


Figure 1: Structure diagram of local hardware end

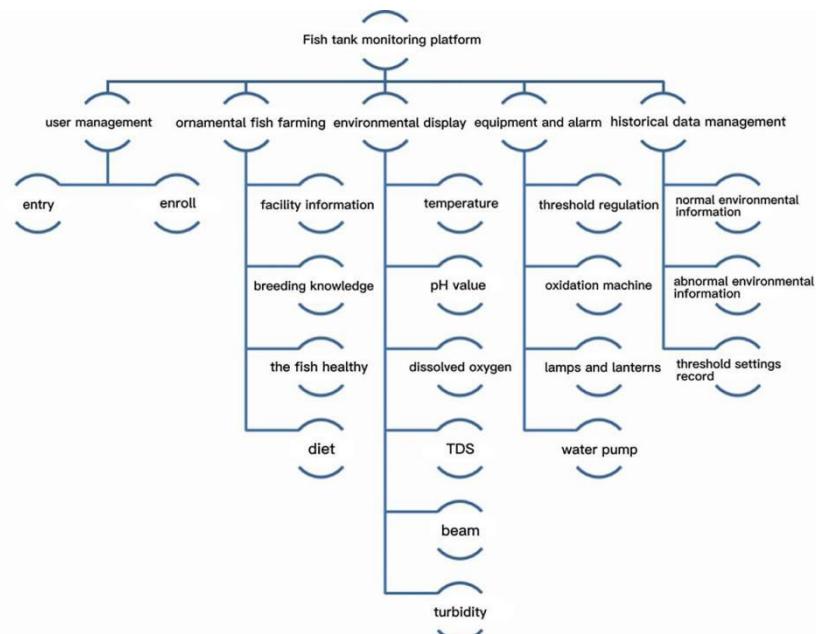


Figure 2: Overall functional diagram of intelligent aquarium monitoring platform of "Water rubik's cube"

(1) User management. Users of the platform are logged in for authentication, and only authorized

users can view and manage the data of the platform.

(2) Ornamental fish culture websites. It mainly consists of three parts: aquarium culture equipment information, daily care and fingerling knowledge of ornamental fish, and food and health, providing users with all-round ornamental fish culture strategies.

(3) Environmental monitoring and adjustment. Including environmental display and equipment alarm, the module is used to display the information of temperature, dissolved oxygen, TDS concentration, water turbidity, pH and illuminance of aquarium water, including real-time data display and dynamic addition of chart data, so that users can observe the recent data changes of water environment more intuitively and adjust the operation of equipment manually, so that they can intelligently adjust the aquarium environment and at the same time manually intervene its environment.

(4) Data management. It mainly includes three parts: historical data display of real-time information of aquarium environment, historical data management when aquarium environment is abnormal and historical setting of alarm threshold, which provides support for data analysis and user viewing.

### **3.2. Android Client Function**

Based on the design principle of Android client, this system divides the client module into real-time environment display module, data analysis module, ornamental fish knowledge module and setting module. The specific functional structure is as follows:

(1) Real-time data display. Mainly responsible for real-time display of temperature, dissolved oxygen, water turbidity, TDS concentration, illuminance, pH and other information in the aquarium.

(2) Data analysis module. Include environmental historical data query, fish species environment match and manual equipment control.

(3) Knowledge module of ornamental fish. It is convenient for users to query the culture strategy information of each fish species and provide manual data entry function.

(4) Setup module. It includes the functions of inputting the information of the current ornamental fish, viewing the user information, viewing the aquarium information and the latest warning information.

## **4. Android Client System**

### **4.1. User Management**

The user management interface mainly realizes the functions of user registration and login.

User registration: users need to register their accounts when using the smart aquarium client for the first time. When registering, they should first check the validity of the data, including whether the input is empty, whether the password length of the account is reasonable, and whether the composition is standardized. HTTP request can be initiated only after the initial check is correct, and whether MySQL contains the user data can be queried. If the user data exists in the database, the registration cannot be successful; otherwise, it means that the user has not been registered and can register. After successful registration, the user's information will be stored in MySQL database and jump to the login interface.

User login: the user can log in only after successful registration, and the user's data is stored in MySQL database. When the user inputs account password information to request the database, only the user information exists in the database can be allowed to log in to the client. If the user data is not found in the database, the system will display the word "Login Failed" and the user is not allowed to log in to the client system.

## 4.2. Environmental Display

The interface is realized by RecyclerView of Android, which is the UI control of Android, and can realize the list display, grid display and waterfall display of data [2]. Here, it is displayed in the form of a list, and each item in the list is a sub-layout of RecyclerView. Temperature, water turbidity, illumination, pH, dissolved oxygen and TDS concentration can share a common layout. In the maintenance of data, array environmentData is used for storage, and the data is adapted through adapter classes. Fig. 3 shows the lighting control interface. The lighting control adopts the fully-automatic simulated sunrise and sunset mode: the sunrise light gradually brightens in the morning, reaches the brightest intensity at noon, and gradually darkens with the sunset in the afternoon.

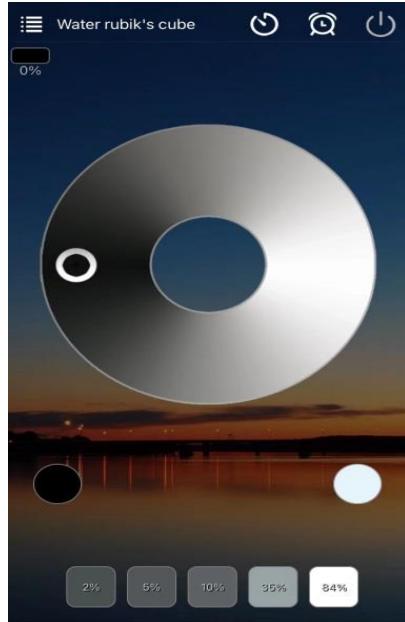


Figure 3: Lighting control interface

## 4.3 Data Management

The interface is mainly divided into three parts [3]:

Equipment control: You can manually control the operation of the equipment. This part requests the Web server to implement through HTTP request.

Selection of ornamental fish species: users can manually select the nearest living environment interval of the fish species they want to view. According to the fish species selected by the user, the system automatically obtains the water quality standard of the ornamental fish and displays it in the corresponding column.

Historical data query: users can query historical data by setting the date range, and the queried data are displayed by line charts. In the design of line charts, the box size of line charts, the thickness and color of drawing lines, whether to display the data of each point and the parameters of vertical and horizontal coordinates should be considered.

## 4.4. Breeding Strategy

The culture strategy module mainly provides users with culture strategy information of ornamental fish, promotes human-computer interaction in a graphical form, and provides users with information such as illustrations, living environment, and culture requirements of various

ornamental fish, so that users can choose their favorite ornamental fish for culture and let them know the culture knowledge of the ornamental fish. And users can manually add the information of ornamental fish, which is convenient for the information expansion of ornamental fish species. When users click on the graphic of each ornamental fish, they can enter the detailed viewing interface and apply it to the system [4].

## 4.5 Information Management

Personal information management interface includes intelligent distribution network, alarm information, user information, ornamental fish data and other modules.

The alarm information mainly records the latest environmental alarm of the aquarium system. The latest record of MySQL database threshold history is queried by HTTP request, and displayed on the interface, which is convenient for users to know the latest alarm information. User information mainly records the user name and other information of the current login account. The information of ornamental fish requires users to manually input data when using the client, including the quantity, species, feeding date and feeding period of ornamental fish in the aquarium at present. The system intelligently matches the best culture strategy for the aquarium and ornamental fish information input by users, so that users do not need to think too much about how to cultivate ornamental fish [5].

## 5. System Technical Basis

### 5.1 Web Server Scheme Selection

#### 5.1.1. Selection of Server Framework

The commonly used frameworks of Web servers mainly include SSH framework, SSM framework and SpringBoot framework.

SSH is mainly composed of spring, Struts and Hibernate, and the system is decoupled by MVC design idea. Struts framework is responsible for establishing the interaction between View and Model and handling the front-end request business; Hibernate is an object-relational mapping framework, which operates the database by binding bean to database tables and accesses the database with object-oriented thinking. Spring framework, as a bridge between the two frameworks, is responsible for the development of business layer. It is convenient to maintain the business layer of the system and reduce the coupling of the system through AOP and IOC control inversion. Although the framework adopts modular programming idea to design the system, it still has great coupling and can't handle the relationship between the front and rear modules well [6].

SSM framework is mainly composed of SpringMvc framework, Spring Framework and MyBatis framework. This framework adopts xml+ annotation mixed configuration mode, which reduces the complexity of configuration to some extent, and uses MyBatis lightweight framework to avoid the disadvantages of Hibernate heavyweight framework. However, the operation of this framework on database is complicated, and the development efficiency of SpringMvc is low, which affects the use of the framework.

SpringBoot is a very popular framework in recent years. This framework is based on Spring framework, which simplifies the complicated configuration of Spring, and basically uses pure annotations to configure the system, so that developers only need to pay attention to their own business logic and don't have to pay attention to the complicated and boring mechanized configuration process. The framework better decouples the system, which is convenient for the later system upgrade and maintenance. Table 1 shows the comparison of the three frameworks.

In order to consider the stability of the intelligent aquarium system and the requirement of later function upgrade, this design adopts the SpringBoot framework to develop the Web server [7].

Table 1: Performance Comparison of Three Mainstream Frames

concept	Spring Framework encapsulation	Spring + MyBatis + SpringMvc	Spring + Struts + Hibernate
Configuration difficulty	simple	medium	More difficult
Configuration method	annotate	annotate+xml	basic xml
Fit degree with other frames integration tomcat	high	medium	low
Development efficiency	high	medium	low
How to deploy	War/jar	War	War
Maintenance costs	low	medium	high

### 5.1.2. Selection of Load Balancing Technology

The technical solutions mainly include Nginx load balancing and Ribbon load balancing. Nginx mainly copies the whole project to each distributed server, and each server has a complete and independent project. When initiating a service request, Nginx will randomly assign the request to a server through an algorithm to reduce the pressure on a server. Ribbon is a component of SpringCloud. SpringCloud adopts micro-service architecture, which divides the whole project into many sub-projects, and each sub-project can run independently, so that the server's requests can be distributed more intelligently by weight in load balancing, rather than simply randomly or evenly.

Compared with Ribbon, Nginx's load balancing technology is not smart enough, and the requests generated by the parts with many business logics are similar to those generated by the parts with idle business, which can't reduce the pressure on the server well. The service request pressure of this system mainly comes from the data display module, and the login registration module requests are relatively few, while Ribbon can better distribute the server requests, so that the server's anti-pressure ability can be maximized. And the load balancing strategy is handled at the local client, which is very suitable for the micro-service architecture design mode, so this system adopts Ribbon as the load balancing technology of the system [8].

## 5.2. Android Client Architecture

### 5.2.1. MVVM Mode

MVVM design pattern is the abbreviation of Model-View-ViewModel. Through this design pattern, the user interface logic and business logic can be further separated, so as to realize the separation of Android UI and data business. This design pattern greatly reduces the coupling of the system and improves its reusability, which provides support for later function expansion. The division of labor of each module is as follows [9]:

Model layer: Model layer is responsible for managing the data and business logic of user programs. This layer monitors the data changes of View layer through Livedata, and transmits its own data changes to View Model layer, providing data support for View Model and decoupling it from View layer.

View Model layer: as the middle layer of MVVM mode, it is responsible for connecting the Model layer and the View layer, and separating the coupling relationship between the Model layer and the View layer through data bidirectional binding.

View layer: As an observer or subscriber in MVVM mode, View layer observes the changes of

data, and once the data changes, it will update UI elements in time to achieve data linkage.

### 5.2.2. The Specific Design of Android Client Architecture

This system designs the Android client architecture based on MVVM design pattern, and maintains the data of intelligent aquarium system including temperature, illumination, dissolved oxygen, water turbidity, pH, TDS concentration, ornamental fish data, user data, threshold data and other information into View Model for management, and establishes a two-way data binding between Android UI layer and Model layer. When the data of Android UI layer changes, it will be synchronized to Model layer immediately. Similarly, when the data in the Model layer changes, it will be quickly synchronized to the Android UI layer. Its structure is shown in Figure 4.

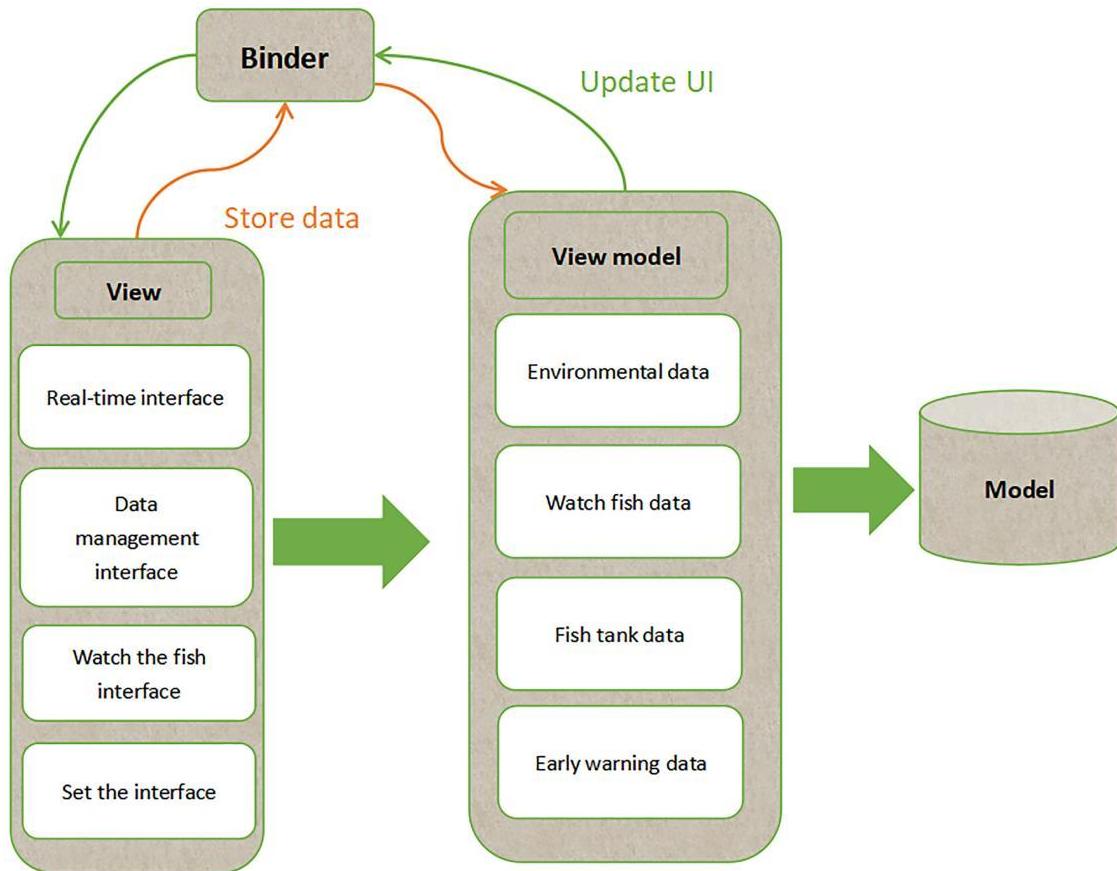


Figure 4: Android client architecture design

The data bidirectional binding between View Model layer and View layer is realized by databinding. Databinding is used to monitor the changes of data in real time and reflect the changes of data to the Model layer and the View layer to complete data linkage. For this reason, it is necessary to bind the view of the Android UI layer and Activity on the traditional Android development mode, and bind the View Model class to the activity.

### 5.2.3. Life Cycle Management

The design of Android client is based on activity/fragment, and the interface required by users is built through the collocation of various controls, in which various business logics are distributed in the life cycle of Activity/Fragment, including `onCreate()`, `onStart()`, `onDestroy()` and so on. Among them, `onCreate()` and `onStart()` are mainly responsible for the acquisition and initialization

of controls, and `onDestroy()` is mainly responsible for the release of resources. This system does not use direct interface management for resource release operation, but uses life cycle monitoring to realize the life cycle management of each interface [10]. Lifecycles object tracks the life cycle of intelligent aquarium components, rewrites the business class to be managed, and hosts it in LifecycleObserver, which monitors the life cycle of the business class. When resources need to be released, it is done automatically by managed classes.

## 6. Conclusion

The system makes full use of the development advantages of remote transmission convenience of Android and web technology, and adopts STM32F103ZET6 as the main controller. Its main functions include: aquarium environmental monitoring and reporting, environmental abnormality indication and equipment control. It realizes the efficient and timely monitoring of the intelligent aquarium system, effectively reduces the overall cost, and obviously improves the intelligence of the aquarium. At present, the system still has great scalability and meets the contemporary requirements for home comfort and intelligence.

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