Indoor Navigation

Using

Spatial Anchors

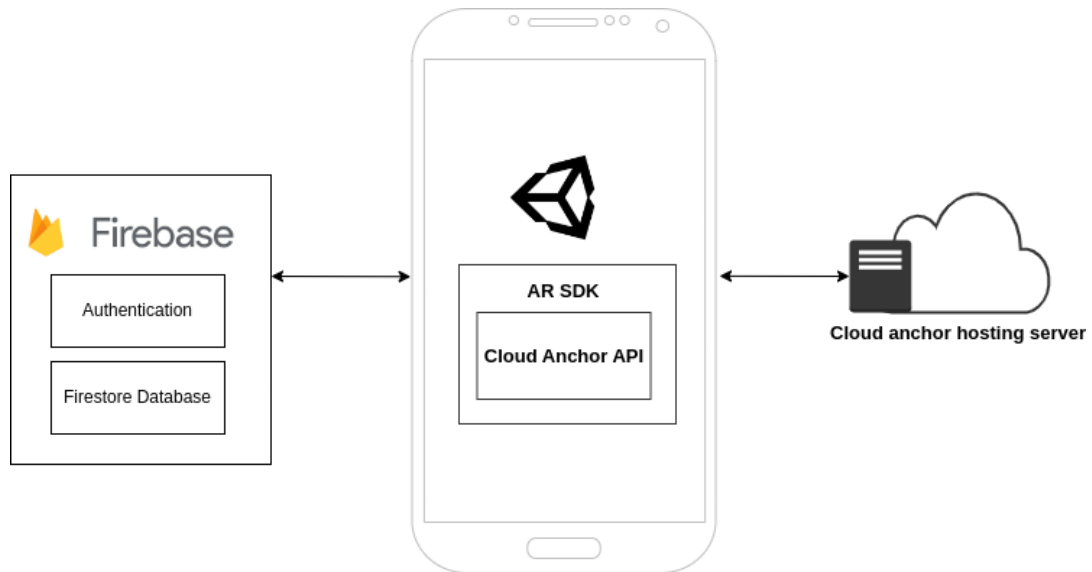## Design Document

In18-S7-CS4472 - Mobile Computing

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1. Components/modules of the proposed application

- Front-end: A renderer with AR support. Unity [1] can be used for this

- AR Software Development Kit (SDK): A SDK that provides a set of APIs and tools to develop AR applications. Google's ARCore [2] can be used as the SDK for this

- Cloud anchor API: A set of APIs that enable creating and resolving spatial anchors in the physical world. Google Cloud Anchors API [3] or Azure Spatial Anchors API [4] can be used as the API.

- Cloud anchor hosting server: This is a server-side component that stores the anchor data and makes it available to mobile devices. The server would be responsible for managing the anchor data, including storing and retrieving it as needed. A Google Cloud Platform (GCP) [5] free trial can be used for hosting Google Cloud Anchors API services.

- Backend server and database: This application uses Firebase as its cloud service provider. The main requirement of the backend server in this project is to authenticate users and control access to the database. Firebase Authentication is used to handle the authentication process, and users must be logged into the system to access the Firebase Firestore database. This limits

access to the database and ensures that only authenticated users can interact with it.
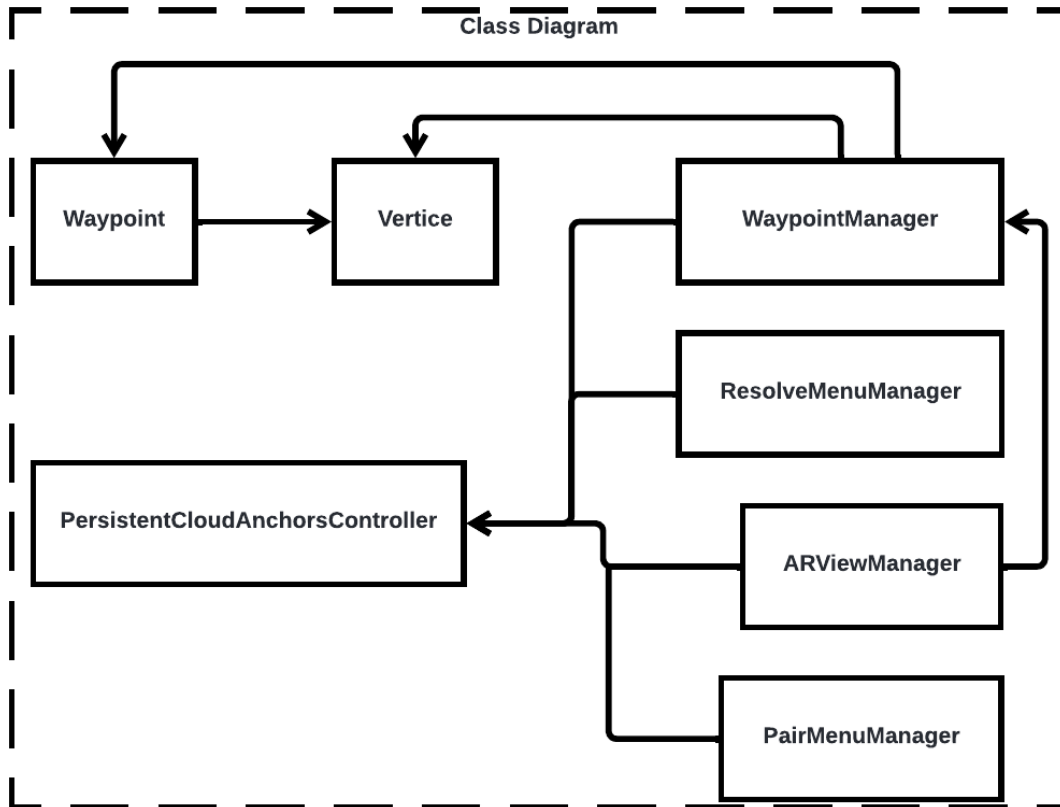
2. Interfaces between these components

2.1 User interacts with the user interface made using Unity UI.

The app uses Unity Interfaces provided by Unity ARFoundation and ARExtensions which provides methods to interact with Google CloudAnchors API

- ARSessionOrigin: A component in Unity that represents the origin of the AR world coordinate system. It is responsible for positioning and orienting the camera in the AR scene
- ARPlaneManager: A component that manages the detection and tracking of horizontal and vertical planes in the AR scene
- ARPointCloudManager: A component that manages the detection and tracking of feature points in the AR scene

- ARAnchorManager: A component that manages the creation and tracking of anchors in the AR scene

- ARRaycastManager: A component that manages raycasting in the AR scene. It allows developers to cast rays from the device's camera into the AR world and detect collisions with virtual objects (ARPlanes in our case)

2.2 Connection between the mobile application, database service, and authentication service

To establish a connection with the Firebase Firestore database, the Unity Firebase admin SDK is used. The process begins by creating a *FirebaseFirestore* instance, which can then be utilized to perform CRUD operations in Firestore. This approach allows for seamless integration between the Unity engine and Firebase's cloud services, enabling efficient and effective data management within the application. Authentication is accomplished by creating a *FirebaseAuth* instance, which enables communication with Firebase's authentication services. This instance provides a simple and secure way to manage user authentication within the application.

3. Technology Stack

3.1   Unity: Used for the front end as a renderer. Also provides SDKs for AR functionalities

- Unity ARFoundation: Framework to create AR applications that can be deployed on multiple platforms

- Unity ARExtensions: A package of tools and APIs that extends the capabilities of Unity ARFoundation and provides additional features for creating AR applications.

- ARCore XR Plugin: This package provides support for cloud anchors

3.2   Firebase: Used for authentication service and database service

- Firebase authentication - Firebase Authentication is a cloud-based authentication service offered by Google's Firebase platform. It provides an easy and secure way to authenticate users in web and mobile applications.

Firebase Authentication supports a wide range of authentication methods. In this project, we are utilizing Firebase's email and password authentication method to handle user authentication

- Firestore database - Firestore is a NoSQL document database offered as a cloud service by Google's Firebase platform.

4. References

[1]   Unity Technologies, "Getting started with AR development in Unity," *Unity3d.com*.   [Online].   Available: https://docs.unity3d.com/Manual/AROverview.html. [Accessed: 18-Dec-2022].

[2]   "Overview of ARCore and supported development environments," *Google Developers*.   [Online].   Available: https://developers.google.com/ar/develop. [Accessed: 18-Dec-2022].

[3]   "ARCore cloud anchor management API," *Google Developers*. [Online]. Available:
https://developers.google.com/ar/develop/cloud-anchors/management-api.
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[4]   "Spatial   anchors,"   *Microsoft.com*.   [Online].   Available: https://azure.microsoft.com/en-us/products/spatial-anchors/.   [Accessed: 18-Dec-2022].

[5]   "Google   Cloud   documentation,"   *Google   Cloud*.   [Online].   Available: https://cloud.google.com/docs. [Accessed: 18-Dec-2022].