Intelligent Itinerary Customization and Real-time Planning System for Private Travel Groups

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ABSTRACT

To address the limitations of traditional tourism services in meeting users' personalized and real-time needs, this study presents an intelligent assistant system designed for small private travel groups. The system integrates user preferences with multi-source real-time data to automatically generate and dynamically optimize personalized itineraries, supporting seamless multi-platform interactions across web browsers, progressive web applications (PWA), and WeChat official accounts. It features intelligent itinerary planning, real-time information pushes, and social interaction functions. Through a user behavior analysis and keyword-based recommendation algorithms, the system enables personalized content delivery and dynamic decision support. In addition, it incorporates real-time external data, such as weather and traffic conditions, to further enhance itinerary optimization. Built with Vue 3, Node.js, and MongoDB, the platform offers efficient performance and secure operation, significantly improving user experience and engagement and contributing to the intelligent development of smart tourism services.

Keywords: Personalized Tourism; Multi-Platform Integration; Recommendation Algorithms; Vue 3; Node.js; MongoDB

1.Introduction

With the rapid growth in demand for personalized tourism, traditional travel services—centered on fixed routes and standardized products—can no longer meet the diverse needs of small private groups and family users, particularly in terms of itinerary flexibility, customization, and real-time responsiveness. Modern travelers increasingly prefer to plan itineraries based on their own interests and time availability while expecting real-time updates on weather, traffic, and points of interest to optimize their overall travel experience.

However, existing online travel platforms generally lack a deep understanding of individual user differences and effective intelligent response mechanisms, making it difficult to deliver personalized services. To address this challenge, this study proposes an intelligent assistance system tailored for private travel groups. The system automatically generates personalized itineraries based on user preferences and integrates multi-source real-time data to enable dynamic optimization and intelligent recommendations. It supports seamless collaboration between web-based and mobile platforms (such

as WeChat Official Accounts), enhancing user experience and interaction efficiency before, during, and after a trip.

Although existing research in areas such as smart tourism, recommendation algorithms, and sustainable development has made notable progress, it often focuses on local technical optimization or models targeted at mass users. There remains a lack of systematic exploration of small teams in terms of itinerary customization, dynamic optimization, and cross-platform coordination. In particular, the integration of user preferences with multi-source data and the construction of highly responsive and interactive service systems are yet to be sufficiently addressed.

To fill this gap, this study presents and implements an intelligent assistant system that integrates intelligent recommendation, itinerary optimization, and multi-platform fusion to achieve innovative breakthroughs in service granularity, response speed, and user experience. Fei et al. (2021) revealed a strong correlation among economy, environment, and services in tourism systems through a spatiotemporal coupling coordination measure, providing a theoretical basis for integrating multi-source data. Luo et al. (2020) emphasized the importance of balancing carbon footprint management with service efficiency in tourism systems, highlighting the significance of green tourism. Zhu and Shang (2021) pointed out that under the "Internet Plus" paradigm, smart tourism can enhance personalization and convenience through information technology. From a sustainability and resilience perspective, Hussain and Haley (2022) stressed that tourism system design should consider both ecological and social resilience. Gamidullaeva et al. (2023), from a regional development standpoint, proposed that intelligent algorithms driven by user data can facilitate the precise promotion of local resources. These studies collectively provide theoretical and practical support for the development of a system in terms of intelligence, environmental sustainability, and regional collaborative growth.

2. System Requirements

2.1 Functional Requirements

This system aims to create a comprehensive tourism interaction platform that integrates information dissemination, social interaction, and personalized travel planning. The core functional modules include a travel forum, real-time chat room, intelligent travel expert system, article search engine, interactive map, and user management with access-control mechanisms. The travel forum module allows users to publish travel guides, share experiences, and engage in interactive comments, thereby enhancing both the visibility and usability of content. The chat room, built on WebSocket technology, supports real-time communication and facilitates instant interaction and group travel discussions. Intelligent travel experts leverage natural language processing and personalized recommendation algorithms to provide users with customized travel advice and route suggestions. The article search engine offers efficient retrieval based on multiple conditions and keywords, thereby improving the speed and accuracy of information access. The interactive map enables users to create and edit personal itineraries, mark locations, navigate routes, and share plans with others, thereby enhancing their collaborative planning experience. The user management module handles registration, login, identity verification, and permission-based operational control to ensure both flexibility and system security. Together, these features form an integrated ecosystem for acquiring and sharing travel information.

2.2 Non-Functional Requirements

To ensure the system's operational efficiency and smooth user experience, the platform must meet a series of critical non-functional requirements. The system should support high-concurrency

access and possess strong scalability and load-balancing mechanisms to accommodate surges in traffic during peak periods, such as holidays. The user interface should be user-friendly, responsive, and compatible with various devices and screen resolutions, ensuring a consistent experience across the PC, mobile, and WeChat platforms. Security is the core focus of system design, requiring encrypted storage of user data, secure encryption of communication processes, and strict access control mechanisms to prevent data breaches and unauthorized access. The AI module should feature learning and self-optimization capabilities, and dynamically adjust recommendation strategies based on user behavior data to enhance the accuracy and personalization of recommendations. Additionally, the system must exhibit strong maintainability and deployability, support version updates, fault recovery, and data backup and restoration to ensure long-term stability. Overall, these non-functional requirements provide a solid foundation for a system's usability, reliability, and sustainable development.

3. Technologies Used

3.1 Front-end Development Technologies

The front-end is primarily built using HTML5, CSS3, and JavaScript to construct the basic page structure and styles, enabling responsive layouts and cross-device compatibility. To enhance development efficiency and interactive user experience, the Vue.js framework was adopted for component-based development, which simplifies page-state management through a data-driven approach. ElementPlus was selected as the UI component library, allowing for the rapid construction of visually consistent and interactive user interfaces. It includes commonly used UI elements, such as forms, dialogs, and pagination, significantly improving the fluidity of user operations (as shown in Figure 1).

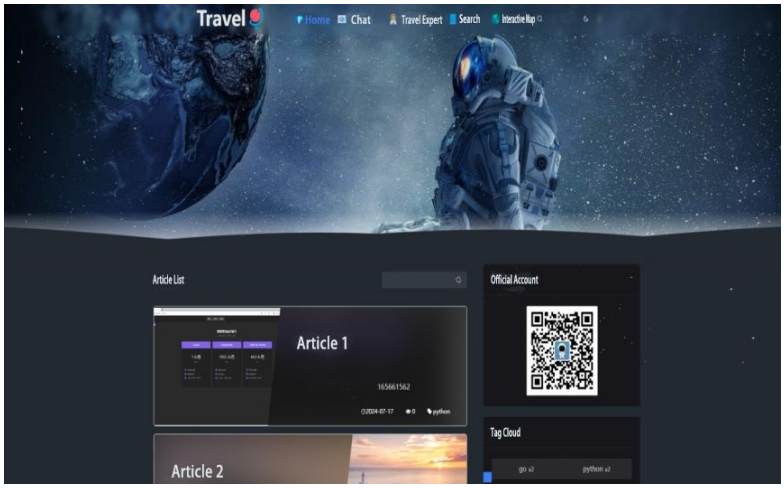

Figure 1. User Interface (UI)

3.2 Back-end Development Technologies

The backend is built on the Node.js runtime environment, using the Express framework to develop the server-side application, which is responsible for handling front-end requests, managing business logic, and facilitating data exchange via APIs. Node.js provides strong support for high-concurrency processing, ensuring the stable operation of the system, whereas the Express framework simplifies route design and middleware management, making it easier to extend and maintain system functions in the future. System data are stored using MongoDB, a NoSQL database well suited for managing flexible schemas, and large volumes of dynamic data, such as user profiles, post content,

and comments (as shown in Figure 2). With the help of the Mongoose ODM tool, developers can interact with the database in an object-oriented manner within the Node.js environment, enhancing the readability of data models and improving the safety of data operations

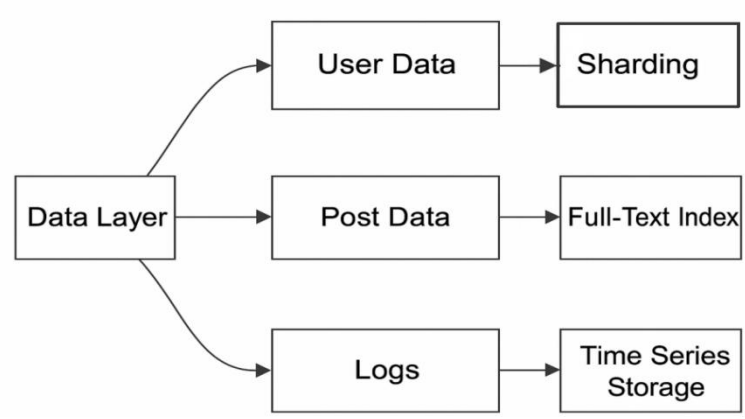

Figure 2. Data Storage Design

3.3 Recommendation Algorithm Design Techniques

The system initially adopts a heuristic keyword-matching approach to implement a user-interest-driven content-recommendation mechanism. By extracting keywords from users' search history, browsing content, and calculating the similarity with post tags, the system enables fast and personalized content recommendations. This method is simple to implement and offers quick response times, making it suitable for lightweight deployment and social interaction scenarios in the early stages of the platform.

However, to further enhance recommendation accuracy and system adaptability, collaborative filtering algorithmssuch as user-based or item-based collaborative filteringcan be introduced in the future to uncover latent interest similarities among users. Alternatively, hybrid recommendation models that combine content features with user behavior data may be employed to address cold-start and interest-drift issues better. Moreover, recommendation strategies incorporating deep learning techniques such as graph neural networks represent a promising direction as they can improve the personalization and scalability of recommendations while maintaining real-time performance.

4. Database Design

4.1 User Management Module

User data are stored in the user collection (Figure 3), which includes account information, personal profiles, social bindings, and a level system. User behaviors such as browsing and liking are recorded in the user action collection for interest analysis and personalized recommendation. Meanwhile, the user follows collection maintains the following relationships between users to support social interactions:

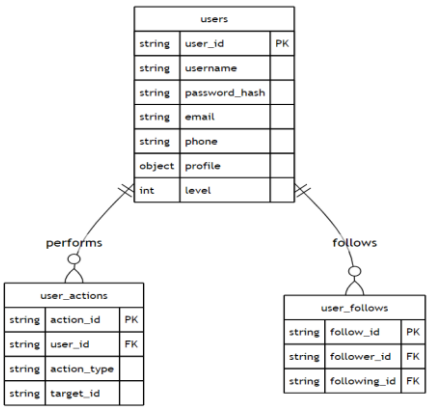

Figure 3. User Management

4.2 Content Management Module

Forum posts, including travel guides, group invitations, and personal experiences, are stored in the post collection (as shown in Figure 4), and linked to interactive data such as comments and likes. The user-created geographic markers (map_markers) support both text and image descriptions, along with moderation status. Trip collection integrates multiple markers to form complete travel itineraries, meeting the needs of travel planning (as shown in Figure 5).

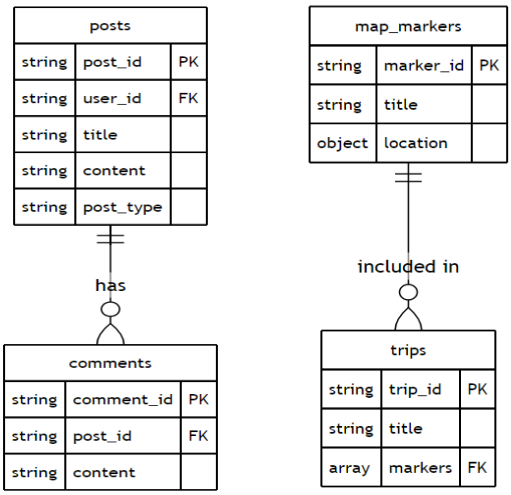

Figure 錯誤! 所指定的樣式的文字不存在文件中。. Forum Storage Figure 5. Marker Storage

4.3 Real-Time Interaction Module

Chat messages (messages) record both private and group conversations, supporting formats such as text and images (as shown in Figure 6). The notification collection handles system alerts and dynamic reminders, ensuring that users receive timely feedback on interactions and platform updates (as shown in Figure 7).

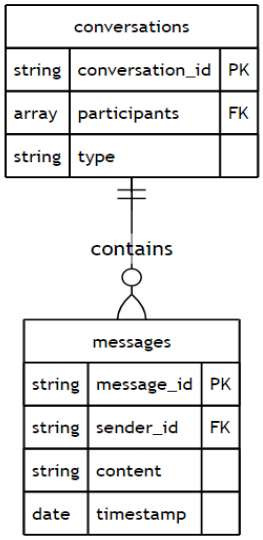

Figure 6. Message Logging

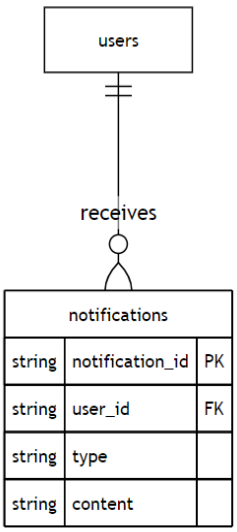

Figure 7. Interactive Feedback

4.4 System Support Module

Administrator permissions (admins) and moderation logs (moderation_logs) ensure content security, whereas api_logs monitor calls to third-party services (such as maps and payment gateways) to maintain system stability. In addition, query performance is optimized through indexing (as shown in Figure 8).

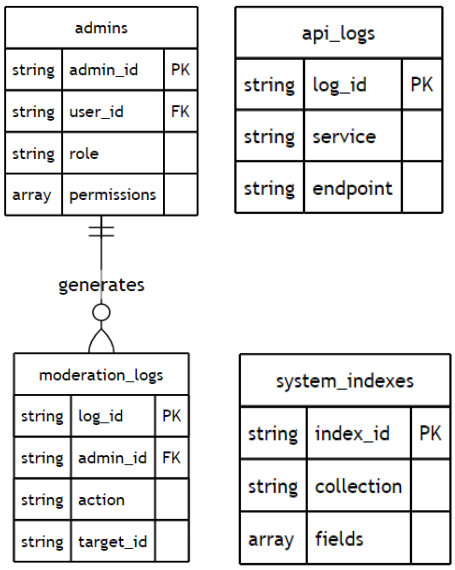

Figure 8. System Support

5. Multi-Platform Integration

This system incorporates deep multiplatform integration, particularly by combining Progressive Web Application (PWA) technology with WeChat Official Accounts to build a unified and efficient intelligent tourism service platform. Users can manage itineraries, engage in social interactions, and seamlessly access intelligent Q&A features across web browsers, mobile devices, and within the WeChat ecosystem, enjoying a consistent and uninterrupted service experience. The platform supports offline access, browser notifications, and WeChat template messages, ensuring basic functionality, even in low-connectivity environments, thereby enhancing service accessibility and

stability in travel scenarios. By leveraging a unified account system and the RESTful API architecture, the platform achieves data synchronization and behavior linkages across different endpoints. For example, users can create itineraries in the app (Figure 9) and receive notifications or manage content within the WeChat Official Account (Figure 10).for example, users can create itineraries in the app (as shown in Figure 9) and receive notifications or manage content within the WeChat Official Account (as shown in Figure 10). The WeChat client also supports intelligent reminders, customizable menus, and social sharing features, boosting user engagement, and facilitating viral content dissemination.

From a technical perspective, the system employs cutting-edge front-end technologies, such as Vue 3, Vite, and Pinia, and uses WebSocket for real-time communication, ensuring responsive performance and smooth interaction under high concurrency conditions.

This design reflects a profound understanding of local Chinese user habits and travel needs, enhancing the platform's usability and dissemination potential in the domestic market, while advancing the technological depth and user value of intelligent tourism services. Future research will further focus on the platform's influence within the smart tourism ecosystem, including promoting personalized service offerings, optimizing user behavior guidance, and supporting the fine-grained management of regional tourism resources. Additionally, it is necessary to evaluate social and environmental aspects, such as potential issues related to data privacy, security, and resource centralization, and explore the platform's potential contributions and challenges in green, low-carbon, and sustainable tourism development, thereby expanding the system's theoretical significance and practical scope.

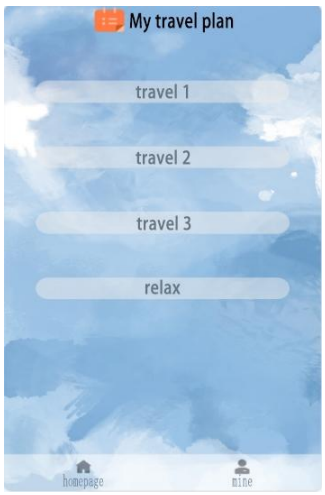

Figure 9. Mobile platform

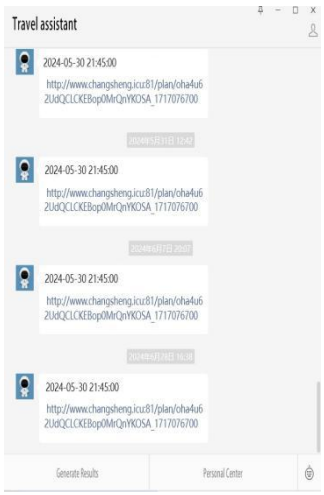

Figure 10. WeChat Official Account

6. Conclusion

This system achieves unified intelligent itinerary management, social interaction, and real-time services through the deep integration of mobile Progressive Web Application (PWA) technology and WeChat Official Accounts. By leveraging a unified account system and a dual-end synchronization mechanism, users can enjoy a seamless and consistent travel experience across multiple devices. This study focuses on the collaborative mechanism of user preference modeling, multi-source real-time data integration, and cross-platform intelligent recommendation, constructing a highly responsive and interactive personalized tourism service framework. The overall design not only enhances platform efficiency and user engagement but also provides an innovative model for smart tourism service

delivery. In the future, the system will be further expanded to areas such as multilingual support, sustainable tourism guidance, and large-scale user behavior analysis to achieve broader adaptability and commercialization potential.

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Conflicts of Interest

The authors confirm that there are no conflicts of interest.

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