# Visualization Research and Application of Water Quality Monitoring Data Based on ECharts

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**Abstract:** Water resources are one of the basic resources for human survival, and water protection has been becoming a major problem for countries around the world. However, most of the traditional water quality monitoring research work is still concerned with the collection of water quality indicators, and ignored the analysis of water quality monitoring data and its value. In this paper, by adopting Laravel and AdminTE framework, we introduced how to design and implement a water quality data visualization platform based on Baidu ECharts. Through the deployed water quality sensor, the collected water quality indicator data is transmitted to the big data processing platform that deployed on Tencent Cloud in real time through the 4G network. The collected monitoring data is analyzed, and the processing result is visualized by Baidu ECharts. The test results showed that the designed system could run well and will provide decision support for water resource protection.

**Keywords:** Water quality monitoring, echarts, data visualization.

## 1 Introduction

In recent years, sudden water pollution incidents have occurred in China, which seriously threaten people's water security. Since there are no fixed ways and means of discharge for sudden water pollution incidents, if this matter is not disposed in times, the water supply safety of tap water will be seriously affected. Automatic detection and identification of abnormal water quality indicators [Manish, Rajni, Rupam et al. (2018)]. Then the sewage information will be released as soon as possible, so that the relevant departments can respond quickly and take measures in time to ensure that people's domestic water is not affected. In order to master real-time water quality data, a water quality monitoring and early warning system is urgently needed [Zhang, Cao and Xie (2013); Jiang and Huang (2010)]. The online water quality monitoring system is a comprehensive online automatic monitoring network consisting of modern sensor technology, computer application technology and communication network [Li, Guo and Zhao (2016); Li and Liu (2012); Chu, Zhang, Li et al. (2015); Xiong, Zhu, Lin et al.

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(2014)]. To this end, we use the Laravel framework to design and implement a water quality data visualization platform based on Baidu ECharts, which realizes the visualization of water quality monitoring data and processing results of each monitoring point, and facilitates further analysis of the trend of water quality monitoring data. The protection of resources provides information and decision support.

## 2 Related technologies

### *2.1 Laravel framework*

Laravel [Taylor (2019)] is a simple and elegant PHP web development framework (PHP Web Framework) [Natalya and Victoria (2017)]. Using this framework can avoid messy code, easy to build a perfect network. It has the following characteristics: Grammatical expressive, high quality documentation (Laravel has a great community support), rich extension packs (Laravel's extension packs are contributed by developers around the world and are constantly growing). Open source, hosted on Github Laravel is completely open source. Laravel has grown faster than any other PHP framework in the past seven years, which is a direct reflection of Laravel's strength. The comparison is shown in Fig. 1.

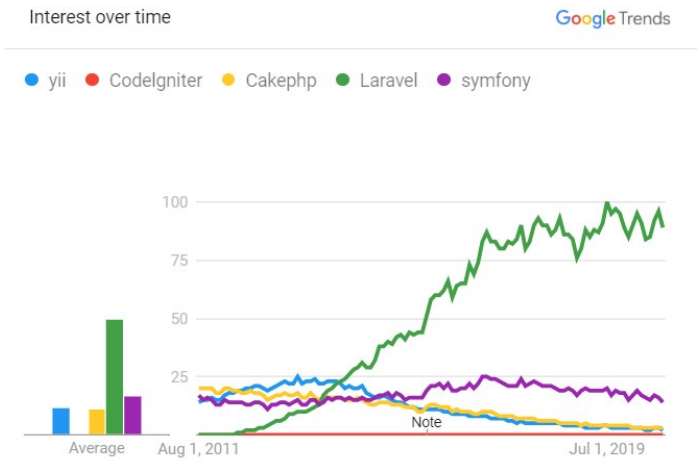


**Figure 1:** Comparison of some PHP frameworks

### *2.2 Adminlte template*

AdminLTE [Almsaeed (2019)] is a bootstrap3-based, fully responsive management template suitable for a wide range of screen resolutions, from small mobile devices to large desktops. 50/5000 Modified translation results have several built-in pages, including dashboard, email, calendar, lock screen, login and registration, 404 error, 500 error and so on. Its use mainly through the following two steps: First, use the package management tool Bower. Bower is a front-end package management tool. The content of the package is not limited. It can be a comprehensive framework, such as Bootstrap, or a JS library, such as jQuery, or it can be a picture, a font, and so on. You can download AdminLTE to use it by executing the Bower command "$ bower install admin-lte--save".

### *2.3 Baidu echart*

ECharts [Dave, Kevin, Wu et al. (2019)], abbreviated from Enterprise Charts, which is commercial-grade data charts, an open source visualization library based on JavaScript. It has good compatibility and can be run on various terminals. It is suitable for most current browsers (IE8/9/10/11, Chrome, Firefox, Safari, etc.). The bottom layer depends on vector graphics Library ZRender, you can choose personalized visual charts according to your preferences. It uses Ajax+JSON+JQuery+MVC architecture to acquire data through Ajax technology and set data using templates for configuration data. Proceed as follows: first initialize (init), then configure Option, and finally set Option (myChart. setOption (option)). Using Baidu ECharts, the focus of work only needs to be placed on the data, which greatly reducing the programming burden.

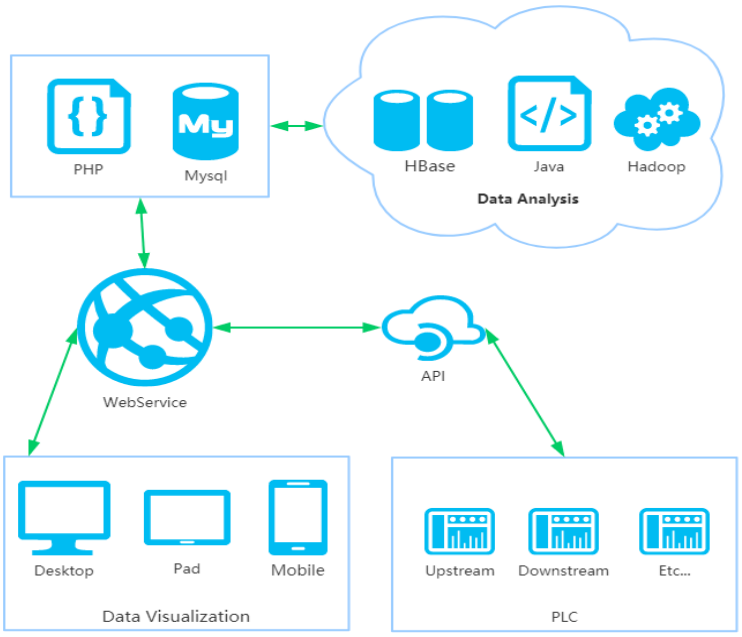


**Figure 2:** The platform frame

## 3 Platform design and implementation

Benefit from the rapid expansion of sensors and Internet of Things technologies, various departments have accumulated a large number of water quality indicators, but they have neglected the resource attributes and data values of water quality data obtained through testing. Now that we are in the era of big data, the core value of big data is precisely the need to achieve scientific predictions of the current situation or problems through tools such as big data collection, mining, and analysis based on the accumulation of factual data [Bansal, Gaur and Singh (2016)]. A scientific warning of the future situation, to make decisions more scientifically and intelligently.

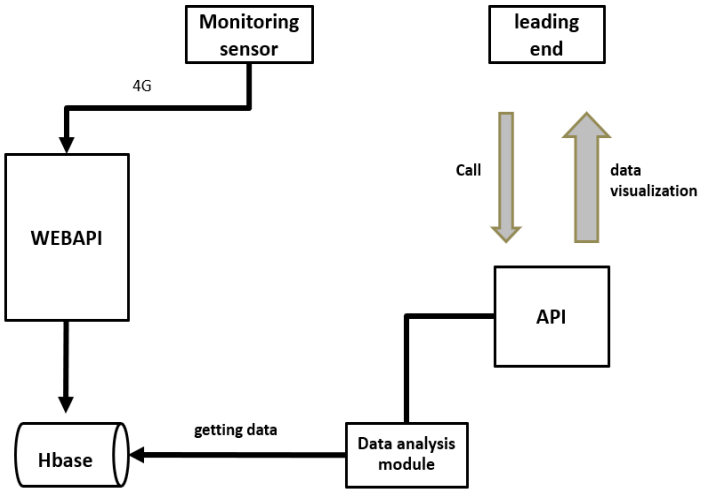


**Figure 3:** The data flow

### *3.1 Architecture design*

The WEB part of the platform adopts the mainstream Laravel framework. The reasons for using this framework are as follows: First, it uses a lot of design modules to make the application more flexible. Secondly, the framework design pattern full follows the five basic principles of the design pattern. Finally, each module has strong independence, the server can easily extend the framework features. The background UI adopts AdminLTE, which is a lightweight background template based on Bootstrap. The framework is beautiful, the skin is diverse, and it can adapt to the mobile terminal. The overall architecture design is shown in Fig. 2.

**Table 1:** The development environment and programming language

| Development Items | Development Tools |
|---|---|
| Development platform or architecture | NET Framework 4.0; Microsoft Visual Studio 2017; JDK1.8; PHP7.2; Apache/Nginx; Apache Hadoop |
| Database | Mysql5; InFluxDB |
| Programming language | PHP7 C#; C; JavaScript; HTML5 |

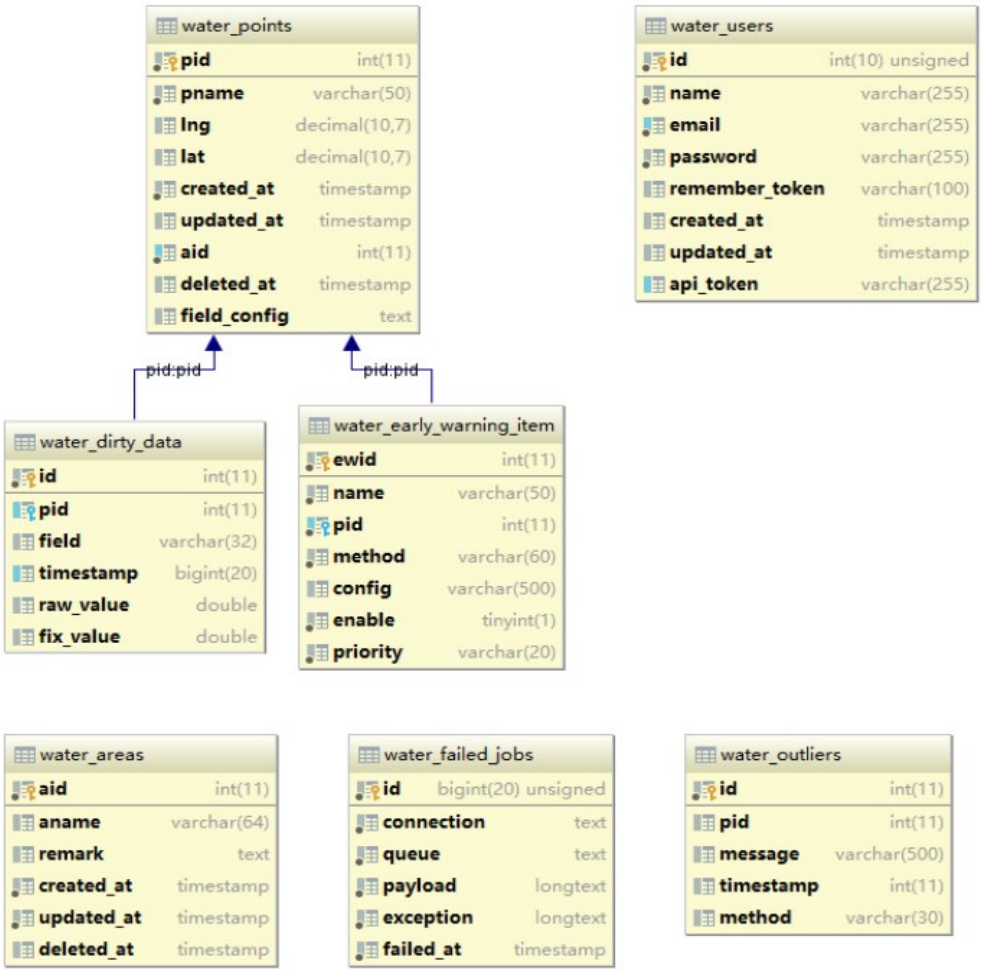


**Figure 4:** The database structure

The main purpose of the platform is to enable users to view water quality in a timely and intuitive manner, as well as to analyze future water quality based on past comprehensive data. Collecting data to the server is that the data collected by multiple sensors is uploaded to the WEBAPI through the network, and the data is stored to the HBase through the API. To the front end display, the data analysis module directly extracts the data from the HBase for averaging (Of course, according to the actual need to use different processing functions to process the data), and then the front-end calling API is displayed by the Echarts plug-in as a line chart (other types or types of charts can also be used according to actual needs). The data processing process is shown in Fig. 3.

### *3.2 Software development environment*

In order to simplify the development process, we did not directly purchase the corresponding server hardware. Instead, we rented Tencent cloud space and deployed the

entire system software platform on Tencent Cloud. Tencent provided cloud computing resources to reduce development costs and network security pressure. The development environment and programming language used are shown in Tab. 1.

### *3.3 Database design*

The water quality monitoring data collected by the platform is time-sequenced data that changes with time. Semi-open-source InfluxDB is the benchmark for new-generation timing databases, so InfluxDB is the first choice in applications where timing data needs to be stored [Jing (2018)]. Through the analysis of the processed data structure and value range, combined with the actual application requirements, the database of the platform mainly includes water_points, water_users, water_failed_jobs, water_early_warnnig_item and other data tables. The structure is shown in Fig. 4.

### *3.4 Water quality monitoring data visualization*

We chose Mysql as the data storage database, and the collected water quality monitoring data is stored in it through the API interface. Combined with WebService, InfluxDB and other tool frameworks, the processing and analysis of the data will be completed, and Baidu's Echarts [De (2017)] is used to send visual results of monitoring data to the computer and other terminals through Webservice. The effect is shown in Fig. 5.

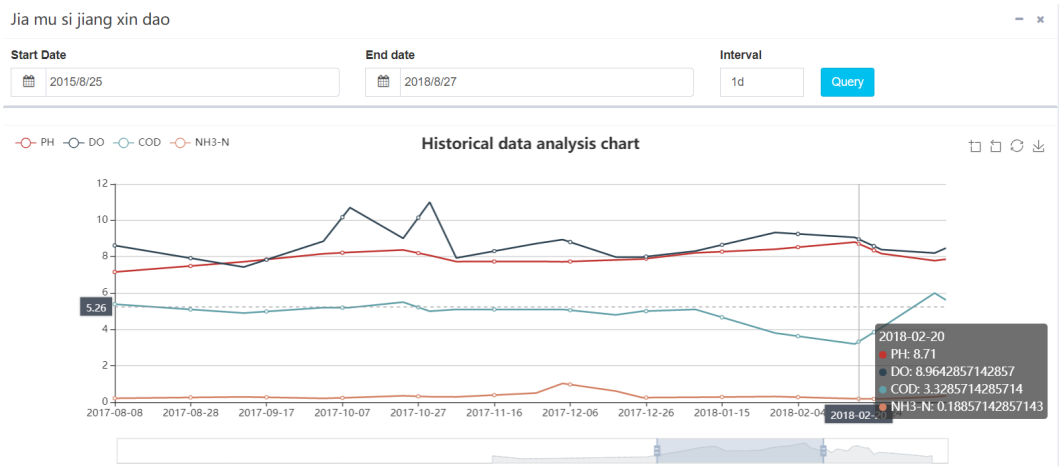


**Figure 5:** Water quality monitoring data visualization

## 4 Conclusion

In order to make better use of water quality monitoring data, and the application value of water quality monitoring data is fully explored. We use the related technologies of Internet of Things, choose Laravel, AdminTE framework and InfluxDB, MySql database, combined with Hadoop and related big data processing technology, design and implement a water quality data visualization platform based on Baidu ECharts. Real-time monitoring of turbidity, PH value, temperature and other related indicators of water in the water is monitored by relevant sensors, and the collected monitoring data is wirelessly

transmitted to the host computer, and then saved to the Hbase database deployed on Tencent Cloud, and then processed by Hadoop big data. The platform analyzes real-time and historical data of monitoring to support administrative and decision-making. In the future, other types of sensor nodes can be added to collect other water indicator parameters of the monitoring waters, and the water quality monitoring data processing results of the mobile end can be designed to better provide real-time warning and decision support.

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**Conflicts of Interest:** The authors declare that they have no conflicts of interest to report regarding the present study.

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