Anov: A Framework for Rapid Construction and Development of Web-Based Large Screen Visual Dashboard

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Abstract. With the advent of the era of big data, extract and display effective information from massive amount of data has become a hot research field. Visualization is the most direct way for users to perceive and understand data. That’s why data dashboard with its cool dynamic visual effect has become so popular. In this paper, we propose a framework for rapid construction and development of web-based large screen visual dashboard—Anov. Anov dedicates to three goals: high efficiency, innovative AI user interaction and 3D scene. First, this framework provides a "30% configuration, 70% customization" development scheme which shortens the development cycle by at least one third. Second, Anov adopts a hierarchical architecture model to achieve high reusability, easy extensibility, high reliability, and easy maintenance. Finally, this paper introduces Anov’s wide range of application field and rich user experience through multiple cases to demonstrate the practicality of the framework.

1. Introduction

In this data-driven era, people are generating and processing a large amount of data every minute, enterprises are carrying out digital reform, how to help entities like government and industries to leverage and analyze the data to make timely informed decisions is meaningful [1][2]. Data visualization is the most intuitive way to help people understand and perceive the pattern behind data [3]. Data visualization is a theory, method and technology that uses computer graphics and image processing to convert data into graphics and display them on the screen and process them interactively, which is a full combination of technology and art [4]. Data visualization is to better share and convey data information, and to serve for monitoring and decision-making [5]. Based on the great impact data visualization will have, we build a framework for rapid construction and development of web-based large screen visual dashboard—Anov with three goals in mind:

High efficiency: Scenarios, components, data, and charts are all implemented as configurable modules to reduce maintenance costs and improve reusability. The built-in general function could shorten the development cycle by at least 30%.

Innovative AI user interaction: Combined with AI to provide a variety of interactions involving voice, gestures, sensor and visual. Extend the sense of touch and enhance user participation and experience.

3D scene: Support city-level large-scale 3D scene rendering. The scene is presented with shocking and realistic visual effects.
2. Related Works

2.1. Development scheme of large screen visual dashboard
At present, there are many large screen visual dashboard products in China, and their development schemes can be divided into two types: customized development and tool configuration.

Customized development refers to the development and implementation from scratch according to specific project requirements. The representative products include Raykite, Digital Hail, etc. The advantage of this scheme is to meet the individual needs of users. The disadvantages are long cycle, high cost, low output, high level of experience for developer, and relatively low maintainability and stability.

Tool configuration refers to building a system through visualization and BI configuration tools. Representative products include DataV, CDV, Sugar, etc. The advantage of this scheme is that it greatly improves the development efficiency and reduces the project cycle. The disadvantage is the large investment in R&D in the early stage. Flexibility and extensibility are limited. The homogenization of the large screen visual dashboard is a problem.

2.2. Visual interaction
Interaction is to transform the one-way passive acquisition of information in the traditional process into a two-way interactive way to improve user participation [6]. The visual interface allows users to perform interactive behaviors on visualization and help users view information from different views. Shneiderman [7] proposed a classic visual information interaction strategy: overview, scaling, filtering, providing details on demand, association, recording and extraction. Michael J [8] et al. proposed that the interaction quality of visual interactive tools mainly depends on their support for complex cognitive activities. Liu Lu [9] divides the behaviors concerned by interaction design into two categories: physical action behavior and logical process behavior. K. Sedig [11] proposed users and big data visual interface can be described at multiple granular levels: physical events, interactive behavior, specific tasks, and cognitive activities. Jiang Lu [12] et al. designed an interactive visualization tool to add interactive functions to the visualizaton modeling process. Chen Yongyue [13] et al. compared the difference between static visualization technology and dynamic interactive visualization technology which provided a theoretical basis for the application and design of interactive visualization.

2.3. Limitations in the development of large screen visual dashboard
Through the analysis of the research status of large screen visual dashboard development scheme and visual interaction, it is found that the current scheme and platform still have the following shortcomings:

(1) The existing large screen visual dashboard development scheme cannot balance between visualization effect and development investment. To achieve diverse customization, fast delivery, cool visual effect and less development investment and more ease of use are problems that need to be solved in the large screen visual dashboard development platform.

(2) The current large screen visual platform focuses too much on improving the effect of visualization, while neglects the design of visual interaction. Many platforms only support basic interactive operations resulting in a lack of user experience.

(3) Some large screen visual dashboard development platforms are launched in the form of software, which need to be downloaded and installed, and have a long learning curve. Some requires users to have a high level of developer skills.

3. Framework design
For large screen visual dashboard, users don’t want to display the same pattern as business charts but expect to show strong visual impact. Users want to highlight personalized and cool displays and
expect to shorten the project development cycle. With the rapid development of front-end technology, we hope to make web-based visual display more vivid, intelligent, and incorporate richer media forms and interactive methods into engineering projects. Based on the above concepts, we build a visual development platform-Anov, it provides a web-based visual platform development program of "30% configuration, 70% customization".

In terms of framework design, the repetitive work is abstracted into the configuration function of the framework, and the corresponding function can be realized by modifying the configuration file; for the customized development work, the framework provides a variety of components, APIs to support customization development. Anov also has a built-in control panel that provides most of the basic services in the framework for users in the form of a graphical interface. At the same time, Anov combines with AI technology to provide a variety of interaction methods and enhance user experience.

3.1. Configurable function
The Anov framework provides some functions that can be achieved by directly modifying configuration items. Configuration items are in JSON format. The main advantages of JSON format are its readability, simple structure, and easy generation and analysis. Configuration functions include page resolution configuration, page layout configuration, page entry and exit animation configuration, and initial option configuration of various basic services. Here are the configuration functions in the Anov framework.

3.1.1. Resolution and Layout Configuration. The screen resolution of different devices is different. In large screen visual application scenarios, the screen resolution of the device is often determined first, and then the large screen visual dashboard is designed according to this size to achieve the best display effect. The pageSize configuration item is provided in the Anov framework, and the width and height can be set to the size of the design draft, so that the large screen visual dashboard developed can be fully adapted to the screen of this resolution. For screens of other resolutions, the large screen visual dashboard can be scaled proportionally and can be adapted to display units of any resolution.

To facilitate centralized management of the page layout, Anov provides a configuration file for each large screen visual dashboard to manage the coordinates of all components. The file exports a layout information that saves all components of the current route. Figure 1 shows the basic format of the layout of a single visual component. The basic layout component anovPart system in Anov will automatically generate a large screen visual dashboard layout based on the configuration file.

3.1.2. Animation configuration. Anov sets up animation lines for each large-screen page to control the entry animation and exit animation of the routing page. Anov provides a configuration file under each routing directory. The file exports the entry animation object of the routing page, which defines the entry time of each visual component. Figure 2 shows the basic format of the entry animation object.

![Figure 1. Basic format of the layout of a single visual component](image1)

![Figure 2. Basic format of entry animation object](image2)
3.1.3 Built-in service configuration. Anov provides several basic services, such as theme management, sound management, data source management, internationalization, etc. These services are all encapsulated in Anov-core. Anov-core exports the instances of these services, and the upper layer implements the corresponding functions by calling the service API and monitoring events. Anov-core is the underlying service. Anov provides a configuration file for each service to set the default config of the service. The project will use this configuration file to create the service when it is initialized. The user can directly modify the configuration file according to specific needs, so as to realize the setting of initial options for each service.

3.2. Customized function

To meet the individual needs of users, make the framework highly flexible and extensible, the Anov framework provides customized functions, that is, supports customized development by providing components, APIs, etc. Customized functions include chart custom development, control panel custom development and secondary development using basic services. Let's introduce the customized functions in the Anov framework.

3.2.1 Chart customization. In order to achieve cool visual effects, the charts and dynamic effects in the dashboard often need to be customized. The bottom layer of Anov provides basic chart library and animation and effects library for support. The basic chart library supports most of the current mainstream charts, providing chart code, testing, release, debugging and other functions. A variety of different styles of charts, animations and other components are available in the library. Animation and effects library provide professional 3D animation effects support, built-in a variety of cool special effects, and can be used for secondary development based on the effects in the library during custom development. The bottom layer of Anov also provides a 3D engine to support the rendering and output of large-scale 3D scenes at the city level.

3.2.2 Control Panel Customization. In order to meet the individual needs of different projects, Anov's control panel provides a project setting module. Users can expand the control panel in this module according to project requirements. To ensure the extensibility and uniformity of the control panel, Anov provides common layout components: CmlModule and CmlModuleItem. A basic user-defined menu module can be developed through these two components. The module is introduced into the control panel assembly, and it is automatically distributed through the slot, and the expansion of the control panel is realized.

As mentioned in the previous section, all the basic services provided by Anov are encapsulated in Anov-core. Anov-core exports instances of basic services, and the exported service instances are mounted on the global object app. In this way, the service can be directly called from any location in Anov. Each service provides a variety of practical APIs. When developing visualization applications, you can use the APIs provided by the basic services for custom development.

3.3. Interaction

At present, the interactive operations provided by most visualization platforms are very basic, such as clicking, zooming, translating, and the interaction provided by the chart itself. Considering the ease of use, Anov provides a rich set of interactivities as follows:

Speech synthesis is to give voice feedback to the user's operation. Speech recognition is that the user initiates voice instructions to control the visualization platform. Gesture recognition allows the user to directly perform gestures Manipulation. Face recognition is to capture the current environment image through the camera, and then recognize the faces in the image to count the current number of people in front of the screen. Light recognition is to transform the theme color of the visualization application by changing the color and light in front of the camera.

These five basic services are also encapsulated in the underlying Anov-core. Each service provides a variety of useful APIs, such as app. voiceFeedbackServer.speak(text: string, option: object, force:...
boolean). It can convert text to speech. Each service also provides some events, which are triggered by `dispatchEvent` when the state changes, and listened by event listeners at the application layer, such as `app.voiceFeedbackServer.addEventListener('start', callback)`. It is triggered when the voice prompt service starts, and then executes the callback function.

4. Architecture

4.1. Architecture design

Anov is a comprehensive visualization solution for front-end engineers. The overall hierarchical architecture of the framework is shown in figure 3. The architecture is mainly divided into four layers, which are supporting layer, core service layer, basic service layer and application layer from bottom up, and lower layer provides APIs for upper layer to consume.

![Figure 3. The overall hierarchical architecture of the framework](image)

4.2. Architecture characteristic

4.2.1. High reusability. Reusability is reflected in all aspects of architecture design. Reusability avoids repetitive construction of the project, the development of components, and the realization of design effects. As the general function can achieve 30% code reuse, the development cycle is shortened by 30% for each development. It not only unifies code specifications and design specifications, but also realizes efficient agile development.

4.2.2. Easy extensibility. The framework provides a variety of personalized extension methods, making it capable of flexible extension. The functions of the basic service layer can be directly extended through configuration files. Moreover, various functional APIs are exposed, and developers can use these APIs to arbitrarily extend platform functions according to their own needs.

4.2.3. High reliability. The basic functions provide hardware self-inspection, software self-inspection, and environmental self-inspection functions, which can perform self-inspection on its own state and current environment, and feedback parameters to users. For example, to solve the problems of stutter, substandard resolution and unsatisfactory network environment in rendering large-scale 3D scene, the visualization platform can achieve intelligent perception and feedback the information to users in time, thus providing high reliability to ensure the fluency of the display effect.

4.2.4. Easy maintenance. The visualization platform has built-in performance monitoring, system log console, system configuration console and other functions. Developers can view the commands
executed by the system and the feedback of the execution results in real time and can view the current configuration items of the system, so as to know the system status at all times. This function provides comprehensive information about the system, making maintenance trackable.

5. Application case

5.1. Application field
With the development of data storage and data processing technology, ubiquitous data and increasingly powerful data processing capabilities are provided. Since the human brain is very good at distinguishing positions, lengths, angles, directions, and colors through vision to capture patterns or information. Therefore, visualization can help us explore the relevance behind the data and present the meaning behind the data. The application areas of visualization cases developed by Anov are very wide. Some visualization applications are closely integrated with government departments to provide data collection and display for public affairs and realize dynamic supervision and governance; some visualization applications are combined with academia to quickly respond to public health events and provide epidemic prediction simulations. Some visualization applications cooperate with tourism, transportation, finance, and other industries to provide data decision-making, data management and data innovation for government and enterprises.

5.2. Immersive visualization and Rich User experience
Anov can not only be applied to the above-mentioned business scenarios, but also achieve stunning artistic presentations. Anov provides the ability to combine visual charts with animation, themes, sound effects, 3D, and rich media presentations. With the built-in AI five-sense interaction on the platform, abstract data can be heard, seen, and spoken. Users can feel the beauty of data in an immersive way. Figure 4 shows the large screen visual dashboard of the trace of people flow after epidemic in Wuhan developed by Anov. Combined with multiple types of media such as news broadcasts and video displays, the major events that occurred in Wuhan during the epidemic were displayed. And the flow of people information is displayed through a 3D column heat map. Figure 5 shows the large screen visual dashboard of Guiyang Cultural Tourism Big Data. The Anov visualization platform supports rendering of large-scale city-level 3D scenes. Using the built-in light recognition of the Anov, the theme color of the dashboard can be changed according to the color of the object in front of the camera. Using the built-in weather perception function of the Anov, real-time weather conditions, such as rain, snow, and cloudy, can be displayed on the screen.

6. Conclusion
This paper first introduces the research background and significance of the large screen visual dashboard development framework, and deeply investigates the current situation of big data's visualization technology and platform. In view of the existing problems and challenges, this article focuses on the development of big data visualization applications for in-depth analysis and research,
proposed a framework for rapid construction and development of web-based large screen visual dashboard—Anov, and introduced its "30% configuration, 70% customization" visualization solution and the personalized interactive operations integrated in the framework. Anov adopts a hierarchical architecture model to build a platform – that has high presentation capabilities and data perception, good maintainability, stability, extensibility, and can provide rapid construction.

In future work, Anov will continue to develop in field of 3D city, VR display, sixth sense, etc., to achieve real-time rendering and detail presentation of large-scale city-level scenes, and to enhance user experience in a more innovative interactive form.

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