GAME DEVELOPMENT REPORT: THE FORGOTTEN VAULT

A Puzzle & AR Adventure

Augmented and Virtual Reality Applications, Winter Term 2024/25

AUTHORED BY

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SUBMITTED TO

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Team

Name:	Matrikel no.:	Role:
Milankumar Ramoliya	00157565	Technical Lead / Game Engineer

Primary Role:

- Responsible for the entire development process of the game and ensured a smooth integration of features and functions.
- Advice during the documentation phase.

Key Contributions:

- Creating the basic gameplay elements for the AR and puzzle mini-games.
- Implementation of the game logic through extensive work with Unity.

Milan Vaishnav	00144384	3D Artist & Gameplay Integrator

Primary Role:

- Creation and use of 3D models, textures**,** and additional virtual components for the game.
- The focus was on optimizing game assets for AR and non-AR modes and ensuring aesthetic consistency.

Key Contributions:

- Support with development tasks such as UI/UX element refinement and asset integration in Unity.

Smit Bhanderi	00155930	UX Researcher & Project Designer

Primary Role:

- Responsible for project documentation, including preparing reports, conducting user testing to gain input for iterative changes, and preparing presentation materials.
- Collaborate with the lead developer to incorporate suggestions and improve game mechanics.

Key Contributions:

- Plans for user testing of the full game and its mini-games have been created and conducted.
- Contribution in the development process, I implemented small features and helped with gameplay testing.

Acknowledgments

We would like to thank our supervisor Prof. Luisa Mayershofer for her important advice, support and helpfulness during this project.

We would also like to express our sincere thanks to Prof. Markus Weißenberger for his insightful suggestions and support during the initial phase of game design and development. His advice has significantly improved the quality of our work.

Finally, we are grateful to our colleagues and testers whose feedback and suggestions played an important role in refining the final product.

GitHub Repository

The project is hosted on GitHub and can be accessed at the following link:

https://github.com/Smitbhanderi-hub/The-Forgotten-Vault

Branches:

- The main branch contains the final code, including all implemented features and bug fixes.
- The presentation branch includes project presentations and visual materials.
- The documentation branch holds supporting documents such as this report and user manuals.

README file in the repository, this contains basic instructions for setting up and running the game.

How to Start the Game

1. Clone the Repository:
- Download the game files by cloning the repository using the following command:
- git clone https://github.com/Smitbhanderi-hub/The-Forgotten-Vault
2. Open the Project in Unity:
- Launch Unity Hub, connect IOS device
- Click on Open Project.
- Navigate to the cloned repository folder and open the project.
3. Build the Game:
- Inside Unity, go to the menu bar and select File > Build Settings.
- Choose your target platform & click Build and Run (Xcode will open automatically).
4. Play the Game:
- Application will be launched in the IOS device automatically after the build is complete, open the executable app to start the game from home screen.

System Requirements

- Unity Version: Unity 2022.3.20f1 or later
- MacOS & IOS device to run. Alternative built on windows with external extensions.

1. Introduction

The Forgotten Vault is an immersive game that combines puzzles and augmented reality (AR) to create a contemporary exploration journey with 3 mini-games. The goal of this project was to create an immersive and interactive environment for players by bridging the gap between traditional storytelling and cutting-edge augmented reality technology.

Initial story Line:

In History's Lost Palace, you play a modern-day explorer who must unravel the secrets of a once majestic palace that lies in ruins after a devastating disaster. Included with ancient map, you must recover it to navigate the decaying halls and find hidden relics buried deep within the ruins. Using augmented reality, you will scan the decayed environment, uncovering long-forgotten symbols and artifacts that provide clues to the treasure's location. With the final relic in hand, you face one final challenge: decode the treasure hidden in the depths of the palace. Only by solving one final puzzle and interacting with the treasure chest through AR can you reveal the ancient riches and restore a piece of forgotten history. Can you unravel the secrets of the Lost Palace?

The Forgotten Vault's unique AR-based mechanics aim to provide:

- A new approach to treasure hunting.
- A difficult final puzzle that requires problem-solving skills.
- Using cutting-edge technology, this experience combines history with modern exploration.

2. Project Concept

In The Forgotten Vault, players take on the role of a modern-day explorer tasked with uncovering the secrets of a once-great palace that lies in ruins after a disaster. The story begins with the discovery of fragmented artifacts and symbols that hold the key to the palace's hidden treasures.

2.1 User Stories and Personas

User Stories:

- **User Story 1:** As a gamer, I want to solve a difficult puzzle game to test my logical skills and feel fulfilled.

- **User Story 2:** As an AR gamer, I want an immersive experience that combines motion control and exploration to take full advantage of my mobile AR.

- **User Story 3:** As a casual gamer, I prefer intuitive gameplay that is easy to learn but difficult to master, allowing me to have fun without becoming frustrated.

Personas:

- **Smeet (22 years old, AR/VR Enthusiast):** Smeet loves trying out new AR experiences, especially those with interactive controls. They value smooth gameplay and appealing visuals.
  - **Needs:** Immersion and sophisticated AR mechanics.
  - **Challenges:** He gets bored if the game is not intuitive or varied.

- **Moksha (15 years old, Puzzle Lover):** Moksha loves logic challenges like Sudoku and escape rooms. She enjoys playing games occasionally and seeks both the challenge and the reward.
  - **Needs:** Logical puzzles with clear clues and increasing difficulty.
  - **Challenges:** Avoid games that are too complicated to understand at first.

2.2 Design Considerations

Game Design Principles:

- Accessibility:
  - The puzzle game uses a simple drag-and-drop mechanic that is suitable for players of all skill levels.
  - The AR gameplay is designed with simple motion controls to make it easier for beginners to learn.

- Engagement:
    - The mini-games are short but challenging enough to keep players interested without overwhelming them.
    - The narrative at the beginning of the game is intended to arouse the player's interest in the game.
- Immersion:
    - AR environments aim to enhance world immersion through detailed visual representations and interactive features.
    - Smooth transitions between puzzles and AR mini-games ensure a seamless experience.

Creative Decisions:

- Why combine a puzzle with AR mini-games?
    - Smooth transitions between puzzles and AR mini-games ensure a seamless experience.
    - The combination offers something for both casual gamers (puzzle) and AR enthusiasts (AR mini-games).

2.3 Gameplay and Mechanics

Using augmented reality, players explore their surroundings and look for hidden clues and symbols that gradually reveal the way to the ultimate treasure. Each artifact and symbol discovered brings them closer to solving the mystery.

- The gameplay involves:
    - **Clue Decoding:** For each object discovered, players must analyse and connect clues to solve the puzzle.
    - **Artifact Discovery:** Use AR scanning to discover symbols and artifacts in the ruins.
    - **Final Challenge:** Players physically move and interact with their environment to find and open a treasure chest.

- The structure of the game is based on the following goals:
    - **Puzzles:** That require multiple steps encourage problem solving.
    - **Exploration:** AR technology allows players to scan and interact with their surroundings.

o **Historical Restoration:** Immerse players in the past by telling the story of the destroyed palace and its treasures.

Target Audience:

The Forgotten Vault is intended for:

o Players aged **10 to 35** who enjoy immersive experiences.

o Fans of **puzzle games** & **Augmented Reality** technology.

o Gamers who prefer a combination of story of **history**, **exploration**, and interactive storytelling.

2.4 Game Flow

- **Start Screen:**

  o The game starts with a captivating story about an explorer and an abandoned castle.

  o Players can either start the game after reading the instructions.

- The instructions briefly explain how to handle the puzzles and AR mechanics.

- **Mini-Game 1: Puzzle:**

  o A logic-based tile-arranging puzzle.

  o Objective: Solve the map puzzle to unlock the AR segment.

  o Features:

    ▪ Hints system: Players can request hints if stuck.

    ▪ Progress bar: Indicates how much of the puzzle is complete.

- **Mini-Game 2: AR Adventure:**

  o Immersive exploration of a virtual world.

  o Objective: Navigate through a maze or collect hidden keys of the treasure.

  o Features:

    ▪ Players use inbuild in mobile camera for AR to move, interact, and pick up keys.

- **Mini-Game 3: AR Combat:**

  o Players scan their real environment using their device's camera to search for a hidden treasure chest.

  o Objective: real-world exploration with virtual interactivity, encouraging players to engage physically with their surroundings

  o Features:

- ▪ Its seamless integration of environment scanning, automatic chest rotation
- ▪ The chest-opening event marks the game's completion

- **End Screen:**
  - o Displays end of the game and win.
  - o Option to replay or exit.
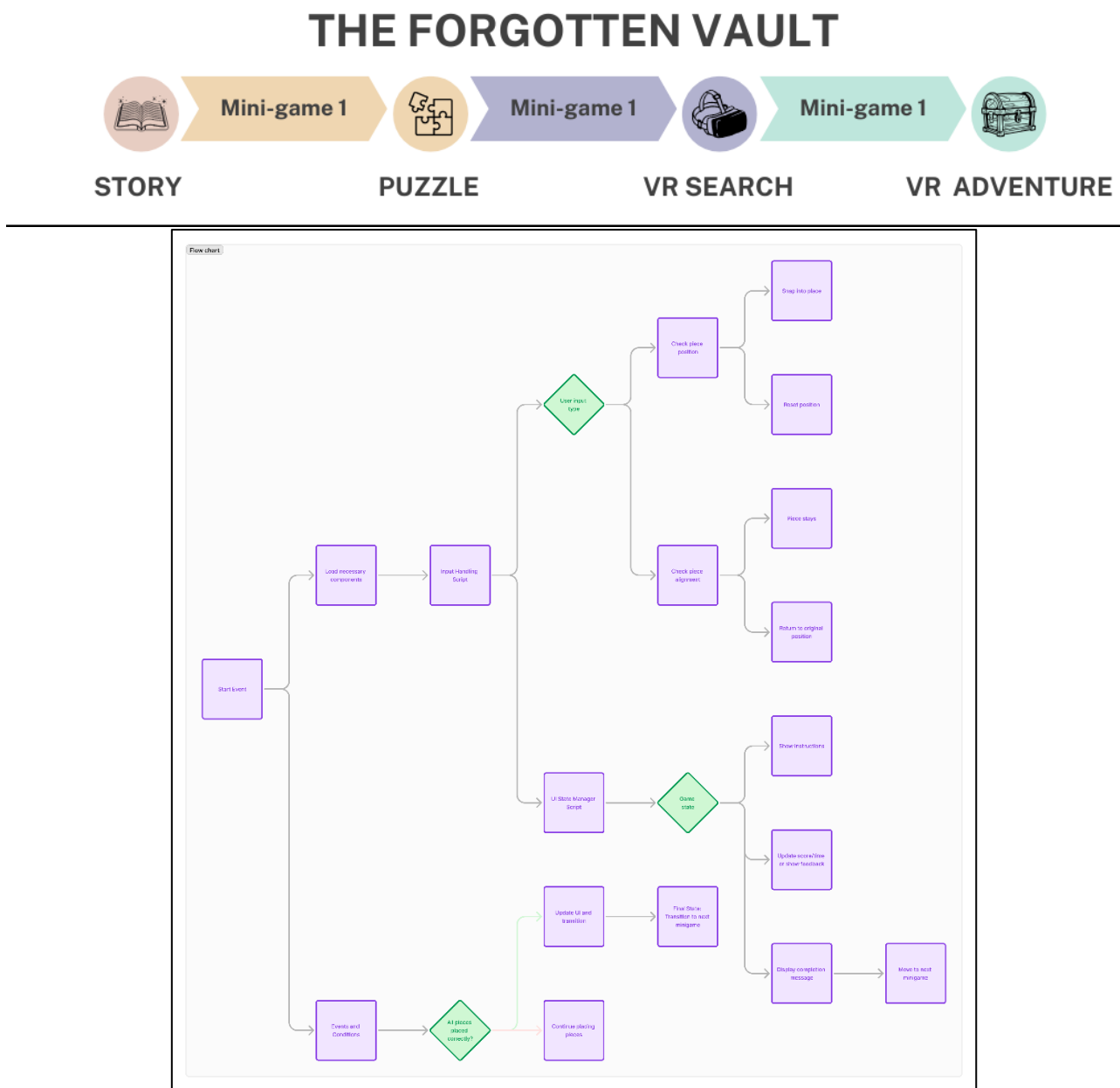
2.5 Flow Diagram

Fig Initial flow chart of the game (In final version of game changes were made later after user reviews)

3. Tools & Development Workflow

Regarding the game's background work, here are details on the tools, technologies, and processes used to create and develop the game.

3.1 Tools

3.1.1 Game Engine

- Unity 3D
    - o Why Unity?
      Unity is a powerful game engine known for its versatility and support for both 2D and 3D game development. It also offers robust support for AR.
- How It Helped:
    - o Building the entire game environment.
    - o Handled the logic for the puzzle and transitions between mini-games.
    - o Integrated AR capabilities seamlessly using additional plugins.

3.1.2 Programming Language

- C# (C-Sharp)
    - o Why C#? It is Unity's primary scripting language. It is beginner-friendly yet powerful enough for advanced functionality.
- How It Helped:
    - o Scripted game logic (e.g., solving puzzles and triggering AR interactions).
    - o Implemented player movement, object interactions, and game transitions.

3.1.3 3D Assets creation

- Blender
    - o Why Blender?
      Blender is a free and open-source 3D modeling tool used to create and edit 3D assets.
- How It Helped:
    - o Created custom models for the puzzle pieces and AR environment.
    - o Optimized existing 3D models to reduce performance lag.

3.1.4 Design and Prototyping

- Figma

    o Why Figma?

      Figma is a cloud-based design tool ideal for creating wireframes, layouts, and UI mock-ups. It supports real-time collaboration, which was invaluable during the planning phase.

- How It Helped:

    o Created UI/UX mock-ups for the game menu and in-game HUD (Heads-Up Display).

    o Designed puzzle layouts before implementing them in Unity.

    o Collaborated with team members on flow diagrams and level designs.

3.2 Development Workflow

 We followed a structured development process to stay organized and efficient.

3.2.1 Planning and Design

- We started by brainstorming the game concept, focusing on combining puzzles with AR experiences.

- Tools Used:

    o Used **Figma** to create initial prototypes for the AR interface and puzzle interactions.

    o **Fig jam** Board to brainstorm with multiples options and research for game.

    o Created a flow diagram for gameplay

    o Google Docs for documenting ideas.

3.2.2 Development and Prototyping into phases

- Set up a basic AR scene in Unity with plane detection and object placement using **AR Foundation**.

- Tested AR interactions like tapping, dragging, and snapping puzzle pieces.

Phases of development:

- **Phase 1: Game Logic and Wireframes**

    o We created wireframes of the initial game after long research on what to develop and concept of game.
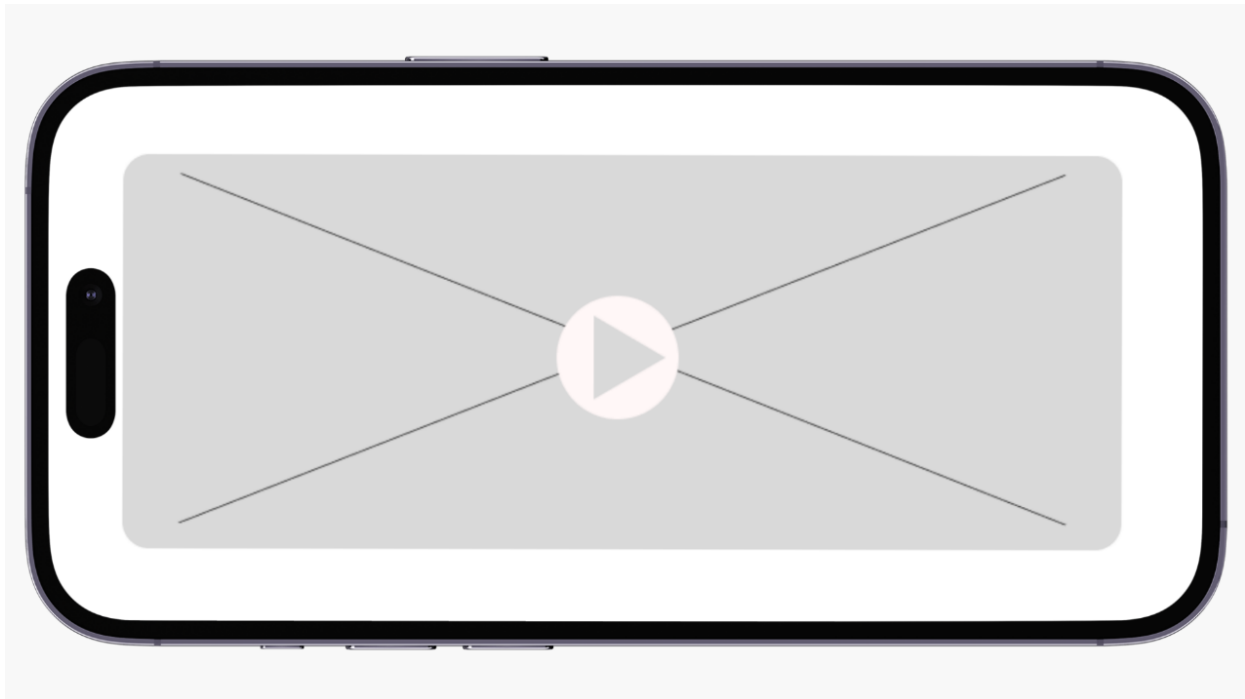
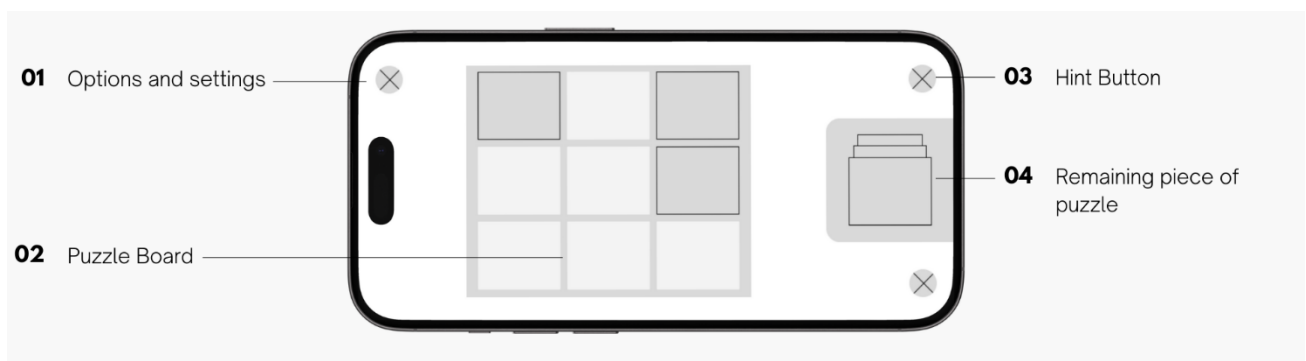Fig. Wireframe of initial story telling opening

Fig. Wireframe of puzzle game mini-game 1

- **Phase 2: Puzzle Game Logic**
    - o Implemented snapping mechanics to ensure pieces align perfectly.
    - o Created a jigsaw image for puzzle of map.
    - o Wrote C# scripts to check if the puzzle is completed.
- **Phase 3: AR Environment Setup**
    - o Configured AR Foundation and tested plane detection on mobile devices.
    - o Set up AR anchors to track puzzle pieces on real-world surfaces.

- **Phase 4: Final mini-game AR setup**
    - AR treasure hunt game in real-world exploration with virtual interactivity, encouraging players to engage physical area in their surroundings.
- **Phase 5: UI and Polishing**
    - Designed the AR HUD in Figma and imported assets into Unity.
    - Added animations for interactions.

Testing During Development:

- Tested AR performance on mobile devices:
    - iOS: iPhone 11.
    - Checked for accuracy in key detection and responsiveness of interactions.

4. Testing the Game

4.1 Phase 1: Mini-Game 1 Testing

- Objective: To test the usability and engagement of Mini-Game 1 (the puzzle).

- Method:

  o Used the **Hand-held Augmented Reality Usability Survey (HARUS)** questionnaire, which employs a **7-point Likert scale** to assess user experience, ease of use, and usability (with the help of google forms after player played the game).

    Link to forms: HARUS questionnaire.

  o Target Audience: Real users.

  o Participants: 3 gamers (10-23 years)
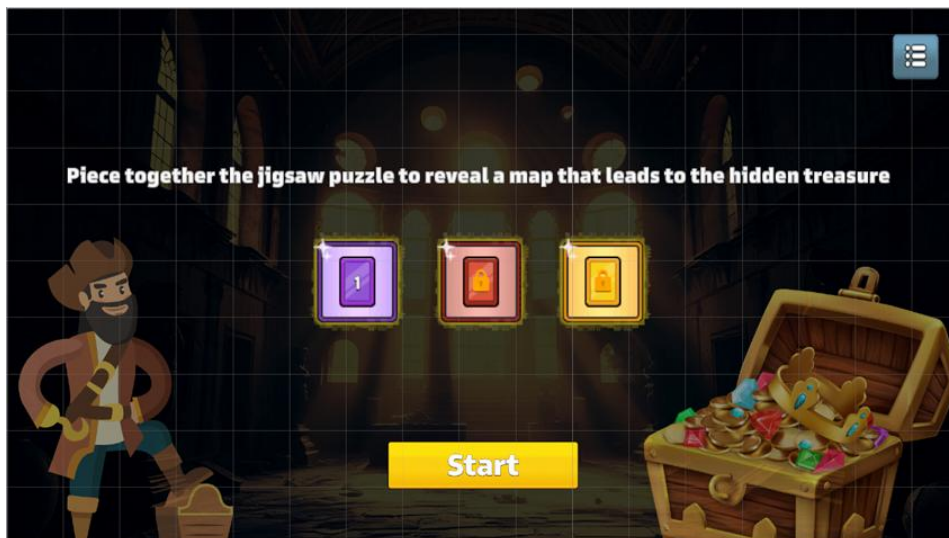
Fig Screenshot of mini-game 1 (development completed until first user-testing).
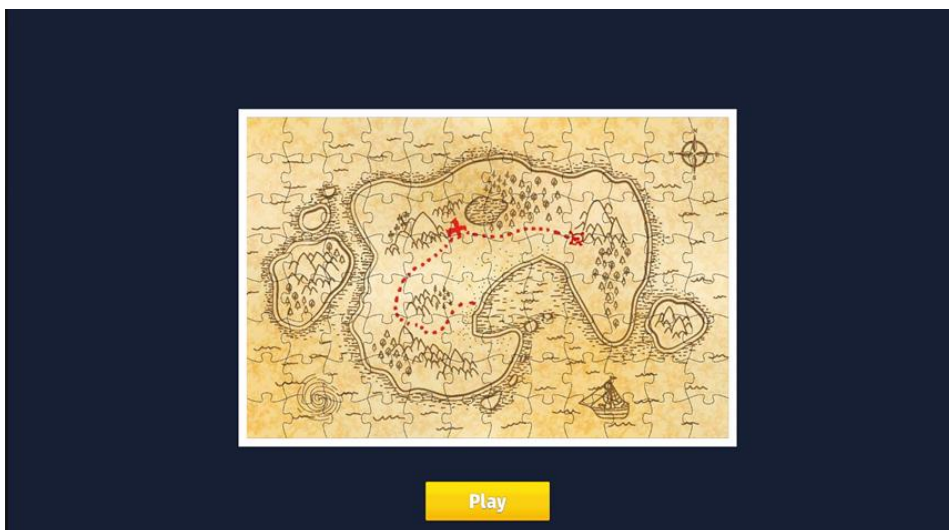
Fig Screenshot of mini-game 1 (development completed until first user-testing).
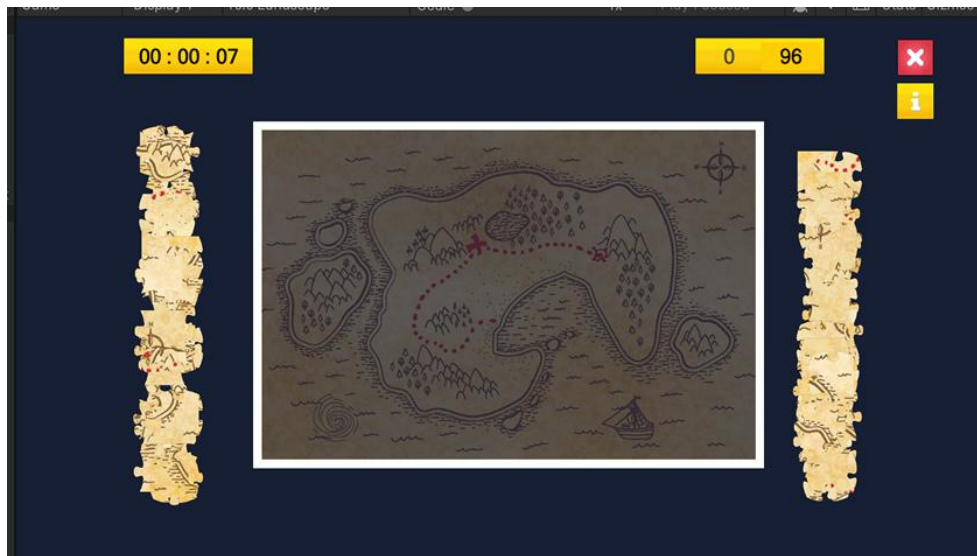
Fig Screenshot of mini-game 1 (development completed until first user-testing).

- Feedback Analysis:
    - Positive Reviews:
        - Easy-to-understand mechanics.
        - Engaging and intuitive design and story landing was a great move.
    - Negative Reviews:
        - Puzzle is having too many jigs to fit.
        - Puzzle game must be portrait.
        - Users struggled with dragging and dropping pieces on smaller screens.
- Actions Taken:
    - Made 3x3 Jigsaw with interactive puzzle elements in background.
    - Enhanced the hints with clearer visual cues with epic effects was added.
    - Adjusted drag-and-drop functionality to improve responsiveness.

4.2 Phase 2: Mini-Game 1, 2 & 3 Testing

- Objective: To evaluate the integration of Mini-Game 1 and the newly implemented Mini-Game 2 (AR Adventure) with some little part of mini-game 3.
- Method:
    - Conducted usability tests with the same audience group (or a mix of new and returning participants).
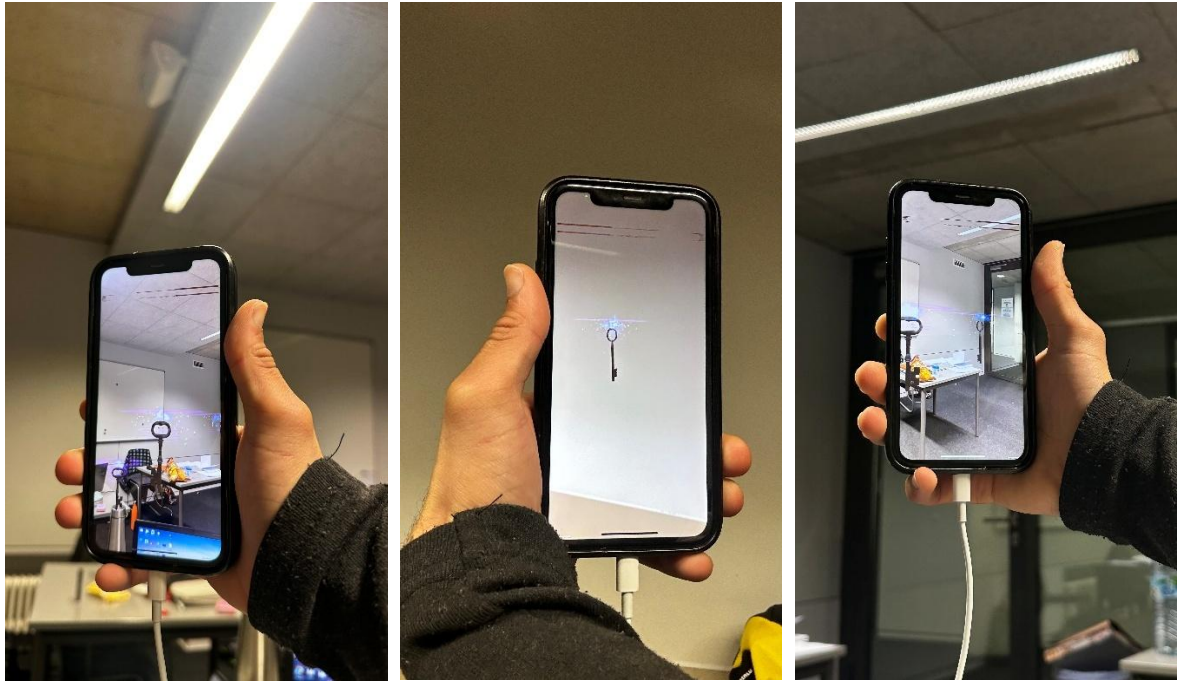   - Combined observational feedback and HARUS scores.

Fig Player playing mini-game 2

- Feedback Analysis:

  o Positive Reviews:

    ▪ Smooth transition between Mini-Games 1 and 2.

    ▪ Players found the AR environment immersive and engaging.

  o Negative Reviews:

    ▪ Some AR players reported lag during rapid head movements.

    ▪ A few users felt that the puzzle took too long, delaying their transition to the AR segment.

    ▪ Mini-game 1 was landscape and mini-game 2 was portrait was weird.

- Actions Taken:

  o Optimized AR elements for better tracking performance.

  o Reduced puzzle complexity for faster progression.

  o Made keys attractive with animation on keys.

  o Puzzle was made portrait and tested again with the same players.

  o Introduce an interactive tutorial at the start of the game. (Already implemented with another user)
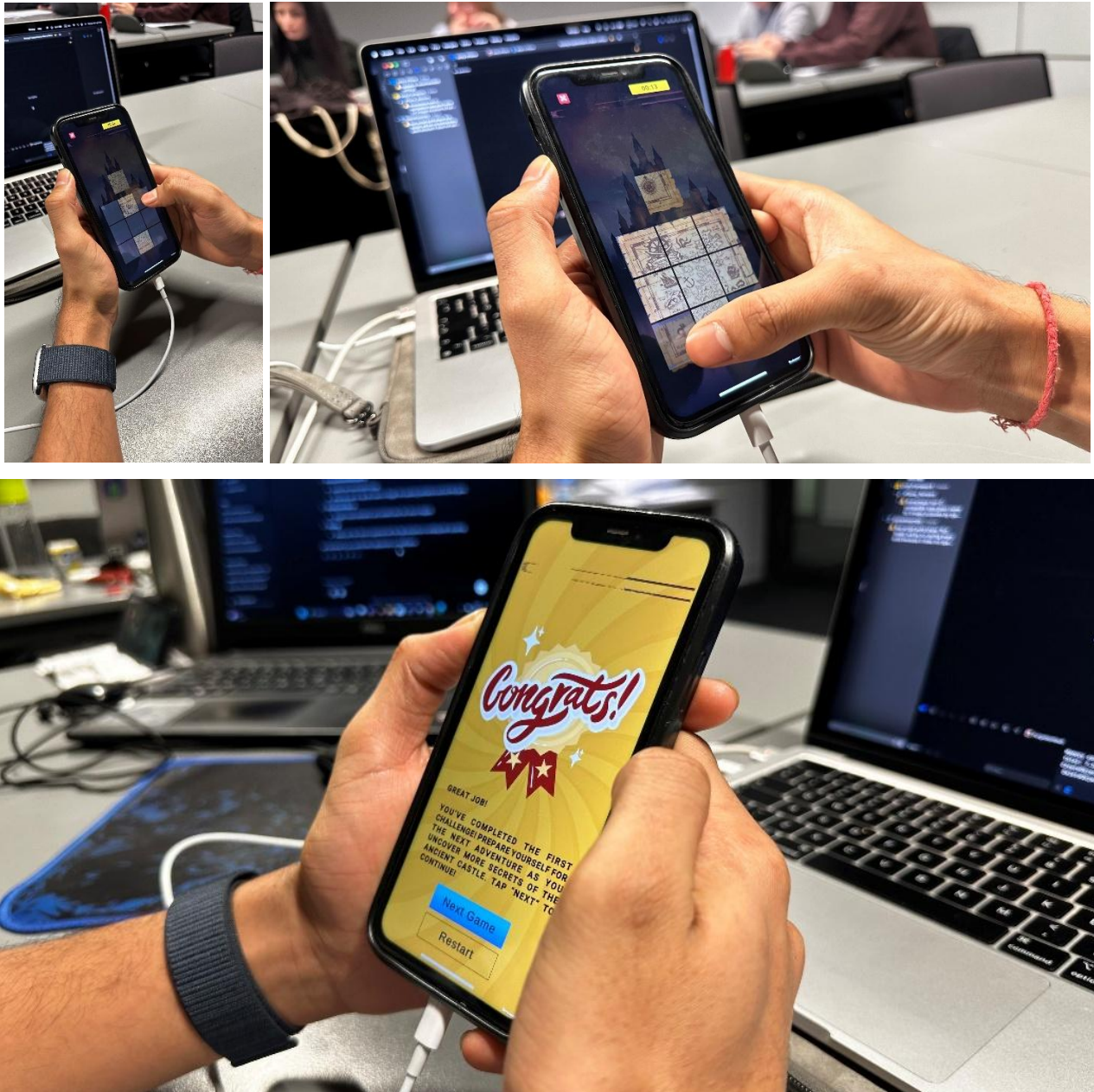
Fig player having interaction with mini-game 1 puzzle game in portrait view.

- Final feedback analysis:

    o Positive Reviews:

        ▪ Seamless flow between all mini-games.

        ▪ Players loved the AR combat mechanics (e.g. searching with crazy experience).

    o Negative Reviews:

        ▪ Some participants wanted additional levels or extended gameplay (We would like to work on that in future).

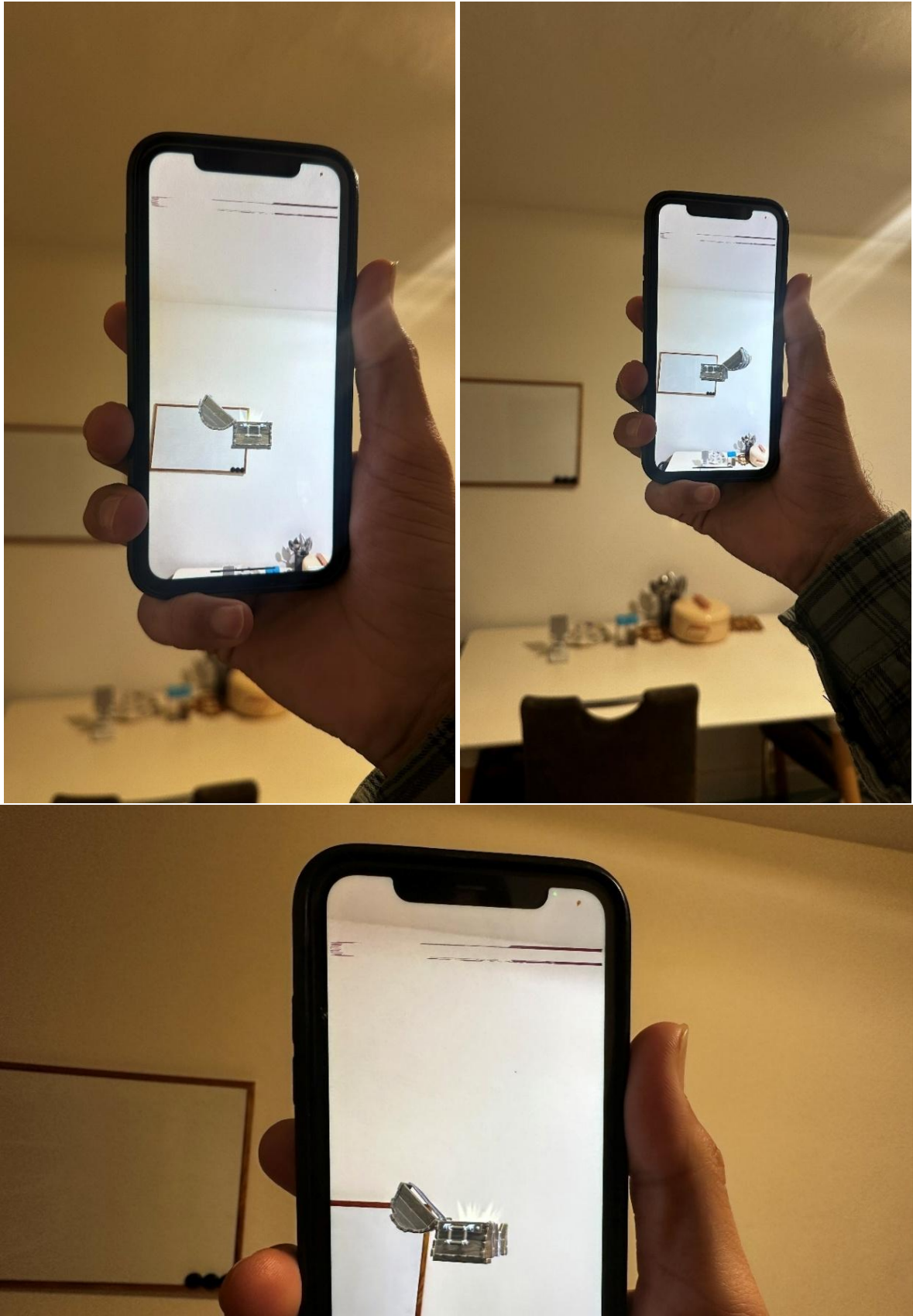   ▪ Minor issues with AR interaction accuracy, e.g., grabbing objects (Solved).

Fig player searching for the treasure in mini-game 3

4.3 HARUS Survey Analysis

- Summarizing the HARUS results for Mini-Game 1, Mini-Game 2, and the full game:

FACTOR	MINI-GAME 1 AVG. SCORE	MINI-GAME 2 AVG. SCORE	FULL GAME AVG. SCORE
EASE OF USE	5.6/7	6.2/7	6.5/7
VISUAL CLARITY	5.2/7	6.3/7	6.0/7
IMMERSION	N/A	6.5/7	6.5/7
OVERALL SATISFACTION	5.4/7	6.3/7	6.8/7

4.4 Observational Feedback and key Insights

- Include key themes that emerged from observing players during gameplay:
  - o Players were more engaged in AR segments compared to the puzzle.
  - o First-time users needed guidance during their initial interaction with the puzzle then we added needed instruction pages inside the game itself.
  - o Players appreciated the increasing difficulty curve across all mini-games.
  - o HARUS scores showed a clear improvement from Phase 1 to the full game, demonstrating the effectiveness of the changes made.
  - o Incorporating user feedback improved overall usability, immersion, and player satisfaction.

5. Goals Achived

5.1 Overall Game Design

- Integrated AR Treasure Hunt Workflow:
- Successful implementation of treasure hunting, where users can find AR treasures unlocked by solving mini-games, including finding keys and searching for treasure in the environment.
    - o How it was achieved:
        - ▪ Using Unity's AR Foundation for key recognition.
- Interactive AR Gold Chest has been added using Unity event triggers to handle user clicks.
    - o Evidence: During testing, users navigated seamlessly from unlocking mini-games to finding treasure.
- Theme Integration:

    Developed a cohesive theme to connect the treasure hunt and mini-games (Theme: Adventure)
    - o Impact: Creating a consistent and engaging gaming experience where all components feel unified within the framework of the game's narrative.

5.2 Mini-Game Implementation

- **Mini-Game 1: 2D Puzzle Game (Non-AR)**

    Created a 2D game of jigsaw puzzle mechanic to challenge players.
    - o Features:
        - ▪ Connecting parts of map to connect with the palace map.
    - o Testing Results: Players found the interface intuitive and engaging, and no major issues were reported.
- **Mini-Game 2: AR Image Tracking Game**

    Implementation of image tracking of keys, where users assemble virtual keys by scanning a specific area and looking for a specific key type that can be used for treasure hunting.
    - o How it was achieved:
        - ▪ Used AR Foundation's image tracking feature.
    - o Evidence: Phase 2 testing showed smooth tracking of keys from multiple keys in the environment and alignment, with most users completing the puzzle without issues and reaching to mini-game 3.

- **Mini-Game 3: AR game to unlock the treasure in the surrounding**

Development of an action-oriented AR game with treasure hunt and user interaction. Players used physical movements to search for the gold.

- o Features:
    - ▪ Intuitive moving (e.g., from one room to another for the hunt) for combat.
- o Testing Results: Users appreciated the immersive gameplay and responsive AR.

6. Conclusion & Future Work

All in all, this initiative achieved its goals by combining cutting-edge augmented reality gaming with a traditional treasure hunt. We learned a lot about game design, Unity, and AR Foundation through this experience. We created a fun game that combines action-packed augmented reality experiences with logical puzzles through collaboration, testing, and iteration. There are countless development and growth opportunities for the future, providing a solid foundation for further research and studies in the field of augmented reality.

By making the gameplay more complicated and nuanced, this project can see tremendous development in the future. For example, we could release more mini-games that use increasingly sophisticated augmented reality features, such as facial tracking, occlusion, or even multiplayer features. This would increase the immersion of the game and appeal to a wider range of players. Adding random or dynamic difficulty levels to the treasure hunt mechanics could improve reproducibility and engagement.

7. Appendices & References

7.1 Final Game Screenshots & Gameplay Recording

Intro Story
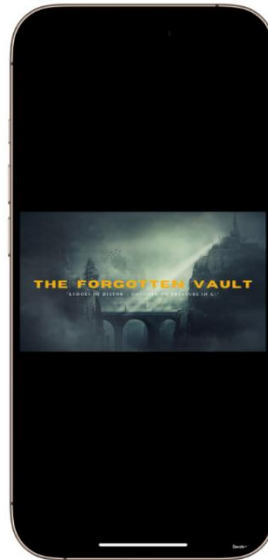
Intro Story
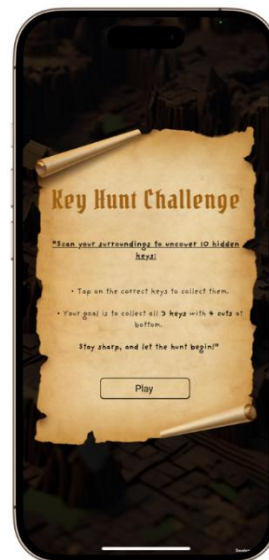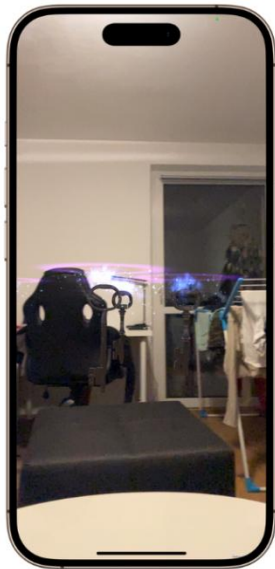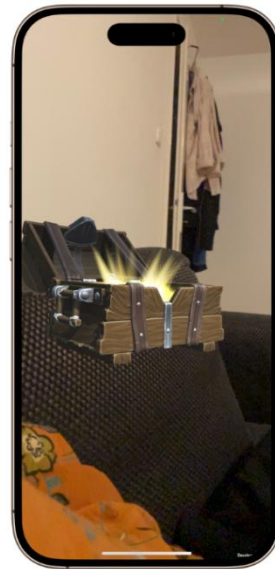

Instruction Screen

Minigame 1

Success Message

Instruction Screen

Minigame 2   Instruction Screen   Minigame 3

- **Gameplay video (Screen recording)** - https://www.veed.io/view/e0d0825b-d156-4814-bfdd-b1006331343d?panel=share

7.2 References

- Keys Graphics:
  - https://sketchfab.com/3d-models/key-ad78fc71092849ca9cd2f264e14a8167
  - https://sketchfab.com/3d-models/key-a4aca11a2259462f8735a60eead33962
- Treasure chest Graphic:
  - https://assetstore.unity.com/packages/3d/props/interior/animated-pbr-chest-demo-194755