Indoor Navigation using Augmented Reality

A

<u>Software Requirement Specification (SRS) and Design Document</u>

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KOLHAPUR INSTITUTE OF TECHNOLOGY'S COLLEGE OF ENGINEERING (AUTONOMOUS), KOLHAPUR

Software Requirement Specification and Design

Title: Indoor Navigation using Augmented Reality

Div: B

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1. Introduction

1.1 Purpose:

The purpose of this Project is to address the challenges faced by modern campus navigation. Systems, particularly in providing intuitive and high-precision navigation for indoor environments. The focus is on enhancing user experience and overcoming limitations such as reliance on 2D information, network queries, and third-party service platforms. The proposed solution integrates augmented reality (AR) technology to superimpose computer-generated. virtual objects and information onto the real environment. This aims to create a more interactive and user-friendly campus navigation experience.

1.2 Scope:

The scope of this project encloses the design and implementation of a mobile campus navigation app that utilizes visual inertial odometry and ARCore-based virtual and real fusion technology. The system's scope includes addressing the shortcomings of existing navigation systems by providing 3D augmented information integrated with real buildings, high-precision navigation in indoor environments, and a rich set of augmented reality content. The focus extends to the use of Unity as the development platform and the incorporation of human-computer interaction functions tailored to different scenarios and user needs.

1.3 Overview:

The project is structured to present a comprehensive overview of the proposed mobile campus navigation app. It begins by summarizing the existing navigation system's defects, highlighting issues such as limited 2D information, lack of high-precision navigation, and challenges in human-computer interaction. The introduction of augmented reality (AR) technology is emphasized as a solution to enhance reality, integrating virtual objects and information into the real environment.

The characteristics of the proposed system are outlined, including the superimposition of virtual routes into the real environment using AR technology, the utilization of visual odometry and inertial sensors for precise navigation, and the development platform choice of Unity for designing interactive functions. The system's ability to provide a variety of augmented reality content is highlighted, enhancing user engagement during navigation.

The structure of the paper is then detailed, with subsequent sections dedicated to related work, key technologies, system implementation, system testing and result analysis, evaluation, and conclusions. This organization ensures a thorough exploration of the research context, technological foundations, practical implementation, testing outcomes, and final reflections on the proposed mobile campus navigation app.

2. Overall Description

2.1 System Perspective

The mobile campus navigation app operates as an integrated solution bridging the gap between traditional campus navigation challenges and modern technological advancements. It serves as a comprehensive tool that leverages augmented reality (AR) technology to transform the user's navigation experience. The system combines visual inertial odometry and ARCore-based virtual and real fusion technology to achieve high-precision navigation in both indoor and outdoor environments.

2.2 System Functions

1. **AR-Based Navigation:**
   The system employs augmented reality (AR) technology to superimpose virtual routes onto the real environment, enhancing the navigation experience by providing visual cues and guidance in 3D space.

2. **Visual Inertial Odometry**:
   Utilizing visual odometry and inertial sensors, the system ensures high-precision navigation in both indoor and outdoor environments, overcoming the limitations of GPS accuracy.

3. **Human-Computer Interaction:**
   Developed on the Unity platform, the system incorporates rich human-computer interaction functions, allowing users to engage with the navigation app through a user-friendly and scenario-specific interface.

4. **Database-Driven Augmentation:**
   The system accesses a database to provide users with a diverse range of augmented reality content creating an interactive and immersive navigation experience.

5. **Real-Time Scene Extension**:
   Through sensor information fusion technology, the system achieves real-time tracking, extending the virtual scene seamlessly into the real world, contributing to a more intuitive understanding of the environment.

6. **Localization and Map Building:**
   Visual odometry and inertial sensors are utilized for real time localization and map building, ensuring accurate and up-to-date information for users navigating through the campus.

7. **Dynamic Route Planning:**
   The system dynamically plans routes based on the user's real time location, considering indoor environments, providing adaptive navigation guidance throughout the journey.

2.3 Software Interface

The software interface of the mobile campus navigation app is designed with a user-centric approach. It features an intuitive graphical user interface (GUI) developed using the Unity platform. Users interact with the app through touch controls, gestures, ensuring a seamless and accessible navigation experience. The software intelligently processes real-time data from visual odometry and inertial sensors, integrating this information with the ARCore-based augmented reality elements.

The GUI provides interactive icons with dynamic overlays, showcasing virtual routes and augmented information. Users can input destinations, customize preferences, and receive real time navigation guidance. The software interface also includes a database-driven content delivery system, enabling the integration of multimedia elements into the navigation experience. Overall, the software interface prioritizes user-friendliness, responsiveness, and adaptability to diverse user scenarios.

2.4 Hardware Interface

The mobile campus navigation app is compatible with standard smartphones equipped with cameras, inertial sensors, and sufficient processing power. It interfaces with the device's camera for AR-based navigation, relying on visual odometry for precise location tracking. Inertial sensors, such as accelerometers and gyroscopes, contribute to accurate motion sensing and positioning.

The system operates seamlessly on devices with moderate hardware specifications, ensuring widespread accessibility. It doesn't rely on specialized hardware, making it convenient for a broad range of users. The hardware interface is designed to optimize the performance of visual and sensor technologies, providing a smooth and responsive navigation experience across various mobile devices.

3. Requirement Specifications

3.1 Functional Requirements

User Registration and Authentication:
Users should be able to create accounts and log in securely. Different user roles (e.g., admin, visitor) with varying privileges.

Real-time Positioning: Accurately determine the user's location in real-time using indoor positioning technologies. Display the user's location on an AR map.

Navigation Guidance: Provide turn-by-turn navigation instructions in AR. Suggest Alternative routes when available. Handle recalculations when a user deviates from the recommended path.

Multi-floor Support: Enable seamless navigation between multiple floors if applicable.

3.2 Hardware Requirements

Android Smartphone: Users will need an Android smartphone with ARCore support. may include devices like Google Pixel, Samsung Galaxy, or other compatible models.

Camera: A smartphone with a reliable camera is essential for capturing the environment and tracking features. Sufficient Processing Power: The smartphone should sufficiently process power and memory to handle real-time AR rendering and calculations.

Internet Connectivity: Users will require an internet connection for downloading applications and accessing any cloud-based features or updates.

3.3 Software Requirements

Unity 3D: You'll need the Unity 3D development environment to create and build the AR application. Unity provides ARCore support through the AR Foundation package.

ARCore SDK for Unity: This software development kit integrates ARCore functionalities into Unity, enabling you to work with point cloud data and AR features.

AR Foundation: AR Foundation is a Unity package that allows for cross-platform AR development, making it essential for ARCore integration.

Android Studio: To build and deploy the Android app, you should have Android Studio installed.

Java or C#: Depending on preference, we can use Java or C# for scripting within Unity.

A* Pathfinding Library: We may need to integrate an A* pathfinding library into our project, which depends on the specific library we choose.

Database (optional): If our navigation system involves storing and retrieving building layout data, we may require a database system like SQLite or Firebase.

3.4 Non-Functional Requirements

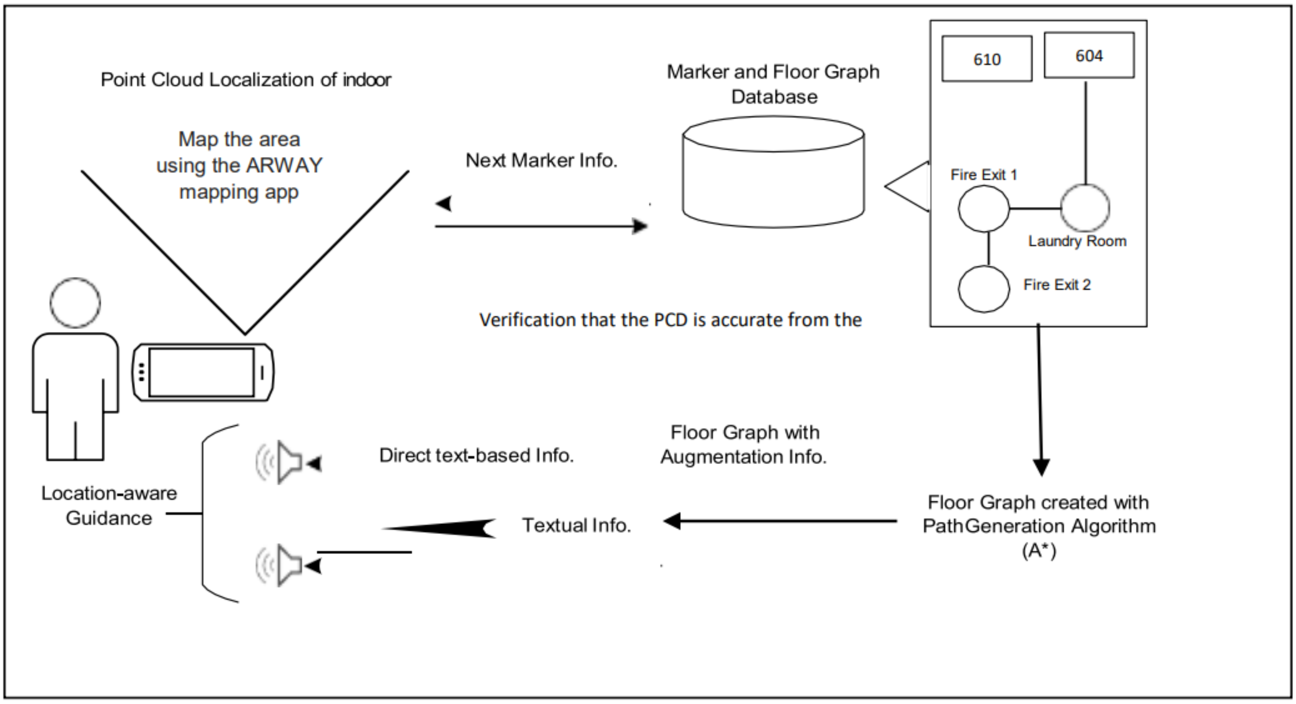
Response Time: The system should provide real-time responses to user actions and location updates. Define acceptable response time thresholds for actions like route calculation, map loading, and user interactions.

Scalability: The system must be able to scale to accommodate many concurrent users, especially during peak usage times.

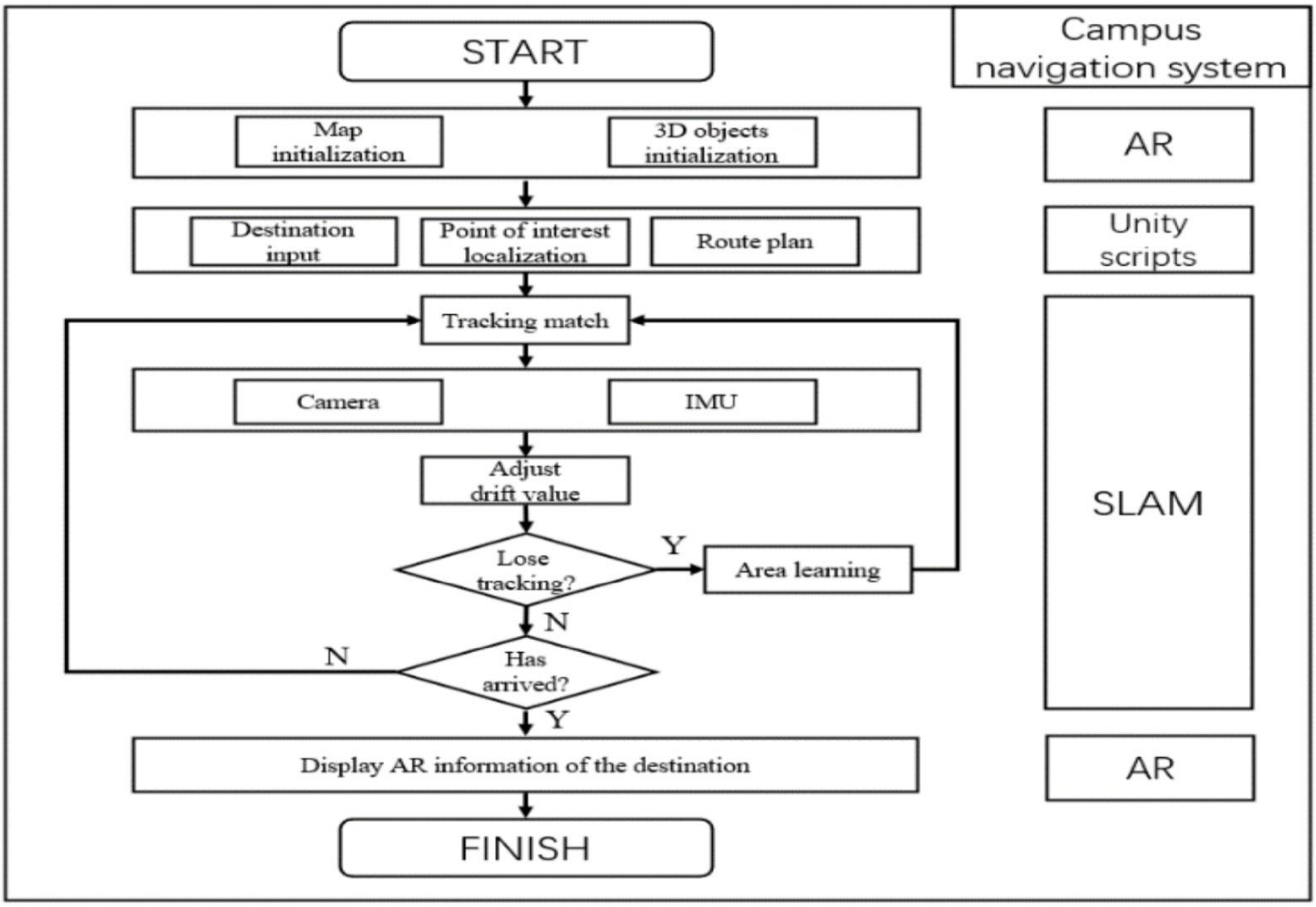
Reliability: The system should be highly reliable, with minimal downtime. Specify availability requirements.

4. System Design

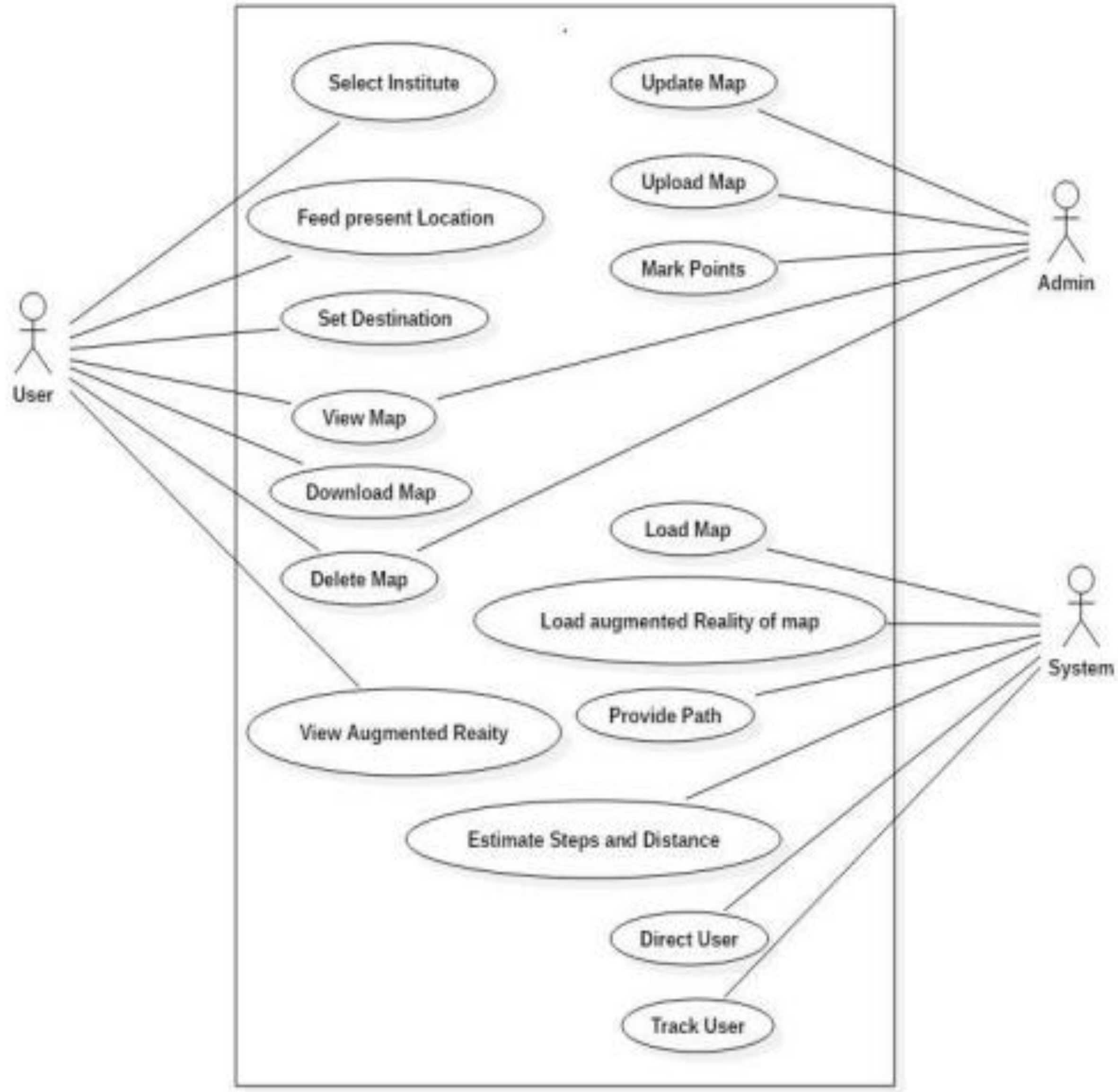
4.1 System Architecture:



4.2 Workflow Diagram:



4.3 Use Case Diagram: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Update Map
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Set Destination
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View Map
Download Map
Load Map
Delete Map
Load augmented Reality of map
System
Provide Path
View Augmented Reaity
Estimate Steps and Distance
Direct User
Track User