UNIVERSITY OF SCIENCE
ADVANCED PROGRAM IN COMPUTER SCIENCE

Thesis Proposal

(submitted by students)

Thesis title: AI ASSISTANT FOR SMART NAVIGATION

Thesis advisor: Assoc Prof. Dr. Tran Minh Triet

Students: Nguyen Ngoc Long (21125079) – **To Quynh Chi** (21125157)

Type of thesis: *Technology with demo application*

Duration: From *September 2024* to *March 2025*

Contents of thesis:

1. Overview

The integration of Artificial Intelligence (AI) with Augmented Reality (AR) has transformed navigation technology, addressing the limitations of traditional tools like maps and directional signs. Traditional navigation methods often fall short in complex and dynamic environments such as hospitals, malls, and airports, where visitors require quick, accurate, and personalized guidance. AR-based navigation systems have demonstrated enhanced user experiences in finding their way in complex environments, leveraging digital overlays to guide them toward desired destinations. To build on the strengths of these systems, this thesis proposes an approach that integrates Large Language Models (LLMs)—such as ChatGPT—with AR navigation. Users can simply describe their target location in natural language, and the LLM interprets these descriptions, mapping them accurately to an internal data structure of known destinations. Once the place is identified, an AR interface offers real-time, customized directional cues, ensuring a seamless navigation experience.

By merging LLMs with AR, this approach accommodates the evolving and context-specific needs of users, enabling them to specify destinations in ways that go beyond selecting from predefined menus. In dynamic and expansive environments like hospitals, malls, or airports, this flexibility can simplify navigation workflows and deliver quick, precise guidance. Through this research, the efficacy of language-driven location analysis is examined, culminating in a system that effortlessly transforms user descriptions into on-the-ground navigational assistance.

2. Motivation

Users in large and complex spaces often have unique or evolving requirements, making it challenging to rely solely on predefined lists or static location labels. Recent advances in natural language processing—exemplified by LLMs—offer a promising way to capture the richness of human language. Integrating these models into an AR environment can greatly enhance user experience, enabling more nuanced requests (e.g., "the software engineer lab next to the library") without needing explicit knowledge of building layout or exact room numbers.

3. Objective

The primary objective of this thesis is to design and evaluate a system that combines LLM-driven language understanding with AR-based navigation. Specifically, it aims to:

- Develop a **robust pipeline** for interpreting user descriptions via an LLM and mapping them to a structured database of places.
- Design a **hierarchy** for efficient places data management.
- Incorporate **AR overlays** to visually guide users from their current position to the identified destination in real time, enhancing user experience.
- Demonstrate scalability across diverse applications, such as hospitals, airports, and university campuses.

This is only the tentative objective of the thesis, and can be updated during the implementation of the project with the approval from the supervisor.

4. Main Content to be Implemented

4.1. Literature Review

- Evaluate existing AR navigation systems, highlighting their strengths and limitations.
- Analyze prior research on integrating AI and AR for navigation, focusing on the application of Large Language Models (LLMs).

4.2. System Design and Architecture

- **AR Component:** Develop visually intuitive overlays (arrows, markers, and 3D maps) to guide users in real time.
- **AI Component:** Apply LLMs for extracting data from places and process natural language for querying places.
- **Hierarchical Data Structure:** Implement hierarchical data structures to efficiently store and query places.
- **Integration Framework:** Combine AR and AI components into a cohesive system that adapts to user needs and environmental conditions.

4.3. Data Preparation

- Collect data of some pivotal places in the university campus and generate Q&A pairs as metadata for building the hierarchical data structure.
- Generate the hierarchical data structure.

4.4. Application Scenarios

- **Hospitals:** Navigate patients and visitors while avoiding overcrowded areas.
- **Airports:** Provide personalized, step-by-step guidance to gates or amenities.
- **University Campuses:** Optimize navigation for new students by considering real-time construction zones or closures.
- **Emergency Response:** Guide responders through obstructed or hazardous environments using indoor localization and AR overlays.

4.5. Implementation and Prototyping

- Develop a functional prototype of the proposed system.
- Use Vuforia Engine and Unity for AR development and integrate OpenAI GPT-4o as the LLM for processing data.

4.6. Evaluation and Testing

- Conduct user studies to assess the system's usability, accuracy, and adaptability.
- Measure key performance indicators (KPIs), including response time, navigation efficiency, and user satisfaction.
- Compare the proposed system against existing solutions in similar environments.

4.7. Expected Contributions

- Enhance user navigation experience through AR applications.
- Advance the field of AR navigation by integrating LLMs for natural language processing for storing and finding places.
- Provide scalable and adaptable navigation solutions for diverse environments.

This thesis aims to contribute to the development of next-generation AR navigation systems that are capable of dynamic real-time navigation utilizing the power of LLMs for assisting user finding their desired destination.

Tentative Research Schedule:

September 15 – September 30:

- Research related works, brainstorm ideas

October 1 – October 15:

- Draft user interface for the application

October 16 – October 31:

- Research tools & technologies for indoor navigation with AR

November 1 – November 15:

- Research features of AR libraries (ARKit/ARCore) on mobile and navigation
- Research Vuforia Engine for developing AR application

November 16 – November 30:

- Implement demo features of Vuforia Engine

December 1 – December 15:

- Implement prototype for navigation with AR
- Research AI Navigation in Unity for routing

December 16 – December 31:

- Research & implement data auto extraction with LLMs

January 1 – January 15:

- Integrate the AR navigation application with AI Navigation
- Implement demo on a specific environment

January 16 – January 31:

- Experiment metrics for navigation and run demo on a specific environment

February 1 – February 15:

- Build hierarchical data structure
- Prompt engineering for AI assistant and data retrieval

February 16 – February 28:

- Implement QR Code demo for user location.
- Finalize the application

March 1 – March 10:

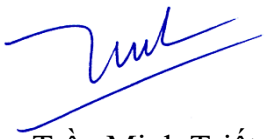
- Finalize documents with results
- Collect, survey, and evaluate the results

References:

1. Codina, M., Castells-Rufas, D., Carrabina, J., Salmon, I., Ayuso, N., Guerendiain, A., Alvarez, G.: Augmented reality for emergency situations in buildings with the support of indoor localization. Proceedings 31(1) (2019). https://doi.org/10.3390/proceedings2019031076, https://www.mdpi.com/2504-3900/31/1/76
2. Fajrianti, E.D., Funabiki, N., Sukaridhoto, S., Panduman, Y.Y.F., Dezheng, K., Shihao, F., Surya Pradhana, A.A.: Insus: Indoor navigation system using unity and smartphone for user ambulation assistance. Information 14(7) (2023). https://doi.org/10.3390/info14070359, https://www.mdpi.com/2078-2489/14/7/359
3. Gerstweiler, G.: Guiding people in complex indoor environments using augmented reality. In: 2018 IEEE Conference on Virtual Reality and 3D User Interfaces (VR). pp. 801–802 (March 2018). https://doi.org/10.1109/VR.2018.8446138
4. Mohd Nizam, D.N., Shin, L.W., Abdullah Sani, Z.H., Thamrongrat, P., Tuah, N.M.: An indoor navigation support for the student halls of residence using augmented reality: A design perspective. Pertanika Journal of Science & Technology 29 (2021)
5. Ueda, N., Naya, F.: Spatio-temporal multidimensional collective data analysis for providing comfortable living anytime and anywhere. APSIPA Transactions on Signal and Information Processing 7, e4 (2018)
6. Verma, P., Agrawal, K., Sarasvathi, V.: Indoor navigation using augmented reality. In: Proceedings of the 2020 4th International Conference on Virtual and Augmented Reality Simulations. pp. 58–63 (2020)

Approved by the advisor **Ho Chi Minh City, 24/02/2025**

Signature of Advisor ***Signature(s) of student(s)***



Trần Minh Triết Nguyễn Ngọc Long Tô Quỳnh Chi