Module Interface Specification for Software Engineering

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1 Revision History

Date	Version	Notes
2025-01-18	1.0	Initial Version

2 Symbols, Abbreviations and Acronyms

See SRS Documentation here.

Contents

3   Introduction

The following document details the Module Interface Specifications for the mobile AR application, *Realm*. The application is designed to provide users with an interactive and immersive experience of the world of AR. The application will be developed using the Unity game engine and will be compatible with both iOS and Android devices. The MIS will provide a detailed description of the modules that will be implemented in the application on both the client and server sides. The modules are decomposed into the hardware-hiding, behavior-hiding, and software decision modules. The hardware-hiding modules are used to abstract the hardware components of the system. The behavior-hiding modules are used to provide the functional requirements of the system. The software decision modules are used to provide the algorithms and data structures that will be used in the system.

Complementary documents include the SRS (System Requirement Specifications) and Module Guide. The full documentation and implementation can be found here.

4   Notation

The following table summarizes the primitive data types used by the *Realm* application.

Data Type	Notation	Description
character	char	a single symbol or digit
string	str	a sequence of characters
integer	$\mathbb{Z}$	a number without a fractional component in $(-\infty, \infty)$
natural number	$\mathbb{N}$	a number without a fractional component in $[1, \infty)$
real	$\mathbb{R}$	any number in $(-\infty, \infty)$
boolean	$\mathbb{B}$	{True, False}
array	$\Theta[\ ]$	Collection of data of type Θ. Fixed size can be mentioned within the brackets. Example: $\mathbb{R}[\ ]$
AR object	$\mathbb{AR}$	a binary blob containing information to read and view the AR object

5 Module Decomposition

The following table is taken directly from the Module Guide document for this project.

Level 1	Level 2
Hardware-Hiding Module	Hardware Module
Behaviour-Hiding Module	Tutorial Module
	Inventory Module
	Sub-Realm Module
	Touring Module
	Tour List Module
	Tour Management Module
	Settings Module
	Help Module
	Friends Module
	Maps Module
	Realm Interface Module
	Object Importer Module
	Object Placement Module
	Object Interaction Module
	Object Render Module
	Collision Detection Module
	Restricted Area Detection Module
	Weather Detection Module
	Tour Proximity Detection Module
	Notifications Module
Software Decision Module	REST API Connection Module
	Local Database Manager Module
	Data Sync Module
	Server Database Manager Module
	Authentication Module

Table 1: Module Hierarchy

6 MIS of Tutorial

The Tutorial module contains the methods needed to produce an interactive tutorial. Once a feature has been demonstrated, a user can choose to move on to the next feature. Once all the features have been shown, the user can quit the tutorial immediately or stay in the sandbox.

6.1 Module

TutorialModule

6.2 Uses

Realm Interface Module
Maps Module
Object Importer Module
Object Placement Module
Object Interaction Module
REST API Connection Module

6.3 Syntax

6.3.1 Exported Constants

6.3.2 Exported Access Programs

Name	In	Out	Exceptions
Full	-	-	-
One	$\mathbb{Z}, string$	-	-
Close	$string$	-	-
Reset	-	-	-

6.4 Semantics

6.4.1 State Variables

page: $\mathbb{Z}$
isLoaded: $\mathbb{B}$
isNextAvailable: $\mathbb{B}$
isLast: $\mathbb{B}$

6.4.2 Environment Variables

N/A

6.4.3 Assumptions

N/A

6.4.4 Access Routine Semantics

Full():

- transition: (isNextAvailable == True ∧ button.pressed == True ∧ isLast == True) ⇒ Close("Realm Interface")

- output: N/A

- exception: N/A

One(page, prev):

- transition: (isNextAvailable == True ∧ button.pressed == True) ⇒ Close(prev)

- output: N/A

- exception: N/A

Close(nav_screen):

- transition: button.pressed == True ⇒ (Reset(), screen == nav_screen)

- output: N/A

- exception: N/A

Reset():

- transition: page = 0

- output: N/A

- exception: N/A

6.4.5 Local Functions

N/A

7 MIS of Settings Module

7.1 Module

Settings Module

7.2 Uses

- Database/Network Manager Module

- Error Manager Module

- Authentication Module

7.3 Syntax

7.3.1 Exported Constants

- None

7.3.2 Exported Access Programs

Name	In	Out	Exceptions
UpdateSettings	Dictionary of key-value pairs	Bool - Success or Fail	InvalidKeyException
FetchSettings	-	Dictionary of current settings	-
ResetToDefaults	-	Bool - Success or Fail	-
UpdateProfileDetails	Dictionary of profile-related key-value pairs	Bool - Success or Fail	InvalidKeyException
FetchProfileDetails	-	Dictionary of profile-related data	-
ChangePassword	Old password, new password	Bool - Success or Fail	AuthenticationException

7.4 Semantics

7.4.1 State Variables

- settings: A dictionary containing user-configurable settings and their current values.

- profileDetails: A dictionary storing user profile-related data (e.g., name, avatar, bio).

7.4.2 Environment Variables

- Device Storage: Used to persist settings and profile details.

- Encryption Mechanism: Ensures sensitive data like passwords and privacy settings are encrypted during storage and transmission.

7.4.3 Assumptions

- The device has sufficient storage for saving and retrieving settings and profile details.

- All keys provided for updates are predefined and valid.

- The user is authenticated before accessing this module.

7.4.4 Access Routine Semantics

UpdateSettings(newSettings):

- **Transition:** Updates the corresponding entries in the settings dictionary with the provided key-value pairs.

- **Output:** Returns true if all updates succeed, false otherwise.

- **Exception:** Throws InvalidKeyException if an invalid key is provided.

FetchSettings():

- **Output:** Returns the current settings dictionary.

- **Exception:** None

ResetToDefaults():

- **Transition:** Resets all settings in the dictionary to their default values.

- **Output:** Returns true if the reset succeeds, false otherwise.

- **Exception:** None

UpdateProfileDetails(newProfileDetails):

- **Transition:** Updates the corresponding entries in the profileDetails dictionary with the provided key-value pairs.

- **Output:** Returns true if all updates succeed, false otherwise.

- **Exception:** Throws InvalidKeyException if an invalid key is provided.

FetchProfileDetails():

- **Output:** Returns the current profileDetails dictionary.

- **Exception:** None

ChangePassword(oldPassword, newPassword):

- **Transition:** Validates the old password and updates the password to the new one if valid.

- **Output:** Returns true if the password is successfully changed, false otherwise.

- **Exception:** Throws AuthenticationException if the old password is incorrect or the user session is invalid.

7.4.5   Local Functions

- ValidateKey(key): Ensures the provided key is predefined and valid for the settings or profileDetails dictionaries.

- EncryptData(data): Applies encryption to sensitive data before storage or transmission.

8 MIS of Help Module

8.1 Module

Help Module

8.2 Uses

- User Interface Manager Module

- Content Storage Module

8.3 Syntax

8.3.1 Exported Constants

- None

8.3.2 Exported Access Programs

Name	In	Out	Exceptions
ViewHelpTopics	-	List of help topics	-
SearchHelp	Query string	Relevant help content	InvalidQueryException
FetchFAQ	-	List of frequently asked questions	-
ContactSupport	User message, user contact info	Confirmation of message sent	MessageDeliveryException
SubmitFeedback	Feedback message	Bool - Success or Fail	FeedbackSubmissionException

8.4 Semantics

8.4.1 State Variables

- helpSections: A collection of predefined help sections, each identified by a unique ID and containing text, images, or links.

- searchIndex: An index to facilitate quick searches within help content.

8.4.2 Environment Variables

- Content Storage: Stores the help documentation (e.g., FAQs, guides, tutorials).

- Device Network: Used for fetching online help content if local content is not available.

8.4.3 Assumptions

- All help content is preloaded in the Content Storage or accessible via a network connection.

- The section identifiers used are valid and correspond to existing help sections.

8.4.4 Access Routine Semantics

FetchHelpContent(sectionID):

- **Transition:** None

- **Output:** Returns the help content associated with the given section identifier.

- **Exception:** Throws ContentNotFoundException if the sectionID is invalid or not found.

SearchHelpContent(query):

- **Transition:** None

- **Output:** Returns a list of section identifiers that are relevant to the search query.

- **Exception:** None

NavigateToHelpSection(sectionID):

- **Transition:** Updates the displayed help section in the user interface to the section corresponding to the given identifier.

- **Output:** Returns true if navigation is successful, false otherwise.

- **Exception:** Throws InvalidSectionException if the sectionID is invalid.

8.4.5 Local Functions

- ValidateSectionID(sectionID): Ensures the section identifier is valid and corresponds to an existing help section.

- PerformSearch(query): Matches the search query against the searchIndex and returns relevant section identifiers.

9   MIS of Friends Module

9.1   Module

Friends Module

9.2   Uses

- User Interface Manager Module

- Database Manager Module

- Notification Module

9.3   Syntax

9.3.1   Exported Constants

- None

9.3.2   Exported Access Programs

Name	In	Out	Exceptions
AddFriend	User ID of friend	Bool - Success or Fail	FriendRequestException
RemoveFriend	User ID of friend	Bool - Success or Fail	FriendNotFoundException
FetchFriendList	-	List of friends	-
AcceptFriendRequest	Request ID	Bool - Success or Fail	InvalidRequestException
RejectFriendRequest	Request ID	Bool - Success or Fail	InvalidRequestException
BlockUser	User ID of user to block	Bool - Success or Fail	BlockException

9.4   Semantics

9.4.1   State Variables

- friendsList: A list of user identifiers representing the user's current friends.

- pendingRequests: A list of incoming and outgoing friend requests.

9.4.2   Environment Variables

- Database: Stores the user's friends and pending requests.

- Notification System: Sends notifications for friend requests and updates.

9.4.3 Assumptions

- All user identifiers provided are valid and correspond to registered users.

- The database connection is available and operational during module use.

9.4.4 Access Routine Semantics

AddFriend(userID):

- **Transition:** Adds the specified user to the friends list if the request is valid and approved.

- **Output:** Returns true if the friend is successfully added, false otherwise.

- **Exception:** Throws UserNotFoundException if the specified userID does not exist.

RemoveFriend(userID):

- **Transition:** Removes the specified user from the friends list.

- **Output:** Returns true if the friend is successfully removed, false otherwise.

- **Exception:** Throws UserNotFoundException if the specified userID does not exist.

FetchFriendsList():

- **Output:** Returns a list of user identifiers representing the user's current friends.

- **Exception:** None

SendFriendRequest(userID):

- **Transition:** Adds a new friend request to the pendingRequests list.

- **Output:** Returns true if the request is successfully sent, false otherwise.

- **Exception:** Throws UserNotFoundException if the specified userID does not exist.

RespondToFriendRequest(requestID, response):

- **Transition:** Updates the status of the specified friend request (accept or reject).

- **Output:** Returns true if the response is successfully recorded, false otherwise.

- **Exception:** Throws RequestNotFoundException if the specified requestID does not exist.

9.4.5 Local Functions

- ValidateUserID(userID): Ensures the user identifier corresponds to a valid registered user.

- NotifyUser(userID, message): Sends a notification to the specified user.

10 MIS of Collision Hazard Detection Module

10.1 Module

Collision Hazard Detection Module

10.2 Uses

- AR Object Manager Module

- Device Sensors Module (e.g., Camera, LiDAR)

- Notification Module

10.3 Syntax

10.3.1 Exported Constants

- None

10.3.2 Exported Access Programs

Name	In	Out	Exceptions
DetectCollision	User's current position, AR object positions	Boolean (Collision Detected/Not Detected)	SensorDataUnavailableException
FetchHazardDetails	Collision ID	Hazard details (Type, Severity, Location)	HazardNotFoundException
LogCollisionEvent	Collision details (Position, Time, Severity)	Bool - Success or Fail	LoggingException
ClearHazardAlerts	-	Bool - Success or Fail	AlertClearanceException
UpdateDetectionSettings	Dictionary of detection settings	Bool - Success or Fail	InvalidSettingsException

10.4 Semantics

10.4.1 State Variables

- collisionEvents: A log of detected collisions, including timestamps, object data, and resolutions.

10.4.2   Environment Variables

- Device Sensors: Provides real-time data for collision detection (e.g., LiDAR, camera).

- Notification System: Sends alerts when collisions are detected.

- Storage System: Logs collision events for future analysis.

10.4.3   Assumptions

- Device sensors are operational and capable of providing accurate real-time data.

- The system has access to sufficient storage for logging collision events.

- All objects in the AR environment are registered and have defined collision boundaries.

10.4.4   Access Routine Semantics

DetectCollision(sensorData):

- **Transition:** None

- **Output:** Returns true if a collision is detected based on sensor data, false otherwise.

- **Exception:** Throws SensorUnavailableException if real-time data cannot be accessed.

ResolveCollision(collisionData):

- **Transition:** Attempts to resolve the collision by adjusting object positions or notifying the user.

- **Output:** Returns true if the collision is successfully resolved, false otherwise.

- **Exception:** Throws CollisionNotResolvableException if the collision cannot be resolved.

LogCollisionEvent(eventData):

- **Transition:** Records the collision event in the system log.

- **Output:** Returns true if the event is successfully logged, false otherwise.

- **Exception:** Throws LogWriteException if the log cannot be updated.

10.4.5   Local Functions

- AnalyzeSensorData(sensorData): Processes real-time data to determine if a collision is imminent.

- NotifyUserOfCollision(collisionData): Sends an alert to the user about a detected collision.

11 MIS of Tour Proximity Detection Module

11.1 Module

Tour Proximity Detection Module

11.2 Uses

- GPS Module
- Notification Module
- AR Object Manager Module

11.3 Syntax

11.3.1 Exported Constants

- None

11.3.2 Exported Access Programs

Name	In	Out	Exceptions
DetectNearbyTours	User's current location, registered tour locations	List of tours within proximity	LocationDataUnavailableException
NotifyTourProximity	User's proximity to a specific tour	Notification message	NotificationFailureException
UpdateTourProximity	Updated user location, updated tour locations	Bool - Success or Fail	UpdateFailedException
FetchProximityDetails	User ID, tour ID	Details of proximity data	DataFetchException

11.4 Semantics

11.4.1 State Variables

- proximityEvents: A log of detected proximity events, including timestamps, tour data, and notifications sent.
- currentLocation: The user's most recently reported GPS coordinates.

11.4.2 Environment Variables

- GPS System: Provides the user's real-time location.

- Notification System: Sends alerts when a user is near a tour location.

- Storage System: Logs proximity detection events for future analysis.

11.4.3 Assumptions

- The GPS system is operational and capable of providing accurate location data.

- The system has sufficient storage for logging proximity detection events.

- All tours in the system have clearly defined geographical boundaries.

11.4.4 Access Routine Semantics

DetectNearbyTour(currentLocation):

- **Transition:** None

- **Output:** Returns a list of tours within proximity to the user's current location.

- **Exception:** Throws LocationUnavailableException if GPS data cannot be accessed.

TriggerTourNotification(tourData):

- **Transition:** Sends a notification to the user about the nearby tour.

- **Output:** Returns true if the notification is successfully sent, false otherwise.

- **Exception:** Throws NotificationSendException if the notification fails to send.

LogProximityEvent(eventData):

- **Transition:** Records the proximity event in the system log.

- **Output:** Returns true if the event is successfully logged, false otherwise.

- **Exception:** Throws LogWriteException if the log cannot be updated.

11.4.5 Local Functions

- AnalyzeLocationData(locationData): Processes the current GPS location to identify nearby tours.

- NotifyUserOfProximity(tourData): Sends an alert to the user about a detected nearby tour.

12 MIS of Notifications Module

12.1 Module

Notifications Module

12.2 Uses

- User Interface Manager Module

- Database Manager Module

12.3 Syntax

12.3.1 Exported Constants

- None

12.3.2 Exported Access Programs

Name	In	Out	Exceptions
SendNotification	User ID, notification message	Bool - Success or Fail	NotificationSendException
FetchNotifications	User ID	List of notifications	DataFetchException
MarkNotificationRead	Notification ID	Bool - Success or Fail	NotificationNotFoundException
DeleteNotification	Notification ID	Bool - Success or Fail	DeleteFailedException
UpdateNotificationSettings	User ID, settings data	Bool - Success or Fail	InvalidSettingsException

12.4 Semantics

12.4.1 State Variables

- notifications: A list of notifications associated with each user, including their status (read/unread).

12.4.2 Environment Variables

- Notification System: Handles the actual delivery of notifications to users.

- Database: Stores notifications for retrieval and management.

12.4.3   Assumptions

- The notification delivery service is operational and capable of sending notifications in real-time.

- All user identifiers and notification identifiers are valid and exist in the database.

12.4.4   Access Routine Semantics

SendNotification(notificationData):

- **Transition:** Adds the notification to the database and attempts to deliver it to the specified user.

- **Output:** Returns true if the notification is successfully sent, false otherwise.

- **Exception:** Throws NotificationSendException if the delivery fails.

FetchNotifications(userID):

- **Output:** Returns a list of notifications for the specified user.

- **Exception:** Throws UserNotFoundException if the user ID is not found.

MarkNotificationAsRead(notificationID):

- **Transition:** Updates the status of the specified notification to "read" in the database.

- **Output:** Returns true if the status update is successful, false otherwise.

- **Exception:** Throws NotificationNotFoundException if the notification ID is not found.

DeleteNotification(notificationID):

- **Transition:** Removes the specified notification from the database.

- **Output:** Returns true if the notification is successfully deleted, false otherwise.

- **Exception:** Throws NotificationNotFoundException if the notification ID is not found.

12.4.5   Local Functions

- ValidateNotificationData(notificationData): Ensures the notification data is valid before sending.

- NotifyUser(notificationData): Sends the notification to the user using the delivery system.

13 MIS of Authentication Module

13.1 Module

Authentication Module

13.2 Uses

- Database Manager Module

- Encryption Module

- Notification Module (for two-factor authentication)

13.3 Syntax

13.3.1 Exported Constants

- None

13.3.2 Exported Access Programs

Name	In	Out	Exceptions
SendNotification	User ID, notification message	Bool - Success or Fail	NotificationSendException
FetchNotifications	User ID	List of notifications	DataFetchException
MarkNotificationRead	Notification ID	Bool - Success or Fail	NotificationNotFoundException
DeleteNotification	Notification ID	Bool - Success or Fail	DeleteFailedException
UpdateNotificationSettings	User ID, settings data	Bool - Success or Fail	InvalidSettingsException

13.4 Semantics

13.4.1 State Variables

- users: A collection of user data, including credentials, authentication settings, and two-factor status.

- activeSessions: A list of currently authenticated user sessions.

13.4.2   Environment Variables

- Database: Stores user credentials and authentication-related data.

- Encryption System: Encrypts sensitive user information like passwords.

- Notification System: Sends two-factor authentication codes or password reset links.

13.4.3   Assumptions

- All usernames and passwords are stored securely and hashed using industry-standard encryption.

- The system has access to a functional notification system for delivering codes and reset links.

- Users provide valid inputs during registration and login attempts.

13.4.4   Access Routine Semantics

AuthenticateUser(username, password):

- **Transition:** Verifies the username and password against stored credentials.

- **Output:** Returns true if the credentials are valid, false otherwise.

- **Exception:** Throws AuthenticationFailedException if the credentials do not match.

RegisterUser(registrationData):

- **Transition:** Adds a new user to the database with the provided registration data.

- **Output:** Returns true if the registration is successful, false otherwise.

- **Exception:** Throws RegistrationFailedException if the registration fails due to invalid data or duplication.

ResetPassword(emailOrUsername):

- **Transition:** Sends a password reset link or code to the associated email.

- **Output:** Returns true if the reset link/code is sent successfully, false otherwise.

- **Exception:** Throws UserNotFoundException if the email or username is not found.

EnableTwoFactorAuth(userID):

- **Transition:** Enables two-factor authentication for the specified user.

- **Output:** Returns true if the feature is enabled successfully, false otherwise.

- **Exception:** Throws UserNotFoundException if the user ID is invalid.

ValidateTwoFactorCode(userID, code):

- **Transition:** Validates the two-factor authentication code provided by the user.

- **Output:** Returns true if the code is valid, false otherwise.

- **Exception:** Throws InvalidCodeException if the code is incorrect or expired.

13.4.5   Local Functions

- HashPassword(password): Generates a secure hash for the given password.

- GenerateTwoFactorCode(userID): Creates a time-sensitive code for two-factor authentication.

- SendNotification(userID, message): Sends a notification to the specified user with relevant authentication details.

14 MIS of Object Render Module

14.1 Module

Object Render Module

14.2 Uses

- Maps Module

- Object Placement Module

14.3 Syntax

14.3.1 Exported Constants

- **RENDER_RESOLUTION_DEFAULT**: Default resolution for rendering objects.

- **RENDER_FPS_LIMIT**: Frame-per-second limit for rendering.

- **RENDER_QUALITY_OPTIONS**: Preset quality levels (e.g., low, medium, high).

14.3.2 Exported Access Programs

Name	In	Out	Exceptions
RenderObject	Object ID, Position, Orientation	Rendered Object	RenderingException
AdjustRenderSettings	Dictionary of key-value pairs	Bool - Success or Fail	InvalidSettingException
FetchRenderSettings	-	Dictionary of current render settings	-
PauseRendering	-	Bool - Success or Fail	RenderingException
ResumeRendering	-	Bool - Success or Fail	RenderingException

14.4 Semantics

14.4.1 State Variables

- **currentRenderSettings**: Stores the current rendering settings, such as resolution and FPS.

- **renderQueue**: A queue of objects to be rendered.

14.4.2 Environment Variables

- Graphics Processing Unit (GPU)
- Rendering Library (e.g., OpenGL, Vulkan, Unity Renderer)

14.4.3 Assumptions

- Objects to be rendered are correctly formatted and preprocessed.
- The rendering hardware meets the minimum requirements.

14.4.4 Access Routine Semantics

RenderObject(Object ID, Position, Orientation):

- transition: Adds the object to the render queue and renders it based on the given parameters.
- output: The rendered object appears in the virtual environment.
- exception: Throws `RenderingException` if the rendering fails due to hardware or software issues.

AdjustRenderSettings(Dictionary of key-value pairs):

- transition: Updates the `currentRenderSettings` variable with the provided values.
- output: Returns a success or failure boolean.
- exception: Throws `InvalidSettingException` if the provided settings are invalid.

FetchRenderSettings():

- transition: None.
- output: Returns the `currentRenderSettings`.
- exception: None.

PauseRendering():

- transition: Pauses the rendering process.
- output: Returns a success or failure boolean.
- exception: Throws `RenderingException` if pausing fails.

ResumeRendering():

- transition: Resumes the rendering process.
- output: Returns a success or failure boolean.
- exception: Throws `RenderingException` if resuming fails.

14.4.5 Local Functions

- **ValidateRenderSettings(settings)**: Ensures that the given render settings are within acceptable ranges.

- **OptimizeRenderQueue()**: Reorders the render queue to improve performance.

15 MIS of Touring Module

15.1 Module

Touring Module

15.2 Uses

Realm Interface Module, Maps Module, Notifications Module

15.3 Syntax

15.3.1 Exported Constants

- **DEFAULT_TOUR_RADIUS:** The default radius for proximity detection during tours.

15.3.2 Exported Access Programs

Name	In	Out	Exceptions
StartTour	Tour ID	Bool - Success or Fail	InvalidTourIDException
PauseTour	-	Bool - Success or Fail	-
EndTour	Tour ID	Bool - Success or Fail	InvalidTourIDException
FetchTourDetails	Tour ID	Tour Object	InvalidTourIDException

15.4 Semantics

15.4.1 State Variables

- **CurrentTour:** Stores the details of the ongoing tour.

15.4.2 Environment Variables

GPS and Maps API for location tracking.

15.4.3 Assumptions

It is assumed that GPS and Maps API services are functional.

15.4.4 Access Routine Semantics

StartTour:

- transition: Initializes the tour with the given Tour ID and marks it as active.

- output: Returns success if the tour starts successfully.

- exception: Throws InvalidTourIDException if the Tour ID does not exist.

PauseTour:

- transition: Pauses the current active tour.

- output: Returns success if the tour is paused successfully.

EndTour:

- transition: Ends the current active tour and updates its status.

- output: Returns success if the tour is ended successfully.

- exception: Throws InvalidTourIDException if the Tour ID does not exist.

16   MIS of Tour List Module

16.1   Module

Tour List Module

16.2   Uses

Touring Module, Maps Module

16.3   Syntax

16.3.1   Exported Constants

- **MAX_TOUR_ENTRIES:** The maximum number of tours that can be displayed in the list.

16.3.2   Exported Access Programs

Name	In	Out	Exceptions
FetchTourList	None	Array of Tours	-
SearchTours	Search Query	Array of Tours	-
SortTours	Sorting Criteria	Array of Tours	-

16.4   Semantics

16.4.1   State Variables

- **TourList:** Stores a list of available tours.

16.4.2   Environment Variables

Database connection to retrieve available tours.

16.4.3   Assumptions

It is assumed that the database is functional and contains valid tour data.

16.4.4   Access Routine Semantics

FetchTourList:

- transition: Retrieves all available tours from the database.

- output: Returns an array of available tours.

SearchTours:

- transition: Filters the available tours based on the search query.

- output: Returns an array of tours matching the search criteria.

SortTours:

- transition: Sorts the available tours based on the specified criteria.

- output: Returns an array of tours sorted by the given criteria.

17 MIS of Tour Management Module

17.1 Module

Tour Management Module

17.2 Uses

Realm Interface Module, Server Database Manager Module

17.3 Syntax

17.3.1 Exported Constants

- **MAX_TOUR_POINTS:** The maximum number of waypoints allowed in a single tour.

17.3.2 Exported Access Programs

Name	In	Out	Exceptions
CreateTour	Tour Object	Bool - Success or Fail	InvalidTourDataException
UpdateTour	Tour ID, Updated Tour Data	Bool - Success or Fail	InvalidTourIDException
DeleteTour	Tour ID	Bool - Success or Fail	InvalidTourIDException

17.4 Semantics

17.4.1 State Variables

- **ManagedTours:** Stores a list of tours created and managed by the organization.

17.4.2 Environment Variables

Database connection to manage tour data.

17.4.3 Assumptions

It is assumed that the database is functional and contains valid tour data.

17.4.4 Access Routine Semantics

CreateTour:

- transition: Adds a new tour to the database.

- output: Returns success if the tour is created successfully.

- exception: Throws InvalidTourDataException if the tour data is invalid.

UpdateTour:

- transition: Updates the details of an existing tour in the database.

- output: Returns success if the tour is updated successfully.

- exception: Throws InvalidTourIDException if the Tour ID does not exist.

DeleteTour:

- transition: Removes a tour from the database.

- output: Returns success if the tour is deleted successfully.

- exception: Throws InvalidTourIDException if the Tour ID does not exist.

18 MIS of Sub-Realms

18.1 Module

SubRealms

18.2 Uses

Local Database Manager

18.3 Syntax

18.3.1 Exported Constants

N/A

18.3.2 Exported Access Programs

Name	In	Out	Exceptions
getMembers	$\mathbb{N}$	Array$\langle\mathbb{N}\rangle$	SubRealmNotFound
addMember	$\mathbb{N}$, $\mathbb{N}$	-	SubRealmNotFound, UserAlreadyIn-SubRealm
removeMember	$\mathbb{N}$, $\mathbb{N}$	-	SubRealmNotFound, MemberNot-Found
createNew	Array$\langle\mathbb{N}\rangle$	$\mathbb{N}$	-
deleteExisting	$\mathbb{N}$	-	SubRealmNotFound

18.4 Semantics

18.4.1 State Variables

- $subRealms$: A mapping of $subRealmID \rightarrow subRealm$, where each $subRealm$ contains a list of $members$ (user IDs).

18.4.2 Environment Variables

- $localDB$: The local database used for storing sub-realm data temporarily.

18.4.3 Assumptions

Sub-realm IDs ($subRealmID$) are unique, and all user IDs ($userID$) are valid.

18.4.4   Access Routine Semantics

getMembers(subRealmID):

- **transition**: N/A

- **output**: Returns the list of $userIDs$ that are members of the sub-realm identified by $subRealmID$.

- **exception**:

  - $SubRealmNotFound$: If $subRealmID$ does not exist.

addMember(subRealmID, userID):

- **transition**: If $subRealmID \in subRealms$ and $userID \notin subRealms[subRealmID].members$, add $userID$ to the members of the sub-realm identified by $subRealmID$.

- **output**: N/A

- **exception**:

  - $SubRealmNotFound$: If $subRealmID$ does not exist.
  - $UserAlreadyInSubRealm$: If $userID$ is already a member of the sub-realm.

removeMember(subRealmID, userID):

- **transition**: If $subRealmID \in subRealms$ and $userID \in subRealms[subRealmID].members$, remove $userID$ from the members of the sub-realm identified by $subRealmID$.

- **output**: N/A

- **exception**:

  - $SubRealmNotFound$: If $subRealmID$ does not exist.
  - $MemberNotFound$: If $userID$ is not a member of the sub-realm.

createNew(memberList):

- **transition**: A new sub-realm is created with a unique $subRealmID$, and its $members$ are initialized to $memberList$. The new sub-realm is stored in both the local and server databases.

- **output**: Returns the unique $subRealmID$ of the newly created sub-realm.

- **exception**: None

deleteExisting(subRealmID):

- **transition**: If $subRealmID \in subRealms$, remove the sub-realm from both the local and server databases.

- **output**: N/A

- **exception**:

  - *SubRealmNotFound*: If *subRealmID* does not exist.

18.4.5   Local Functions

- `syncWithLocalDB()`: Synchronizes sub-realm data with the local database.

- `syncWithServerDB()`: Synchronizes sub-realm data with the server database.

19   MIS of Maps

19.1   Module

Maps

19.2   Uses

Local Database Manager, Maps API (external)

19.3   Syntax

19.3.1   Exported Constants

N/A

19.3.2   Exported Access Programs

Name	In	Out	Exceptions
getMapData	$\mathbb{N}$	MapData	LocationNotFound
addMarker	$\mathbb{N}$, Location, Details	-	-
removeMarker	$\mathbb{N}$, Location	-	MarkerNotFound
updateMarker	$\mathbb{N}$, Location, Details	-	MarkerNotFound
displayMap	$\mathbb{N}$	RenderedMap	LocationNotFound

19.4   Semantics

19.4.1   State Variables

- *markers*: A collection of markers, where each marker includes its *Location* and associated *Details*.

- *mapViews*: A mapping from $\mathbb{N}$ (view IDs) to rendered map states.

19.4.2   Environment Variables

- Access to the Google Maps API.

- Access to the local database for location details.

19.4.3   Assumptions

The Google Maps API and the local database are available and functioning properly.

19.4.4 Access Routine Semantics

getMapData(viewID):

- **transition**: N/A

- **output**: Returns $MapData$ for the $viewID$, including all markers and details for the associated location.

- **exception**: $viewID \notin mapViews$

addMarker(viewID, location, details):

- **transition**: If $viewID \in mapViews$, adds a marker to the map at $location$ with the given $details$.

- **output**: N/A

- **exception**: None

removeMarker(viewID, location):

- **transition**: If $location \in markers[viewID]$, removes the marker at $location$ from the map.

- **output**: N/A

- **exception**: $location \notin markers[viewID]$

updateMarker(viewID, location, details):

- **transition**: If $location \in markers[viewID]$, updates the marker at $location$ with new $details$.

- **output**: N/A

- **exception**: $location \notin markers[viewID]$

displayMap(viewID):

- **transition**: Renders the map for the $viewID$, including all markers and relevant details.

- **output**: Returns $RenderedMap$, which is a visual representation of the map.

- **exception**: $viewID \notin mapViews$

19.4.5 Local Functions

- `fetchLocationDetails(Location)`: Communicates with the local database to retrieve detailed information for a given location.

- `renderMap(viewID)`: Generates a visual representation of the map for the given $viewID$ using the Google Maps API.

20 MIS of Object Interaction Module

20.1 Module

ObjectInteraction

20.2 Uses

Local Database Manager

20.3 Syntax

20.3.1 Exported Constants

N/A

20.3.2 Exported Access Programs

Name	In	Out	Exceptions
reportObject	$\mathbb{N}$, Reason, Details	-	ObjectNotFound
reactToObject	$\mathbb{N}$, Reaction	-	ObjectNotFound
fetchReactions	$\mathbb{N}$	Array⟨Reaction⟩	ObjectNotFound
fetchReports	$\mathbb{N}$	Array⟨Report⟩	ObjectNotFound
resolveReport	$\mathbb{N}$, ResolutionDetails	-	ReportNotFound

20.4 Semantics

20.4.1 State Variables

- *objects*: A collection of AR objects, each identified by a unique $\mathbb{N}$.

- *reports*: A collection of reports associated with AR objects, including *Reason* and *Details*.

- *reactions*: A collection of user reactions, associated with specific AR objects.

20.4.2 Environment Variables

- AR objects are rendered and interactable in the environment.

- The system must have a connection to the local database for storing reports and reactions.

20.4.3 Assumptions

All AR objects are assigned unique identifiers and are interactable within the system. Users have access to a predefined set of reaction types (e.g., Like, Dislike).

20.4.4 Access Routine Semantics

reportObject(objectID, reason, details):

- **transition**: Adds a new report to *reports* for the object identified by *objectID*, with the specified *reason* and *details*.

- **output**: N/A

- **exception**: $objectID \notin objects$

reactToObject(objectID, reaction):

- **transition**: Adds a *reaction* (e.g., Like, Dislike) to *reactions* for the object identified by *objectID*.

- **output**: N/A

- **exception**: $objectID \notin objects$

fetchReactions(objectID):

- **transition**: N/A

- **output**: Returns all *reactions* associated with *objectID*.

- **exception**: $objectID \notin objects$

fetchReports(objectID):

- **transition**: N/A

- **output**: Returns all *reports* associated with *objectID*.

- **exception**: $objectID \notin objects$

resolveReport(reportID, resolutionDetails):

- **transition**: Marks the *report* identified by *reportID* as resolved and stores the *resolutionDetails*.

- **output**: N/A

- **exception**: $reportID \notin reports$

20.4.5 Local Functions

- `validateObject(objectID)`: Ensures *objectID* corresponds to a valid AR object in the system.

- `notifyUser(reportID)`: Sends a notification to the user who submitted the report, indicating its resolution status.

21 MIS of Local Database Manager

21.1 Module

LocalDBM

21.2 Uses

Server Database Manager

21.3 Syntax

21.3.1 Exported Constants

N/A

21.3.2 Exported Access Programs

Name	In	Out	Exceptions
fetchData	Query	Data	DataNotFound
saveData	Key, Data	-	-
updateData	Key, Data	-	DataNotFound
deleteData	Key	-	DataNotFound
syncWithServer	-	-	ServerError
getCachedData	Key	Data	DataNotCached

21.4 Semantics

21.4.1 State Variables

- *localCache*: A local in-memory or on-disk cache, keyed by unique *Key*, storing frequently accessed data.

- *lastSyncTime*: A timestamp of the last successful synchronization with the server database.

21.4.2 Environment Variables

- Access to the server database for retrieving and storing persistent data.

- A local caching mechanism (e.g., in-memory cache or local storage).

21.4.3 Assumptions

The server database is available and operational for syncing, and the local caching system has sufficient storage capacity.

21.4.4 Access Routine Semantics

fetchData(query):

- **transition**: N/A

- **output**: Executes *query* on the local cache or the server database if the data is not cached, and returns the *Data*.

- **exception**: Returns *DataNotFound* if the query does not match any records.

saveData(key, data):

- **transition**: Stores *data* in the *localCache* with the associated *key*. Also updates the server database asynchronously.

- **output**: N/A

- **exception**: None

updateData(key, data):

- **transition**: Updates *data* in *localCache* and synchronizes the change to the server database.

- **output**: N/A

- **exception**: $key \notin localCache$

deleteData(key):

- **transition**: Removes *data* identified by *key* from *localCache* and the server database.

- **output**: N/A

- **exception**: $key \notin localCache$

syncWithServer():

- **transition**: Synchronizes the *localCache* with the server database, updating any stale or missing records.

- **output**: N/A

- **exception**: *ServerError* if the server database is unavailable or the synchronization fails.

getCachedData(key):

- **transition**: N/A

- **output**: Returns *data* from *localCache* associated with *key*.

- **exception**: $key \notin localCache$

21.4.5 Local Functions

- `isCacheStale(key)`: Determines whether the cached data for *key* is outdated compared to the server database.

- `resolveConflict(localData, serverData)`: Resolves discrepancies between *localCache* and server database data.

22 MIS of Data Sync Module

The Data Sync Module updates the common data on both the local and server databases based on whichever has the most up-to-date information. This will mostly just apply to locally stored AR Objects.

22.1 Module

DataSyncModule

22.2 Uses

Server Database Manager Module
Local Database Manager Module

22.3 Syntax

22.3.1 Exported Constants

N/A

22.3.2 Exported Access Programs

Name	In	Out	Exceptions
Sync	-	-	SyncFailureException

22.4 Semantics

22.4.1 State Variables

syncInProgress: $\mathbb{B}$

22.4.2 Environment Variables

N/A

22.4.3 Assumptions

N/A

22.4.4 Access Routine Semantics

Sync():

- transition: local_obj.lastModified < server_obj.lastModified == True $\Rightarrow$ LocalDatabaseManager.update(local_obj, server_obj)

- exception: (LocalDatabaseManager == null ∨ ServerDatabaseManager == null) ⇒ SyncFailureException

22.4.5 Local Functions

N/A

23 MIS of Server Database Manager

23.1 Module

ServerDBM

23.2 Uses

Local Database Manager

23.3 Syntax

23.3.1 Exported Constants

N/A

23.3.2 Exported Access Programs

Name	In	Out	Exceptions
fetchData	Query	Data	DataNotFound, NetworkError
saveData	Key, Data	-	NetworkError
updateData	Key, Data	-	DataNotFound, NetworkError
deleteData	Key	-	DataNotFound, NetworkError
syncWithLocal	DataDiff	-	NetworkError

23.4 Semantics

23.4.1 State Variables

- *database*: The server database that stores all permanent data associated with the app.

- *lastSyncTime*: A timestamp indicating the last synchronization with the local database.

23.4.2 Environment Variables

- Network connectivity must be available for communication between the server database and local database manager.

23.4.3 Assumptions

The server database is accessible, operational, and synchronized with the local database manager periodically.

23.4.4 Access Routine Semantics

fetchData(query):

- **transition**: N/A

- **output**: Executes *query* on the server database and returns the corresponding *Data*.

- **exception**:

    - *DataNotFound*: If *query* does not match any records in the database.
    - *NetworkError*: If the network connection fails.

saveData(key, data):

- **transition**: Adds *data* to the server database with the associated *key*.

- **output**: N/A

- **exception**:

    - *NetworkError*: If the network connection fails.

updateData(key, data):

- **transition**: Updates *data* in the server database associated with *key*.

- **output**: N/A

- **exception**:

    - *DataNotFound*: If *key* does not exist in the database.
    - *NetworkError*: If the network connection fails.

deleteData(key):

- **transition**: Removes the record associated with *key* from the server database.

- **output**: N/A

- **exception**:

    - *DataNotFound*: If *key* does not exist in the database.
    - *NetworkError*: If the network connection fails.

syncWithLocal(dataDiff):

- **transition**: Synchronizes the *database* with changes provided in *dataDiff* from the local database manager.

- **output**: N/A

- **exception**:

  - *NetworkError*: If the network connection fails during synchronization.

23.4.5 Local Functions

- `applyDataDiff(dataDiff)`: Applies the changes from $dataDiff$ to the server database during synchronization.

- `logSyncOperation(status)`: Logs the success or failure of the synchronization operation.

24 MIS of REST API Communication Module

24.1 Module

RESTAPICommunication

24.2 Uses

Server Database Manager, HTTP Client Library (external)

24.3 Syntax

24.3.1 Exported Constants

N/A

24.3.2 Exported Access Programs

Name	In	Out	Exceptions
sendRequest	Endpoint, Method, Params	Response	APIError, NetworkError
parseResponse	RawResponse	ParsedResponse	ResponseParsingError
setHeaders	Headers	-	-
handleAuthentication	AuthToken	-	AuthError
checkServerStatus	-	ServerStatus	APIError, NetworkError

24.4 Semantics

24.4.1 State Variables

- *baseURL*: The base URL for the REST API server.

- *headers*: Key-value pairs for HTTP headers, including authentication tokens and content type.

24.4.2 Environment Variables

- Network connectivity for sending HTTP requests to the REST API server.

24.4.3 Assumptions

The REST API server follows standard HTTP and REST conventions, and the API endpoints are well-documented and accessible.

24.4.4 Access Routine Semantics

sendRequest(endpoint, method, params):

- **transition**: Sends an HTTP request to the API server at $baseURL + endpoint$ using the specified HTTP *method* (e.g., GET, POST, PUT, DELETE) and *params* as query parameters or request body.

- **output**: Returns the *Response* received from the API server.

- **exception**:

  - *APIError*: If the server responds with an error status code (e.g., 4xx or 5xx).
  - *NetworkError*: If the request fails due to network issues.

parseResponse(rawResponse):

- **transition**: N/A

- **output**: Converts $rawResponse$ (raw HTTP response) into a structured $ParsedResponse$ (e.g., JSON or XML object).

- **exception**:

  - *ResponseParsingError*: If the $rawResponse$ cannot be parsed due to invalid format.

setHeaders(headers):

- **transition**: Updates the *headers* used for subsequent HTTP requests.

- **output**: N/A

- **exception**: None

handleAuthentication(authToken):

- **transition**: Sets the authentication token in the *headers* for authorized requests.

- **output**: N/A

- **exception**:

  - *AuthError*: If the *authToken* is invalid or rejected by the server.

checkServerStatus():

- **transition**: N/A

- **output**: Returns the *ServerStatus* indicating whether the API server is reachable and operational.

- **exception**:

  - *APIError*: If the server responds with an error status code.
  - *NetworkError*: If the request fails due to network issues.

24.4.5   Local Functions

- `buildURL(endpoint, params)`: Constructs the complete URL for the API request by appending *endpoint* to *baseURL* and encoding *params* as query parameters.

- `logRequest(requestDetails)`: Logs details of the outgoing API request for debugging purposes.

- `retryRequest(requestDetails)`: Attempts to resend a failed request based on the retry policy.

25 MIS of Object Importer Module

25.1 Module

ObjectImporter

25.2 Uses

Local Database Manager

25.3 Syntax

25.3.1 Exported Constants

N/A

25.3.2 Exported Access Programs

Name	In	Out	Exceptions
importObject	FilePath	ObjectID	InvalidFileFormat, ImportError
validateObject	FilePath	Boolean	InvalidFileFormat
addObjectToInventory	ObjectID	-	ObjectAlreadyExists
listSupportedFormats	-	Array⟨String⟩	-

25.4 Semantics

25.4.1 State Variables

- *supportedFormats*: A list of file formats (e.g., OBJ, FBX, GLTF) that the module can process.

- *importedObjects*: A mapping of $ObjectID \rightarrow ObjectMetadata$, representing all objects imported by the user.

25.4.2 Environment Variables

- File system access for reading 3D model files.

- Network connectivity for syncing imported objects with the server database.

25.4.3 Assumptions

The file paths provided are accessible, and the objects being imported are in formats supported by the module.

25.4.4 Access Routine Semantics

importObject(filePath):

- **transition**: Reads the 3D model file from $filePath$, parses it using the 3D Model Parser Library, and generates an $ObjectID$. The object is then stored locally and synced with the server database.

- **output**: Returns the $ObjectID$ of the successfully imported object.

- **exception**:

  - $InvalidFileFormat$: If the file format is not supported.
  - $ImportError$: If the file cannot be read or parsed due to corruption or other issues.

validateObject(filePath):

- **transition**: N/A

- **output**: Returns $true$ if the file at $filePath$ is in a supported format and passes initial validation, $false$ otherwise.

- **exception**:

  - $InvalidFileFormat$: If the file format is not supported.

addObjectToInventory(objectID):

- **transition**: Adds the object identified by $objectID$ to the user's inventory and marks it as available for use within the app.

- **output**: N/A

- **exception**:

  - $ObjectAlreadyExists$: If the object is already present in the user's inventory.

listSupportedFormats():

- **transition**: N/A

- **output**: Returns the list of $supportedFormats$, indicating which file types can be imported.

- **exception**: None

25.4.5   Local Functions

- `parseFile(filePath)`: Reads and parses the 3D model file to extract metadata and geometry.

- `generateObjectID(metadata)`: Generates a unique identifier for the imported object based on its metadata.

- `syncObjectWithServer(objectID)`: Uploads the imported object's metadata to the server database.

26 MIS of Realm Interface Module

26.1 Module

RealmInterface

26.2 Uses

, , 3D Renderer, AR Framework

26.3 Syntax

26.3.1 Exported Constants

N/A

26.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayObjectsInRealm	$\mathbb{N}$	-	SubRealmNotFound
navigateToMap	-	-	-
updateDisplayedObjects	$\mathbb{N}$, Array$\langle\mathbb{N}\rangle$	-	SubRealmNotFound
getActiveSubRealm	-	$\mathbb{N}$	NoActiveSubRealm
setActiveSubRealm	$\mathbb{N}$	-	SubRealmNotFound

26.4 Semantics

26.4.1 State Variables

- *activeSubRealm*: The *subRealmID* of the currently selected sub-realm.

- *displayedObjects*: A list of 3D objects being rendered in the current view.

26.4.2 Environment Variables

- 3D rendering engine for displaying AR objects.

- Maps module interface for quick navigation.

26.4.3 Assumptions

A valid *subRealmID* corresponds to an existing sub-realm, and all objects in the realm are properly loaded.

26.4.4   Access Routine Semantics

displayObjectsInRealm(subRealmID):

- **transition**: Retrieves the 3D objects associated with *subRealmID* and displays them in the AR view.

- **output**: N/A

- **exception**:

    - *SubRealmNotFound*: If *subRealmID* does not exist.

navigateToMap():

- **transition**: Opens the Maps interface to display the map view.

- **output**: N/A

- **exception**: None

updateDisplayedObjects(subRealmID, objectIDs):

- **transition**: Updates the list of objects displayed in the AR view for the specified *subRealmID*. Removes any previously displayed objects not in *objectIDs*.

- **output**: N/A

- **exception**:

    - *SubRealmNotFound*: If *subRealmID* does not exist.

getActiveSubRealm():

- **transition**: N/A

- **output**: Returns the *subRealmID* of the currently active sub-realm.

- **exception**:

    - *NoActiveSubRealm*: If no sub-realm is currently active.

setActiveSubRealm(subRealmID):

- **transition**: Sets the *subRealmID* as the *activeSubRealm* and updates the displayed objects accordingly.

- **output**: N/A

- **exception**:

    - *SubRealmNotFound*: If *subRealmID* does not exist.

26.4.5 Local Functions

- `loadObjects(subRealmID)`: Loads 3D object data for the given *subRealmID* from the local or server database.

- `renderObjects(objectList)`: Renders the provided list of 3D objects in the AR view.

- `clearDisplay()`: Removes all objects currently displayed in the AR view.

27 MIS of AccessHardware

The AccessHardware module is used to interface with the hardware components of the device. The module will be used to access the camera, GPS, and an array of device sensors on the mobile device.

27.1 Module

Short Name: AccHard

27.2 Uses

AccHard does not use any other modules.

27.3 Syntax

27.3.1 Exported Constants

1. CAM_RES_WIDTH = 1920 (Default width of the camera resolution)

2. CAM_RES_HEIGHT = 1080 (Default height of the camera resolution)

27.3.2 Exported Access Programs

Name	In	Out	Exceptions
getResH()	None	Resolution height : $\mathbb{N}$	None
getResW()	None	Resolution width : $\mathbb{N}$	None
getFrameRate()	None	Frame rate : $\mathbb{N}$	None
getNextFrame()	None	Frame : $\mathbb{Z}[\ ]$	**FrameNotFoundException**
getFrame()	FrameID : $\mathbb{N}$	Frame : $\mathbb{Z}[\ ]$	**FrameNotFoundException**

27.4 Semantics

27.4.1 State Variables

1. FRAME_COUNT : $\mathbb{N}$ (Number of frames captured by the camera)

2. FRAME_BUFFER : $\mathbb{Z}[\ ][\ ]$ (Buffer to store frames captured by the camera)

3. CAM_PROG_SCAN : $\mathbb{B}$ (Camera scans progressively if true, else scans using interlaced)

4. CAM_ACC : $\mathbb{B}$ (Access to device camera)

5. GPS_ACC : $\mathbb{B}$ (Access to device GPS)

27.4.2 Environment Variables

1. CAM_RES_WIDTH : $\mathbb{N}$ (Current width of the camera resolution)

2. CAM_RES_HEIGHT : $\mathbb{N}$ (Current height of the camera resolution)

3. FRAME_RATE : $\mathbb{N}$ (Current frame rate of the camera)

4. CAM_ON : $\mathbb{B}$ (Device camera turned on)

27.4.3 Assumptions

- Device provides the ability to access the camera and GPS through device applications

27.4.4 Access Routine Semantics

getResH():

- transition: No transition

- output: Returns the camera resolution height

- exception: No exceptions

getResW():

- transition: No transition

- output: Returns the camera resolution width

- exception: No exceptions

getFrameRate():

- transition: No transition

- output: Returns the camera frame rate

- exception: No exceptions

getNextFrame():

- transition: No transition

- output: Returns the next frame as a buffer.

- exception: Raises **FrameNotFoundException** if the next frame cannot be returned.

getFrame(FrameID):

- transition: No transition

- output: Returns the frame matching the given FrameID.

- exception: Raises **FrameNotFoundException** if the specified frame cannot be found.

27.4.5 Local Functions

1. ReqCamAccess(): None → $\mathbb{B}$

28 MIS of Inventory

The Inventory module is used to manage the user's inventory of 3D and 2D AR objects. The module will be used to add, remove, and view objects in the user's inventory. The module will also be used to access the user's inventory while placing objects in the AR environment.

28.1 Module

Short Name: Inventory

28.2 Uses

- RESTAPICommunication

- Object Render Module

- LocalDBM

- DataSyncModule

28.3 Syntax

28.3.1 Exported Constants

1. MAX_OBJ_COUNT = 100 (Maximum number of objects that can be stored in the user's inventory (except for application-provided objects))

2. FILTER_OPTS = {Favorites, Oldest, Newest, Most Shared, Least Shared, Largest Size, Smallest Size} (Fixed list of filter options that can be applied to the user's inventory)

28.3.2 Exported Access Programs

Name	In	Out	Exceptions
getObjCount	None	$\mathbb{N}$	None
addObj	Object : $\mathbb{AR}$	$\mathbb{B}$	**ObjAddException**
getObj	ObjectID : $\mathbb{N}$	$\mathbb{AR}$	**ObjNotFoundException**
delObj	ObjectID : $\mathbb{N}$	$\mathbb{B}$	**ObjDelException**
getObjList	ObjectIDs : $\mathbb{N}$[ ]	Object List : $\mathbb{AR}$[ ]	**ObjNotFoundException**
setBackColor	Color code : $\mathbb{N}[\mathbf{3}]$	None	None

28.4   Semantics

28.4.1   State Variables

1. OBJ_SYNCED : $\mathbb{B}$ (true if objects that are synced with the server, else false)

2. TOTAL_OBJ_COUNT : $\mathbb{N}$ (Total number of objects in the user's inventory)

3. 3D_OBJECT_COUNT : $\mathbb{N}$ (Number of 3D objects in the user's inventory)

4. 2D_OBJECT_COUNT : $\mathbb{N}$ (Number of 2D objects in the user's inventory)

5. BACKGROUND_COLOR : str (Color code of the background of the inventory)

28.4.2   Environment Variables

No environment variables for this module.

28.4.3   Assumptions

No assumptions are made for this module.

28.4.4   Access Routine Semantics

getObjCount():

- transition: No transition

- output: Returns the number of objects in the user's inventory.

- exception: No exceptions

addObj(Object : $\mathbb{AR}$):

- transition: Adds the specified AR object to the user's inventory.

- output: Returns a boolean indicating whether the object was successfully added (true for success, false otherwise).

- exception: Raises **ObjAddException** if the object cannot be added.

getObj(ObjectID: $\mathbb{N}$):

- transition: No transition

- output: Returns the AR object corresponding to the given ObjectID.

- exception: Raises **ObjNotFoundException** if the specified object cannot be found in the inventory.

delObj(ObjectID: $\mathbb{N}$):

- transition: Removes the AR object corresponding to the given ObjectID from the user's inventory.

- output: Returns a boolean indicating whether the object was successfully removed (true for success, false otherwise).

- exception: Raises **ObjDelException** if the object cannot be deleted.

getObjList(ObjectIDs: $\mathbb{N}[\ ]$):

- transition: No transition

- output: Returns a list of AR objects ($\mathbb{AR}[\ ]$) corresponding to the specified ObjectIDs

- exception: Raises **ObjNotFoundException** if any of the specified objects cannot be found in the inventory.

setBackColor(ColorCode: $\mathbb{N}[\mathbf{3}]$):

- transition: Updates the background color setting for the inventory view using the specified RGB color code ($\mathbb{N}[\mathbf{3}]$).

- output: None

- exception: None

28.4.5 Local Functions

1. filterObj(): (Filter option : str, Objects : $\mathbb{AR}[\ ]$) $\rightarrow$ $\mathbb{AR}[\ ]$

2. syncObjs(): None $\rightarrow$ $\mathbb{B}$

29 MIS of ObjectPlacement

The Object Placement module is used to place 3D and 2D AR objects in the AR environment. The module will be used in the Realm interface to begin the object placement workflow. It will place objects from the user's inventory.

29.1 Module

Short Name: ObjPlacer

29.2 Uses

- RESTAPICommunication

- Object Render Module

- Inventory

29.3 Syntax

29.3.1 Exported Constants

There are no constants for this module.

29.3.2 Exported Access Programs

Name	In	Out	Exceptions
beginPlacement	None	$\mathbb{B}$	**PlacementFailException**
displayEditor	None	$\mathbb{B}$	None
hideEditor	None	$\mathbb{B}$	None
termPlacement	None	$\mathbb{B}$	**PlacementFailException**
endPlacement	None	$\mathbb{B}$	**PlacementFailException**
rotateObj	(Angle : $\mathbb{Z}$, Axis : char)	Angle rotated : $\mathbb{Z}$	None
translateObj	(Distance : $\mathbb{Z}$, Axis : char)	Dist Translated : $\mathbb{Z}$	None
placeObj	ObjectID : $\mathbb{N}$	$\mathbb{B}$	**ObjPlaceException**

29.4 Semantics

29.4.1 State Variables

1. PLACEMENT_STATUS : $\mathbb{B}$ (true if object placement is in progress, else false)

2. OBJ_PLACED : $\mathbb{B}$ (true if object is placed in the AR environment, else false)

3. OBJ_ID : $\mathbb{N}$ (ID of the object being placed)

4. OBJ_POS : $\mathbb{Z}[\mathbf{3}]$ (XYZ position of the object in the AR environment)

29.4.2 Environment Variables

1. DEVICE_LOCATION : $\mathbb{Z}[\mathbf{3}]$ (Current location of the device)

29.4.3 Assumptions

- The user is not located in a restricted area.

- The user has objects in their inventory.

- The weather is not hazardous.

- The user surroundings is large enough for the object to be placed.

29.4.4 Access Routine Semantics

beginPlacement():

- transition: Initiates the object placement workflow in the AR environment.

- output: Returns a boolean indicating whether the workflow started successfully (true for success, false otherwise).

- exception: Raises **PlacementFailException** if the workflow cannot be initiated.

displayEditor():

- transition: Displays the object placement editor in the AR environment.

- output: Returns a boolean indicating whether the editor was displayed successfully (true for success, false otherwise).

- exception: No exceptions

hideEditor():

- transition: Hides the object placement editor from the AR environment.

- output: Returns a boolean indicating whether the editor was hidden successfully (true for success, false otherwise).

- exception: No exceptions

termPlacement():

- transition: Terminates the object placement workflow in the AR environment without finalizing the placement.

- output: Returns a boolean indicating whether the workflow was terminated successfully (true for success, false otherwise).

- exception: Raises **PlacementFailException** if the workflow cannot be terminated.

endPlacement():

- transition: Ends the object placement workflow, finalizing the placement in the AR environment.

- output: Returns a boolean indicating whether the workflow ended successfully (true for success, false otherwise).

- exception: Raises **PlacementFailException** if the workflow cannot be ended.

rotateObj(Angle: $\mathbb{Z}$, Axis: char):

- transition: Rotates the object in the AR environment by the specified angle (Angle) around the specified axis (Axis).

- output: Returns the total angle the object was rotated.

- exception: No exceptions

translateObj(Distance: $\mathbb{Z}$, Axis: char):

- transition: Translates the object in the AR environment by the specified distance (Distance) along the specified axis (Axis).

- output: Returns the total distance the object is translated by.

- exception: No exceptions

placeObj(ObjectID: $\mathbb{N}$):

- transition: Places the specified object (identified by ObjectID) from the user's inventory into the AR environment.

- output: Returns a boolean indicating whether the object was placed successfully (true for success, false otherwise).

- exception: Raises **ObjPlaceException** if the object cannot be placed.

29.4.5   Local Functions

1. getObj(): None $\rightarrow \mathbb{AR}$

2. checkRestrictArea(): None $\rightarrow \mathbb{B}$

3. checkWeatherHaz(): None $\rightarrow \mathbb{B}$

4. checkObjCollisions(): None $\rightarrow \mathbb{B}$

5. getCoords(): None $\rightarrow \mathbb{Z}[\mathbf{3}]$

30 MIS of RestrictedAreaDetect

The Restricted Area Detection module is used to detect if the user is located in a restricted area. The module will be get the user's location and determine if they are present in a pre-defined restricted area.

30.1 Module

Short Name: RestrictAreaDet

30.2 Uses

- RESTAPICommunication

- Maps

30.3 Syntax

30.3.1 Exported Constants

The module does not have any constants.

30.3.2 Exported Access Programs

Name	In	Out	Exceptions
checkCurrAreaRestrict	None	$\mathbb{B}$	None

30.4 Semantics

30.4.1 State Variables

There are no state variables for this module.

30.4.2 Environment Variables

There are no environment variables for this module.

30.4.3 Assumptions

There are no assumptions for this module.

30.4.4 Access Routine Semantics

checkCurrAreaRestrict():

- transition: No transition

- output: Return a boolean indicating whether the user is in a restricted area (true if in a restricted area, otherwise false).

- exception: No exceptions

30.4.5 Local Functions

1. getUserLocation(): None $\to \mathbb{Z}[\mathbf{3}]$

2. getRestrictedAreas(): None $\to \mathbb{Z}[\ ][\mathbf{3}]$

31 MIS of WeatherHazardDetect

The Weather Hazard Detection module is used to detect if the user is in a hazardous weather condition. The module will get the current weather conditions and future warnings based on the user's current location. The module will determine if there is incoming or present hazardous weather conditions based on the information accessed.

31.1 Module

Short Name: WeatherHazDet

31.2 Uses

- RESTAPICommunication

31.3 Syntax

31.3.1 Exported Constants

DETECTION_RADIUS = 30 (Radius in kilometers to detect weather hazards)

31.3.2 Exported Access Programs

Name	In	Out	Exceptions
checkWeatherHaze	None	str	-

31.4 Semantics

31.4.1 State Variables

LAST_UPDATE : ℕ (Number of minutes passed since last time the weather data was updated) CURR_WEATHER : str (Current weather conditions)

31.4.2 Environment Variables

There are no environment variables for this module.

31.4.3 Assumptions

There are no assumptions for this module.

31.4.4 Access Routine Semantics

checkWeatherHaz():

- transition: No transition

- output: Returns a string indicating the current weather conditions and any hazardous weather warnings.

- exception: No exceptions

31.4.5 Local Functions

1. getUserLocation: None → $\mathbb{Z}[\mathbf{3}]$

2. updateWeather: None → $\mathbb{B}$

3. determineHaz: None → str

References

Appendix — Reflection

1. What went well while writing this deliverable?

   The modules were distributed relatively well according to what each group member seems most comfortable and experienced with.

2. What pain points did you experience during this deliverable, and how did you resolve them?

   Deciding the modules initially was a bit of a challenge, but after speaking with our TA, it helped us decide which modules to split and which ones to combine.

3. Which of your design decisions stemmed from speaking to your client(s) or a proxy (e.g. your peers, stakeholders, potential users)? For those that were not, why, and where did they come from?

   Our design decisions came as a natural consequence of our requirements, many of which did stem from speaking to clients. So while indirectly influenced, our design decisions were mostly made to be the easiest way to meet the requirements we set out.

4. While creating the design doc, what parts of your other documents (e.g. requirements, hazard analysis, etc), it any, needed to be changed, and why?

   We did not need to change any parts of other documents.

5. What are the limitations of your solution? Put another way, given unlimited resources, what could you do to make the project better? (LO_ProbSolutions)

   One of the key components of our design is the client server system for storing user data. If we had infinite resources, it would be beneficial to move more logic to the server to relieve the client from certain expensive computations. The reason our current design has them on the client side is to reduce the complexity of client server communication to simplify the implementation.

6. Give a brief overview of other design solutions you considered. What are the benefits and tradeoffs of those other designs compared with the chosen design? From all the potential options, why did you select the documented design? (LO_Explores)

In our initial solution, user content generation was meant to be internal, and more components were designed to be on the server. This design would have been ideal for users, and more maintainable in the long run, but came at an exorbiant cost for compute for object generation, and a complex design that would be infeasible to build in the alloted time. The driving force behind our changes since then were to make our app easier to implement, and less expensive to run.