SCHOOL OF ADVANCED TECHNOLOGY

SAT301 FINAL YEAR PROJECT

Campus Quest: A Location-Based Interactive Exploration Game Powered by AI

Interim Progress Report

In Partial Fulfillment
of the Requirements for the Degree of
Bachelor of Engineering

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Abstract

This report Outlines the interim progress of FYP, a project focused on developing Android campus exploration and navigation apps. The app is designed to address the challenges students face on campus, such as navigating unfamiliar campus environments and efficiently accessing resources. It integrates dynamic task generation, personalized navigation, and gamification capabilities to enrich the campus experience and promote a deeper connection to the campus environment.

The method consists of two core parts: the implementation of maps and basic functions, and the integration of AI agents. The Baidu Map API is used for real-time location tracking, navigation and geofencing. AI agents are also used for dynamic task generation and user behavior analysis to ensure personalized interactions. Finally, the database is used to store task-specific tips and user data.

Preliminary results include UI implementation, interactive features, and core map functionality. A demonstration was developed to validate the feasibility of implementing real-time geolocation updates, navigation, and exploration capabilities. Initial efforts in Bluetooth broadcast and task interaction design to support multi-device connectivity are also explored.

The project demonstrates the feasibility of integrating mapping APIs and AI agents into campus navigation and exploration. While significant progress has been made, AI agent models and other system features are not yet complete. Future work will focus on perfecting AI integration, optimizing system architecture, and enhancing database capabilities. The project lays a solid foundation for the development of a more comprehensive campus navigation solution that facilitates students' campus life experience.

Contents

1 Introduction

1.1 Motivation, Aims, and Objective

1.1.1 Motivation

In campus life, students often struggle to access information and resources about their surroundings. Freshmen find the campus environment unfamiliar, while current students face challenges in locating classrooms, printers, and other facilities efficiently. These difficulties decline learning efficiency and create a sense of inconvenience. Since Traditional campus navigation apps mainly focus on path planning and static, normal information, they lack features like personalized recommendations, interactivity, and an engaging exploration experience.

Students also tend to overlook hidden cultural or interesting resources on campus. The monotonous routine of learning limits students' curiosity and prevents them from exploring new things surrounding them. This lack of exploration leads to less knowledge of the campus environment and less interaction with campus culture. Additionally, campus clubs and class activities often seem repetitive and unattractive. This situation has led to a gradual decrease in the number of students who are willing to participate in activities.

To solve these problems, developing an application that includes dynamic tasks and personalized navigation could be an effective method. The app will not only help students navigate the right destination but also enrich their campus life experience, by encouraging exploration and strengthening connections with the environment.

1.1.2 Aim

This project aims to develop a campus exploration and navigation application based on the Android platform. The app would address students' difficulties in getting environmental information and resources on campus, by integrating a mapping API and an AI agent to create dynamic tasks and include gamification features.

The apps help users navigate the campus efficiently while improving their curiosity to explore their surroundings, and to provide students with a practical and engaging way to experience campus life.

1.1.3 Objectives

1. **Campus explore and navigate**

   The app offers real-time location tracking and combines map API functionality to provide users with exploration tasks and navigation services.

2. **Integrate AI Agents:**

   Implement AI agents to dynamically generate and adjust tasks based on the user's current location and task progress, delivering a personalized exploration experience in real time.

3. **Gamification Feature:**

   Realize an achievement system, reward mechanisms, task progress tracking, and a multiplayer leaderboard to boost user engagement and interaction.

4. **Task-Driven interactive experiences:**

   Design exploration missions that guide users to key campus locations, encouraging interest in campus culture and uncovering hidden resources.

1.2 Literature Review

This section presents a literature review of the key technologies used in this project. It will cover their applications and discuss their relevance to the project's objectives.

a) Map APIs and location services:

Map APIs are an important part of navigation systems. Tools like Google Maps and Baidu Maps provide users with accurate navigation information. These tools are effective in helping new students get used to their campus environment [1]. However, they have limitations in specific scenarios. For instance, they may struggle to guide users to the correct building entrance, a classroom, or a printing facility within the final few meters of navigation [2,3].

Traditional navigation tools work well in general scenarios, but they lack adaptability for refined domains like university campuses. Campus navigation requires more than just basic directions, which are needed to offer specific details about classrooms, printing facilities, or event venues. Freshmen or those unfamiliar with the campus layout often need quick and accurate guidance.

Furthermore, Static maps or signs may not always show enough help in practice. This can confuse users and lower their efficiency [2,3]. Additionally, most navigation tools statically present data. They cannot adjust dynamically to users' behaviors or needs. This limitation reduces their ability to improve the overall user experience [2].

b) AI agent implementation:

AI agent technology has illustrated great potential development trends in dynamic task generation and personalized content customization in recent years. By applying AI APIs or training large language models (LLM) models, users can get real-time requirements and solutions. A study has shown that the LLM model can generate highly relevant content, not only improves user engagement but also supports personalized task generation in complex scenarios [4].

Another study has shown that AI agents can combine some features, including the user's current location and navigation which are demanded to provide users with intuitive, personalized navigation content. For instance, by analyzing users' behavior patterns and surrounding environments, AI agents can adjust task objectives and recommended paths to ensure real-time and efficient navigation and improve users' usage efficiency [5]. This technical variant illustrates that AI agents can be used as a technical basis for task generation in campus discovery applications, making it possible to create tailored discovery tasks based on the user's current location.

c) **Gamification design:** Gamification design is a technical means of applying game elements to non-game scenarios. Studies have shown that the core elements of gamification design, such as point rewards, leaderboards, or challenge mechanisms, can increase users' motivation and participation in the system [6], and that these mechanisms, by giving users clear goals and feedback, do not only enhance their interactive experience but also improve their satisfaction with the system [7]. Their satisfaction with the system [7].

These design concepts can be applied to campus exploration scenarios, such as motivating students to learn more about the campus or to connect with the campus through virtual rewards for task completion, or point rankings.

1.3 Industrial Relevance

This content will focus on the analysis of project requirements, technical implementation of the rationality, and potential industry applications

1.3.1 Project Background

Students and visitors can use basic navigation functions through school provided or mapping software. However, functionality often fails to meet the complex needs of specific environments, such as the same building with different entrances, the school print room, or the school computer room.

At the same time, school cultural resources and exploration are often ignored, and there is a lack of effective incentive methods to promote user participation. At present, the campus navigation realized in the market is not closely connected with students' lives, for example, there is only calling API or surrounding geographical description, but no localization adaptation to the campus.

This project is to fill this gap, meet students' campus exploration and navigation needs, and achieve the dual function of functionality and fun.

1.3.2 Rationality of implementation

Based on map API and AI agent technology, this project proposes a dynamic and interactive campus exploration and navigation solution. From the perspective of technical implementation, calling map APIs (such as Baidu Map or GaoDe Map) primarily focuses on designing the implementation of location services and the front-end interaction interface, while integrating AI agent and prompt technology focuses on back-end development. Specifically, the application of AI agent technology emphasizes the implementation of back-end logic, including task generation and user behavior analysis.

In the existing technical framework, the official documentation of map APIs provides detailed explanations of relevant call methods, and there are also mature research and design schemes for AI agent and prompt technology available for reference.

The goal of this project is not to develop a complete product that is commercially viable or fully adapted to the campus environment. Instead, it aims to explore the feasibility of combining mapping services with AI agent technology through a demo. During this process, the project will focus on implementing core features, such as dynamic task generation and personalized navigation, and verifying the potential value of integrating these technologies to enhance user experience.

While the scope of functionalities implemented in this project is limited, this exploration provides a foundation and valuable reference for the future development of more comprehensive campus navigation solutions.

1.3.3 Industrial Relevance

The project's design scheme can effectively address the challenges of campus navigation and resource access faced by freshmen when entering the university. At the same time, through dynamic tasks and personalized interactive functions, it can enhance the connection and bond between students and the campus.

The design scheme, based on LBS and AI agent technology, is not limited to the campus environment but can be extended to a wider range of scenarios. Examples include museums, sightseeing tours, and even smart-city construction. In museums and tourist attractions, personalized guide tasks can be provided to tourists, allowing them to intuitively understand the historical background and details of exhibits. This enables users to experience the historical atmosphere and enhances immersion in cultural experiences. In smart cities, it can serve as a local exploration tool, encouraging users to discover hidden corners of the city and deepen residents' understanding of urban culture and resources.

Furthermore, the project’s design scheme holds significant potential in the market. Strengthening the connection between students and the campus and integrating school resources, allows institutions to better serve the needs of teachers and students, ultimately improving student satisfaction with campus life. For relevant enterprises, the project can be developed as a highly customizable service, providing essential resource integration and technical support for the operation of educational institutions.

2 Methodology and Preliminary Results

2.1 Methodology

This section provides an overview of the methodology utilized in the project, focusing on the tools, techniques, and processes involved. It is important to note that these methods have only been assessed for feasibility, and final implementation has not yet been fully determined. Some of the actual development will take place in the next semester or during the winter holiday.

Specifically, the core methodology of the project is divided into two main parts: the implementation of the map and basic functions, and the integration of the AI agent.

2.1.1 Map and Basic Function Implementation

In the map and basic function implementation, the key to the project is to fully utilize the capabilities of the Baidu Map API. By calling it, the system can obtain the user's real-time location and convert it into a basic location tag. This tag serves as the core foundation for other system functionalities, ensuring that all operations and validations are performed based on the user’s geographical location.

For example, the navigation function can use location tags to plan an accurate travel route for the user. Similarly, the geofencing function can determine whether the user has entered specific areas, such as a teaching building or other designated zones.

2.1.2 Interaction and its Design

In addition, the project will implement basic interactive functions, such as allowing users to record scenes during the exploration process or provide proof of task completion using the built-in photo feature. The pictures taken will not only serve as a recording tool for users but may also be implemented in subsequent development phases to incorporate image recognition technology, enabling integration with AI agents, which facilitate the analysis of user behavior data and the dynamic generation of personalized tasks.

In terms of interaction design, users can engage with the system through a simple and intuitive interface. For example, users can click on points of interest (POIs) on the map to view detailed info or trigger specific tasks. Based on their current location, the system can automatically push relevant notifications to encourage exploration of nearby locations and tasks.

2.1.3 AI-Agent Integration

For AI agent integration, the core of the project is to convert surface map interactions and basic function results into prompts that the AI agent can understand. This process requires not only formatting and standardizing the interaction data but also designing prompts with sufficient context to accurately reflect the user's intentions. For instance, when a user clicks on the "library" POI, the system might generate a prompt such as: *"The user is near the library. Fetch the user's class schedule and provide a self-study time arrangement that does not conflict with existing classes"* (assuming that class schedule has been uploaded). To support real-time AI agent calls, some pre-designed prompts will be stored in a database. Additionally, the database will store interaction data and historical behavior to facilitate subsequent task generation and personalization. To ensure real-time performance, the system may adopt caching mechanisms or message queues in future implementations to optimize data reading and processing efficiency.

After receiving the prompt, the system processes it by applying a pre-processed or fine-tuned model. If an external API interface is called, considerations such as network latency, call frequency limits, and other constraints are taken into account. To mitigate these issues, a local model may be used as an alternative to reduce reliance on real-time computation.

The generated output is further processed and then returned to the surface layer. When exploration tasks are generated, the results are filtered and ranked to ensure the content is relevant to the user's needs.

It is important to note that the establishment of the AI agent model has not yet been completed this semester. The methodology described above just serves as a reference for the project and may be modified and optimized during the actual development process.

2.1.4 AI-Agent Integration

The application attaches great importance to the security and privacy protection of user data. Although we do not use data encryption in the current release, we use a privacy agreement to ensure that users understand and consent to how our data is collected and used. We only collect the necessary location information and activity data of users during the use of the application, and promise not to use them for commercial purposes or share them with third parties. Currently, the login method is simple, and we recognize that this may be a security risk. To further secure user accounts, in the future, we will add more secure login methods such as two-factor authentication (2FA) and encrypt the transmission of sensitive user data.

Through these measures, we hope to be able to provide users with a convenient and safe use experience, while also ensuring compliance with laws and regulations to protect users' privacy

2.1.5 Methodology System Framework Illustration

The following Fig.1 is a brief system framework diagram of the whole project. The overall system architecture is divided into multiple levels and its functional modules. The topmost map and the basic functional interface and the user interface form the surface of the system, which is used to display basic modules such as navigation, positioning, and message notification. The user interacts with the system through the UI to generate tags, and the tags are processed by interaction analysis and converted into instructions that can be understood by AI.

At a deeper level, as the basis of data storage and support for back-end decision-making, the database is combined with the user interaction results to promote the work of Decision Generation, Dynamic Tasks and Prompts Generation. model processing optimizes the decision. Eventually, these decision results will be applied to the surface interface and map display through the control and feedback module.

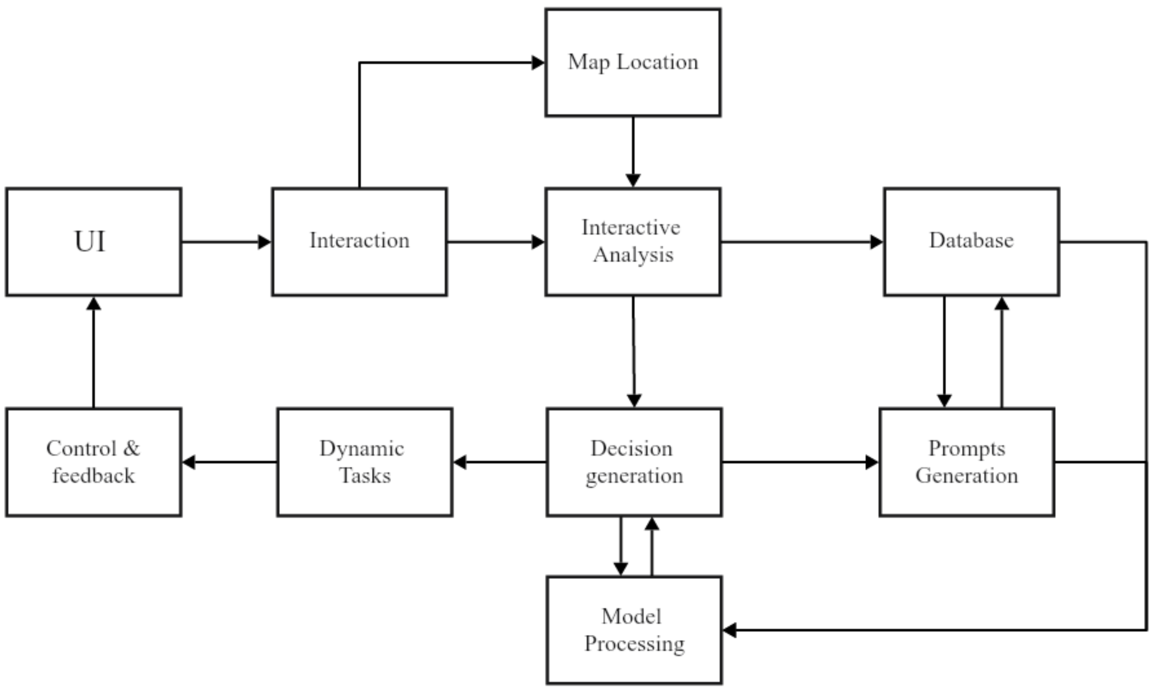


Fig 1. The technical framework of the system.

2.1.6 Risk assessment and envisioned countermeasures

Some risks and challenges in the development of this project are taken into consideration. To ensure the project progresses on time and maintains system stability, security, and usability, the following risks and their corresponding mitigation measures have been assessed:

1. **Data Privacy:**

   The user's geolocation or active location may be stolen during transmission, especially in the current version, and the user's data may be unpacked while it is stored in the database. It is also possible to reverse engineer and extract or steal the models deployed in the installation. For this reason, more secure data encryption protocols will be considered in future versions.

2. **Performance and Latency Issues:**

   This may be a major problem in the future, for calling external APIs or relying on cloud-based models can cause latency, but local deployment needs to consider the performance of the device. To balance these options, both local and cloud-based models will be tested to determine the best solution. Techniques such as caching and message queuing will be explored to reduce data-fetching delays. These improvements will be part of future work.

3. **Accuracy and robustness of the model:**

   The system's performance relies heavily on the model's accuracy. If the task generated by the model is not related to the recommendation, the user's experience will be weakened.

   To address this, I may evaluate the need for local model training or reliance on existing cloud-based AI agents. Or continuously and optimally debug the model and filter the generated content, these are trade-offs that need to be made in future work.

4. **System Complexity**

   Multiple API calls may increase development difficulty, which is reflected in the inconsistency of components and affects the thread flow. Therefore, the current decision is to modularize all code definition, establish clear interface, and create more detailed development documentation, and test each component separately to increase their extensibility.

2.2 Preliminary Results

As shown in Figure 2 below, the preliminary results include the implementation of UI, user interaction, map positioning, and its related functions, as well as interactive analysis. As of the deadline, the development of the database is nearly 30% complete. It is important to note that these preliminary results are part of a demo that demonstrates the current feasibility of the project. Specific optimizations and interface design will likely be addressed in the final stages.

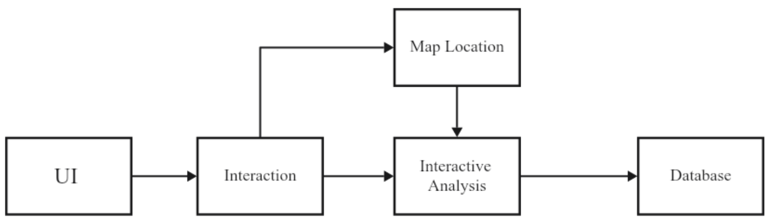


Figure 2

To explore those features, I initially implemented a user navigation and positioning function in a garden party scenario. This scenario focuses on addressing common problems freshmen may face during enrollment or when participating in a garden party, such as difficulty locating specific teaching buildings or wanting to enhance the event's overall enjoyment. Below is the program component Figure 3 that illustrates the implementation of this feasibility program:

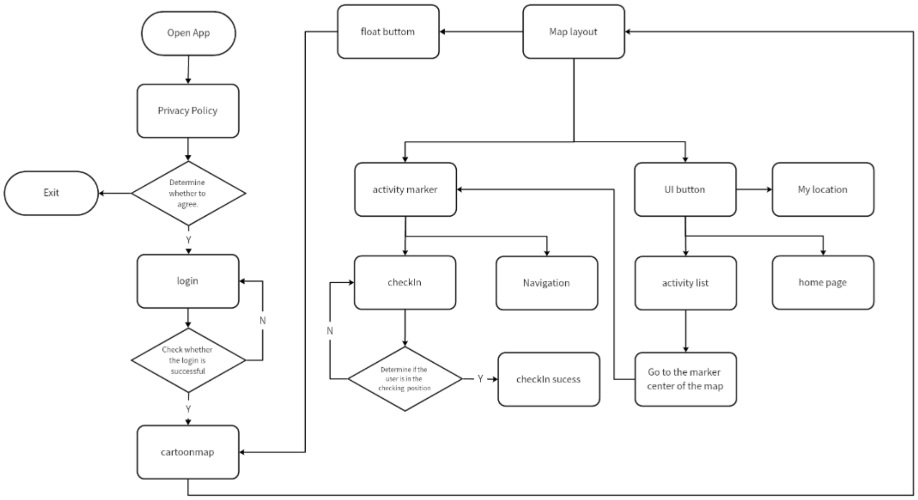
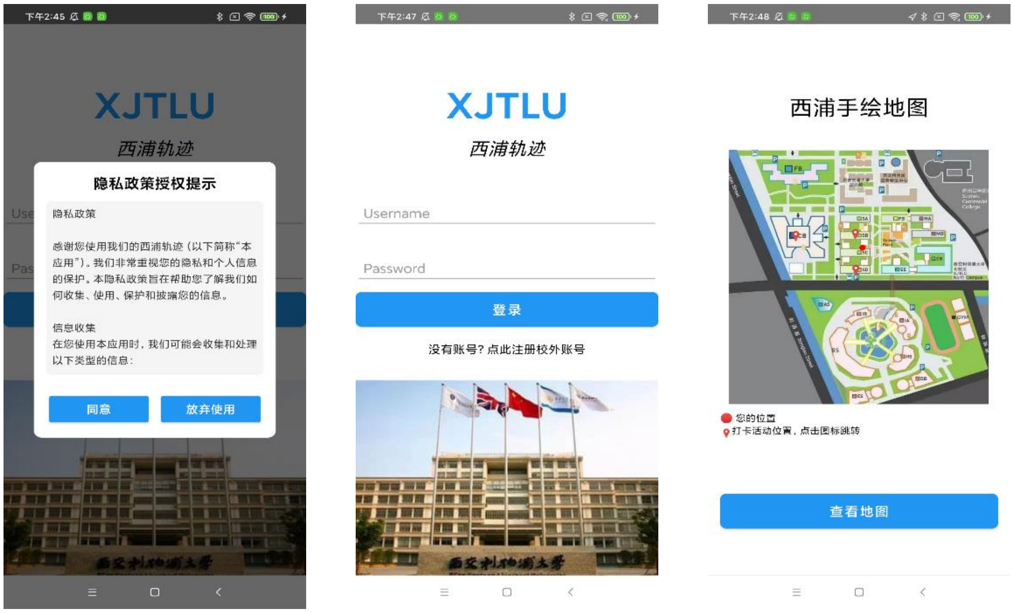


Figure 3

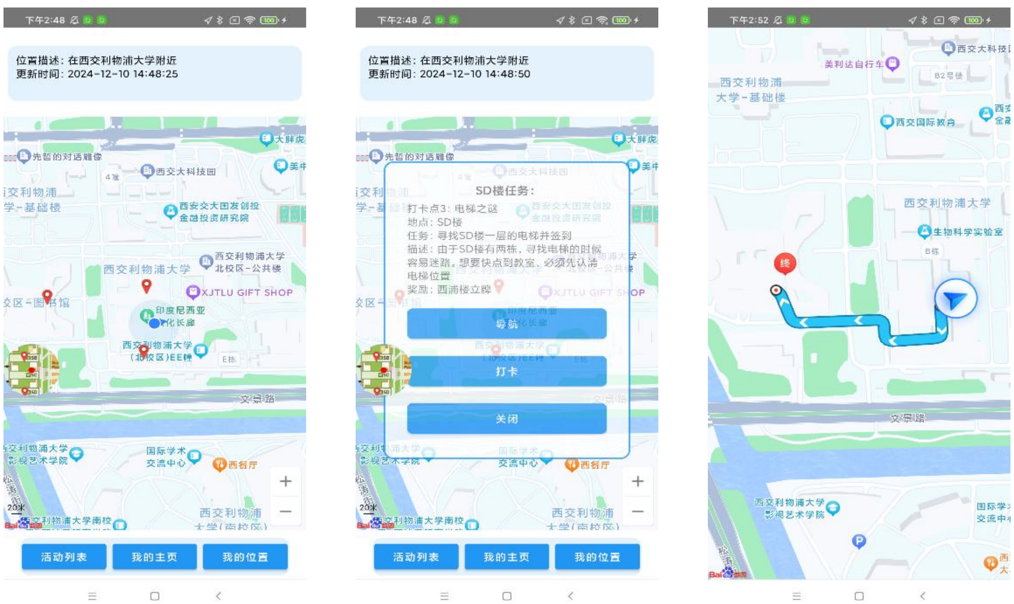
In the app design, users must agree to a privacy agreement before logging in. To log in, users need to enter their student number and password (see Figures 4 and 5). After logging in, users are directed to the school's hand-drawn map interface. A red dot is displayed on the map, marking the user's real-time location. The hand-drawn map also includes three preset activity markers (see Figure 6). These markers represent simulated activities for a garden party scenario. When users click on these markers or choose to view the map, the interface switches to the real map.



Figures 4, 5, 6

In the real-world map, I placed three markers at the same locations as those on the hand-drawn map (see Figure 7). When users click on these markers, the system shows the details of the activities associated with the building (see Figure 8). The details page offers two functions: "Navigation" and "Check In."

When users click the "Navigation" button, the system generates a navigation path based on their current location, guiding them to the destination (see Figure 9).



Figures 7, 8, 9

When the "Check In" button is clicked, the system checks whether the user is at the designated location and the broadcast from the point is detected (a device was set up to simulate the Bluetooth broadcast, see Figure 10). If both conditions are met, the user can access the Check-point interface (see Figure 11) and complete the process by taking a photo. If the conditions are not met, it cannot proceed (see Figure 12).

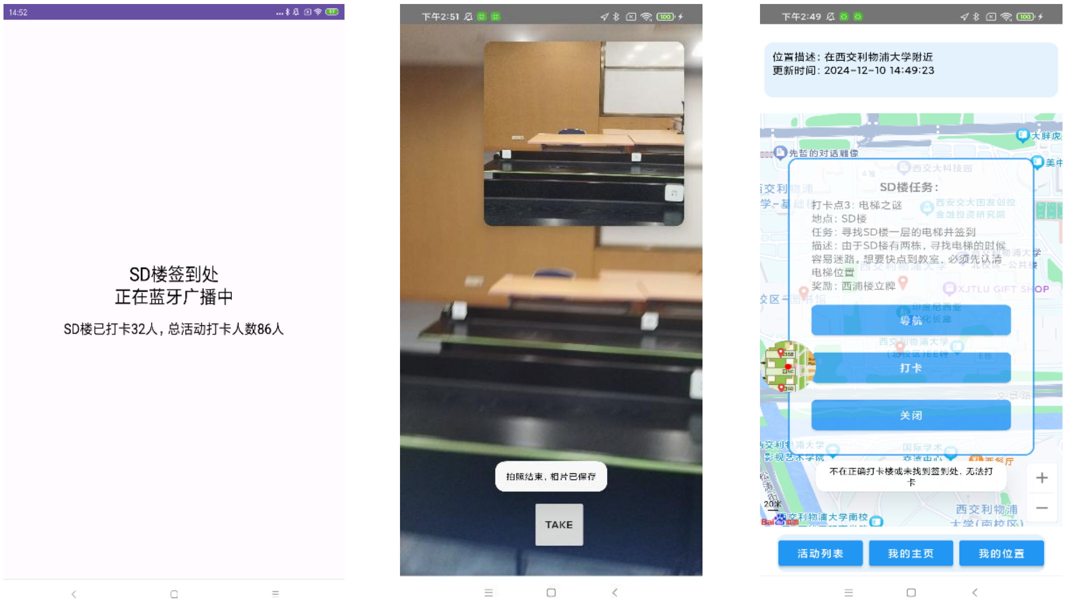


Figure 10, 11, 12

In addition, I implemented other functional interfaces. For example, by clicking on " Activity Lists" (see Figure 13), users can select an activity and either jump directly to the location of the corresponding building (see Figure 14) or immediately move the map window to its current location.

Figures 13, 14

It should be noted that the code of this project is too large to include the entire implementation process or even pseudo-code in the report. Even if the code is uploaded to the school platform, it requires configuring a series of environments to run due to the encryption mechanism of the map API. To address this, I have provided a link to a demonstration video hosted on a Chinese video platform in the appendix.

Additionally, the content presented here should not be considered as the actual progress of the project. Certain components, such as Bluetooth broadcasting, the second layer of the campus hand-drawn map, or the UI design, are exploratory in nature, thus these designs don't necessarily show up in the final result.

In the following sections, I will elaborate on the exploration and implementation of each component in detail.

1. First, I implemented the login function and database archive functionality. I optimized the button's dynamic effects and display while gaining a deeper understanding of logical behaviors such as floating windows. At first, I envisioned the floating window as a tool component similar to the floating window in the iOS system. However, due to my abilities and shortage of knowledge in Android Studio, I only managed to implement the function of capturing the user's real-time location (represented by a red dot) on the hand-drawn map and displaying surrounding campus buildings. This exploration confirms that the concept of UI interface design is highly feasible.

   Additionally, to enable real-time updates of the user's location on the hand-drawn map, I applied mathematical algorithms, including the least square method, polynomial matrix calculations, and coefficient conversion. These methods successfully mapped latitude and longitude coordinates to the hand-drawn map in real-time, achieving a dynamic location display. This work lays a technical foundation for integrating hand-drawn maps with realistic maps in the future. However, it is important to note that the current implementation is not the final version. In future improvements, I plan to redesign and optimize the display to enhance the overall user experience.

2. In the implementation of the map API call and interaction functions, I successfully realized the basic features of the Baidu Map API, including geofencing, real-time

updates of the user's geographical location, and navigation functionality. The data is transformed into a format with special labels, serving as a normalization process for subsequent interaction analysis.

For Bluetooth broadcasting, I experimented with using Bluetooth for information transmission between multiple devices. This exploration provided valuable experience that will help in implementing multi-device linkage functionality in the future.

3 Conclusion and Future Work

3.1 Conclusion

This report outlines the FYP project completed this semester. It includes the implementation of the UI design, the integration of map API calls, and several exploratory practices. Based on these, a complete experimental program was designed to test the feasibility of earlier hypotheses. Through this program, the project successfully implemented core functions such as real-time geolocation updates, navigation features, and a preliminary framework for interactive analysis. Also, multi-device linkage was explored as part of the development process.

The results demonstrate that these functions effectively validate the initial design's feasibility. They also establish a strong technical foundation for improving and expanding future functionalities. It is important to note that this experimental program is not the final product. Instead, it serves as an early-stage validation of the project's technology and design approach. Although the current scope is limited, the outcomes clearly show the effectiveness and practicality of the core implementation methods.

3.2 Progress Analysis

In the Project Specification Report, Gantt chart is shown as follows: In the Project Specification Report, Gantt chart is shown as follows in Figure 15:

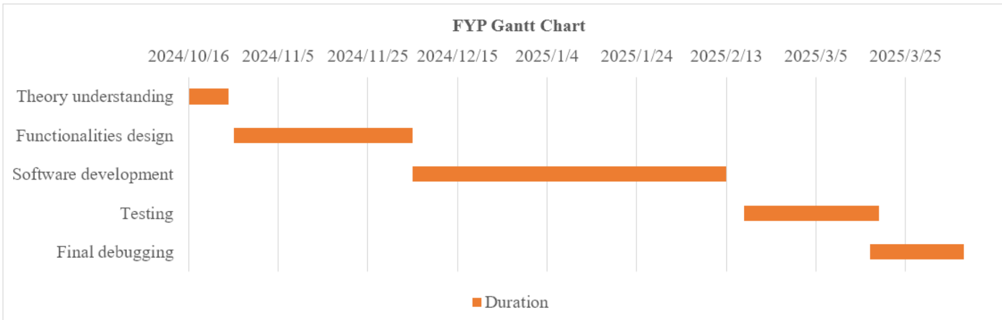


Figure 15

In the actual development process, the software development schedule was much earlier than expected, while the functional design time was relatively short. Software development was supposed to start in the last few days of mid-December, but in fact, it started in early November. Compared to the Gantt chart, the development overall is still proceeding according to my plan.

However, during the development process, I underestimated the difficulty of development, especially when developing with Android Studio, and encountered many problems. These errors took a lot of time to debug. Nevertheless, these issues were finally resolved by reviewing the development documentation and analyzing the code line by line. In terms of UI design and map API calls, although the implementation is simpler than the AI agent, there were still many bugs, such as thread conflicts or problems with the test device itself. Considering my weak foundation in artificial intelligence and the difficulty of LLM model training, I expect to encounter more challenges in the development of subsequent AI agent. Therefore, I plan to spend the whole winter vacation further studying and developing my FYP project.

Despite the difficulty of development, I would not feel frustrated. Struggling to solve bugs is an inevitable part of my development process, and being able to envision a project as an individual and complete it has truly improved my technical skills.

3.3 Future Work

Based on the research and development of this semester, the next work will focus on the following aspects, considering that the process has been explained in more detail in the methodology, here is a brief overview of the key tasks.

1. **Improve the establishment of AI agent**

   The current model has not yet been established, and further development and integration on this basis are needed in the future to achieve its core functions.

2. **Select a deployment plan**

   To ensure the real-time performance of the model, I will compare the different performances of local deployment and network deployment to find the best solution for system performance.

3. **Improve database functions**

   The database will be perfected in the subsequent development, the need to store the default prompts, and the need to label the user's behavior for subsequent task invocation and analysis.

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Appendix A. Demo Application Demonstration

The experimental program demonstration is shown in the link

【implementation of interimprogress in FYP】

https://www.bilibili.com/video/BV1TqqfYVEpW/?share_source=copy_web&vd_source=c088ab2fc6aef02f4bdd72d222eaedb4

Appendix B. The FYP Poster

Xi'an Jiaotong-Liverpool University
西交利物浦大学

Campus Quest: A Location-Based Interactive Exploration Game Powered by AI

Yikai Guo

School of Advanced Technology Supervisor: Dr. Teng Ma

Abstract: This poster outlines the interim progress of an FYP project focused on developing an Android campus exploration and navigation app. The app addresses challenges like navigating unfamiliar environments and accessing resources efficiently. It integrates dynamic task generation, personalized navigation, and gamification to enhance campus experiences.

The project has two core components: implementing maps and basic functions using the Baidu Map API for real-time location tracking, navigation, and geofencing, and integrating AI agents for dynamic task generation and user behavior analysis. A database stores prompts and user data for personalized interactions. Preliminary results include real-time geolocation updates, navigation features, and exploratory functionality. Initial work on Bluetooth broadcasting and task interaction supports multi-device connectivity. While the AI agent model is not yet complete, the project has demonstrated feasibility and provides a solid foundation for future development.

Introduction

Students often face challenges navigating campus environments and accessing resources efficiently. Traditional navigation tools lack adaptability for specific campus needs, such as detailed guidance to classrooms or facilities [1,2]. They also present static data and fail to adjust dynamically to user behavior, limiting their overall effectiveness [1].

This project addresses these gaps by developing an Android-based campus navigation app that integrates a mapping API and AI agents. AI agents analyze user behavior, generate dynamic tasks, and provide personalized navigation [3,4]. To enhance engagement, the app incorporates gamification features, such as rewards and leaderboards, which have been shown to increase user motivation and participation [5].

By combining practical navigation with AI and gamification, the app encourages exploration and creates a more interactive campus experience.

Methodology

The project uses the Baidu Maps api to generate real-time location labels for users. These tags support core functionality such as navigation and geofencing. Users interact with the system through a simple and intuitive interface.

They can click on the poi, record the scene, and trigger dynamic prompts. The system processes these interactions into standardized hints on an AI-powered backend.

The database stores pre-designed prompts and user behavior data. This enables personalized and context-aware recommendations. The model processing improves these results.

The control-feedback loop then delivers tasks, notifications, and visual guidance to the user interface. By providing personalized tasks, campus exploration is encouraged and user experience is enhanced. The figure below shows the system framework.

Results and Discussion

Preliminary results show that the proposed system is feasible. The system's user interface and interaction features are in place. Basic map positioning and navigation functions are working. The database is about 30% complete. In a garden party scenario designed for freshmen, the system integrates hand-drawn maps with real-world maps.

This integration allows users to locate buildings, view activities, navigate to destinations, and check in at specific points. These elements ensure that the system feels intuitive and user-friendly.

Mathematical methods, such as least squares and polynomial fitting, support real-time location display on the hand-drawn map. The integration of Baidu Map APIs enables geofencing, location tracking, and route planning.

Early tests with Bluetooth broadcasting suggest the potential for multi-device interaction. Some elements, like the second layer of the hand-drawn map and certain UI features, remain exploratory. Even so, these early results confirm that the project is practical. The team will refine the system, improve the database, and optimize its interactive features in future stages.

Here are four of the most distinctive screenshots from the app:

Conclusion and Future Work

The work of this semester verified the technical feasibility of the system. The implemented UI design, integration of Baidu Maps API, and preliminary exploration show that the core functions such as real-time location update, navigation, and basic interaction analysis are effective. While still at an early stage, these results indicate the potential to support more advanced features.

In the future, the project will develop and integrate AI agents, evaluate the real-time performance of local and web-based deployments, and enhance database capabilities for better data storage and timely management. Through these efforts, the system aims to become more robust, intelligent and responsive, evolving from an initial concept to a fully implemented dynamic solution.

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