cat distribution system inc.

Hannah Müller – 00168694   Monika Szuban – 00168004   Vanessa Scherer – 00115936

Hannah Müller was responsible for the implementation of the 1st minigame "Memory" as well as of designing the overall UI Elements. She has a BA in Information Management and Corporate Communications and has already worked for 3.5 years as a UX/UI Designer in an agency. She had no previous experience in working with unity or developing in C#.

Monika Szuban was responsible for the implementation of the 2nd minigame and creating additional 3d models. She has a BA in Industrial Design with specialisation in Product Design. She had no previous experience in working with Unity and C#, although she was familiar with creating the environments and in game elements in such programs as Blender and Unreal Engine.

Vanessa Scherer was responsible for the implementation of the 3rd minigame "Flappy cat" as well as the overall structure of the unity project including the build of the overall game logic and the image tracker. She has a BA in UXD, where she learned the basics of computer science as well as design. Through a previous class in the Bachelor's studies, she already had some basic experience in the implementation of an AR or VR game in unity.

GitHub

For Joed Lopes da Silva and Markus Weißenberger we already invited them to the GitHub repository. For additional access please write a mail to: vas9341@thi.de.

Acknowledgement

Initial concept

Objective

The concept revolves around using gamification with cats to encourage users to manage and care for a virtual pet in a playful and engaging way. The ultimate goal is to help users become the best cat parent by focusing on the cat's well-being through fun and interactive tasks. The game blends responsibility with entertainment, creating a memorable experience for players.

Game descriptions

The app is built around the theme of a treasure hunt, where players scan images in their real-world surroundings to unlock mini-games. The progression through the mini-games leads to a rewarding conclusion, with players achieving the goal of being the ultimate virtual cat parent.

1st minigame: Memory
Players play the memory card game where different cat characters are shown.
The first pair will be their future ingame cat.

2nd minigame: Toy Hunt
Players collect and retrieve cat toys distributed throughout the game world.

3rd minigame: Flappy Cat
In a mini-game, the cat runs, climbs, and jumps over objects, with the added challenge of helping the cat lose weight.

Personas

- **Helena (19)** is an animal lover that is interested in adopting a real cat. She wants to simulate pet care responsibilities in a fun and engaging way, to ensure she is ready

for a real animal. Her goal is to learn about cat care through an engaging and realistic game that combines fun with practical knowledge.

- **Alexander (14)** is a tech-savvy teenager who enjoys gaming and seeks interactive AR experiences to keep him entertained and challenged. He seeks a fun and interactive game that offers progression, challenges and rewards to keep him engaged. His goal is to enjoy taking care of a virtual cat while avoiding repetitive tasks, keeping the game fresh and exciting.

User flow

The user starts in a start screen, where they get an overall game introduction. Afterwards they will reach the home screen where images in real life can be scanned to open the minigames. In the minigames the users will get an explanation of the game mechanics and goal. After the minigame completion a congratulations message will be shown and the user will be redirected to the home screen. This will be repeated for the other two minigames. In the end there will be another congratulatory message for the overall game with a a note of gratitude and the options to exit or restart the game.
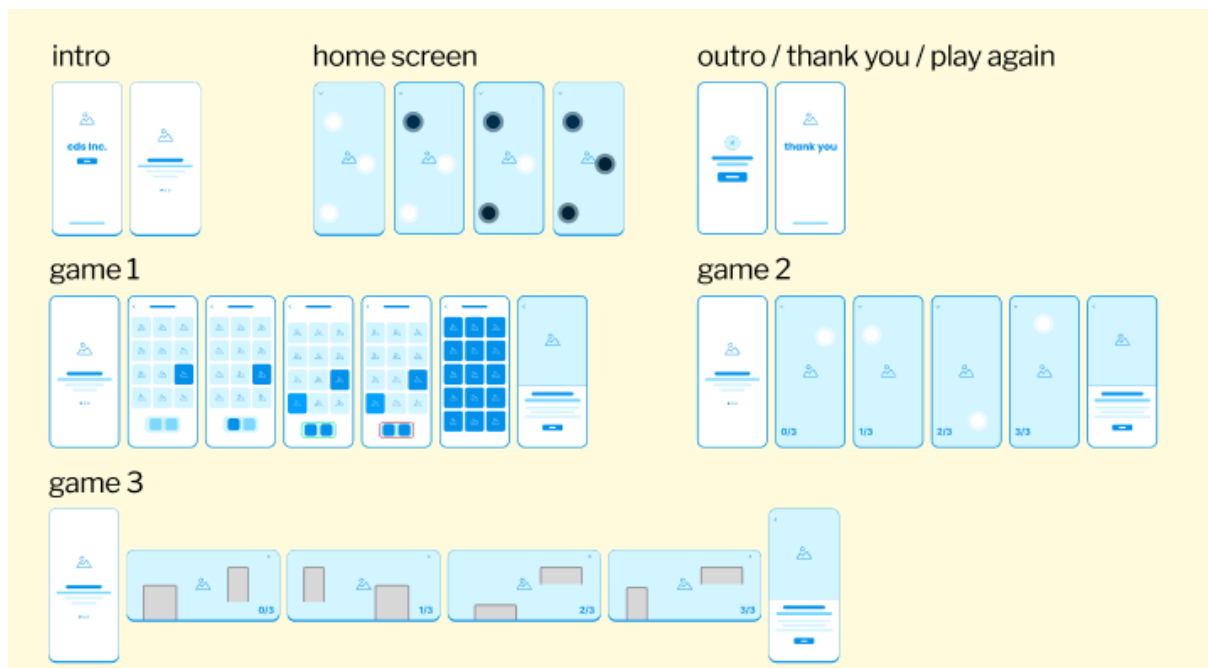
Wireframes

Figure 1: First low-fidelity Wireframes

Implementation

Our approach to collaborating was to have a simple folder structure within the project file. For each of the minigames a new folder was created, where everything specific to that game was located. This meant that for fusing the different parts together, only the respective folder had to be imported into the file.

ChatGPT and Claude were used for help with the initial setup of the project as well as creating codes for the different scripts.

User Flows & UML Diagrams

After establishing the initial game concepts, we developed user flows and basic UML diagrams for each game to guide the Unity implementation process. These diagrams served as valuable tools for understanding the required structure and interactions, helping us plan out the game's architecture. Especially as 2 of us were completely beginners in unity. Some of the initial flows and diagrams differ from the final concept.

Overall Game

When opening the game the user starts in the home screen where the **MarkerDetector** is active, which identifies AR markers from a predefined **MyImageLibrary**. Each detected marker corresponds to a specific mini-game: the **FlappyCatController** manages the Flappy Cat game, the **MemoryGameController** oversees the memory card game by tracking matched pairs and player interactions, and the **ToyHuntController** handles the Toy Hunt game. Progress across these mini-games is monitored by the **GameProgressController**, which ensures all games are completed. Once all games are finished, the flow transitions to the **FinalSceneController**, which allows players to either replay the experience or exit the game entirely.
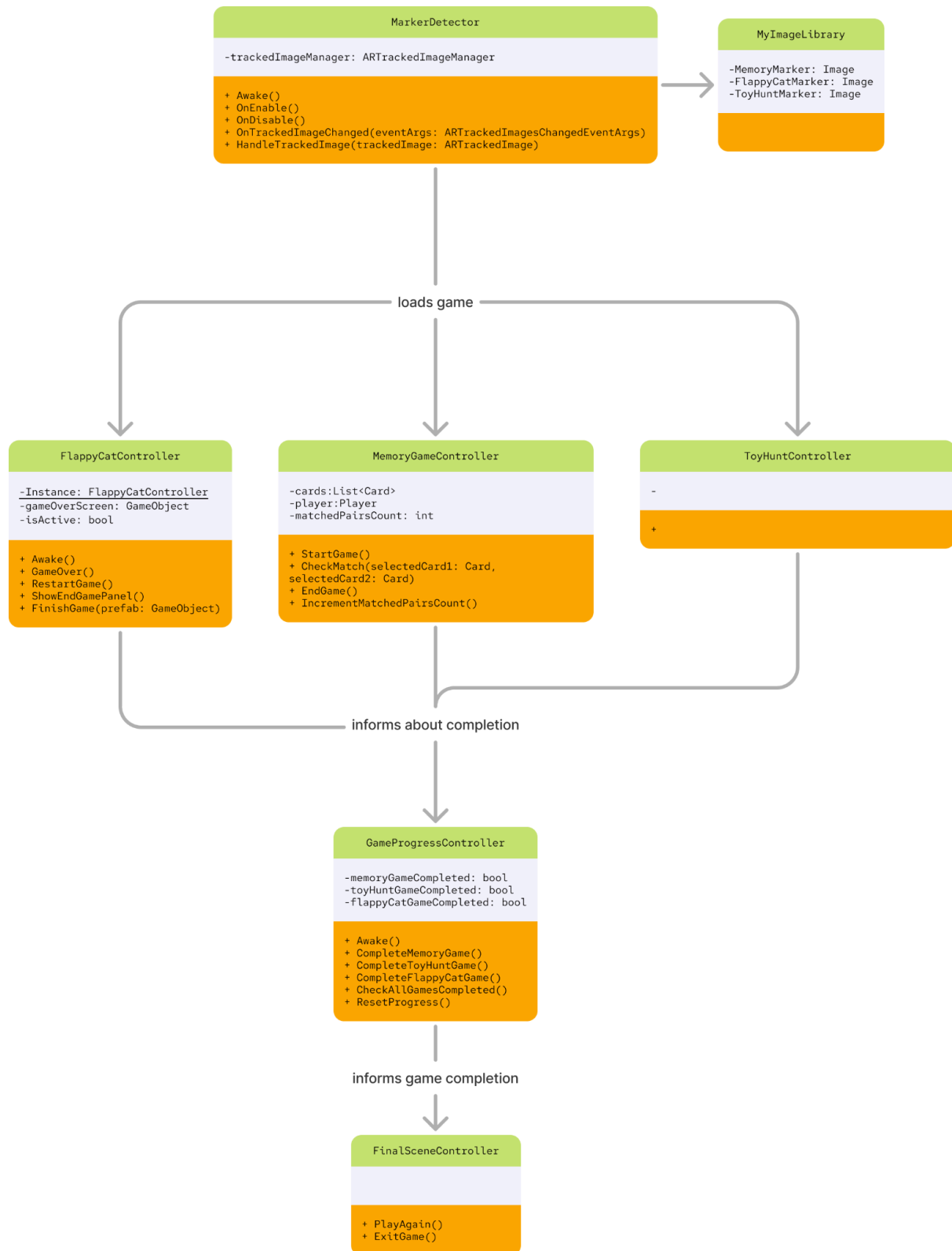
MarkerDetector

-trackedImageManager: ARTrackedImageManager

+ Awake()
+ OnEnable()
+ OnDisable()
+ OnTrackedImageChanged(eventArgs: ARTrackedImagesChangedEventArgs)
+ HandleTrackedImage(trackedImage: ARTrackedImage)

MyImageLibrary

-MemoryMarker: Image
-FlappyCatMarker: Image
-ToyHuntMarker: Image

loads game

FlappyCatController

-Instance: FlappyCatController
-gameOverScreen: GameObject
-isActive: bool

+ Awake()
+ GameOver()
+ RestartGame()
+ ShowEndGamePanel()
+ FinishGame(prefab: GameObject)

MemoryGameController

-cards:List<Card>
-player:Player
-matchedPairsCount: int

+ StartGame()
+ CheckMatch(selectedCard1: Card, selectedCard2: Card)
+ EndGame()
+ IncrementMatchedPairsCount()

ToyHuntController

-

+

informs about completion

GameProgressController

-memoryGameCompleted: bool
-toyHuntGameCompleted: bool
-flappyCatGameCompleted: bool

+ Awake()
+ CompleteMemoryGame()
+ CompleteToyHuntGame()
+ CompleteFlappyCatGame()
+ CheckAllGamesCompleted()
+ ResetProgress()

informs game completion

FinalSceneController

+ PlayAgain()
+ ExitGame()

Figure 2: Initial user flow

5

Memory Game

In the case of the Memory game, the concept evolved over time, meaning that the final game mechanics differ from the original design. Consequently, the UML diagram and user flow shown here are somehow outdated in relation to the final concept. However, they played a crucial role in shaping the overall structure and functionality within Unity. Moreover clearly defined folders, such as prefabs, sprites, and sounds helped to always have a well structured overview within the progress.
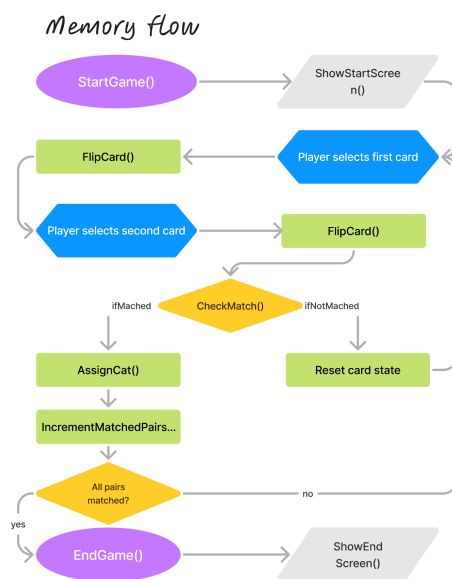
Figure 3: Initial Memory user flow

The initial user flow begins with the initialization of the game, displaying the start screen. The player then selects and flips two cards, with the game checking for matches. If a match is found, the cat is assigned to the player; if not, the cards reset. The game continues until all pairs are matched, after which the end screen is shown.
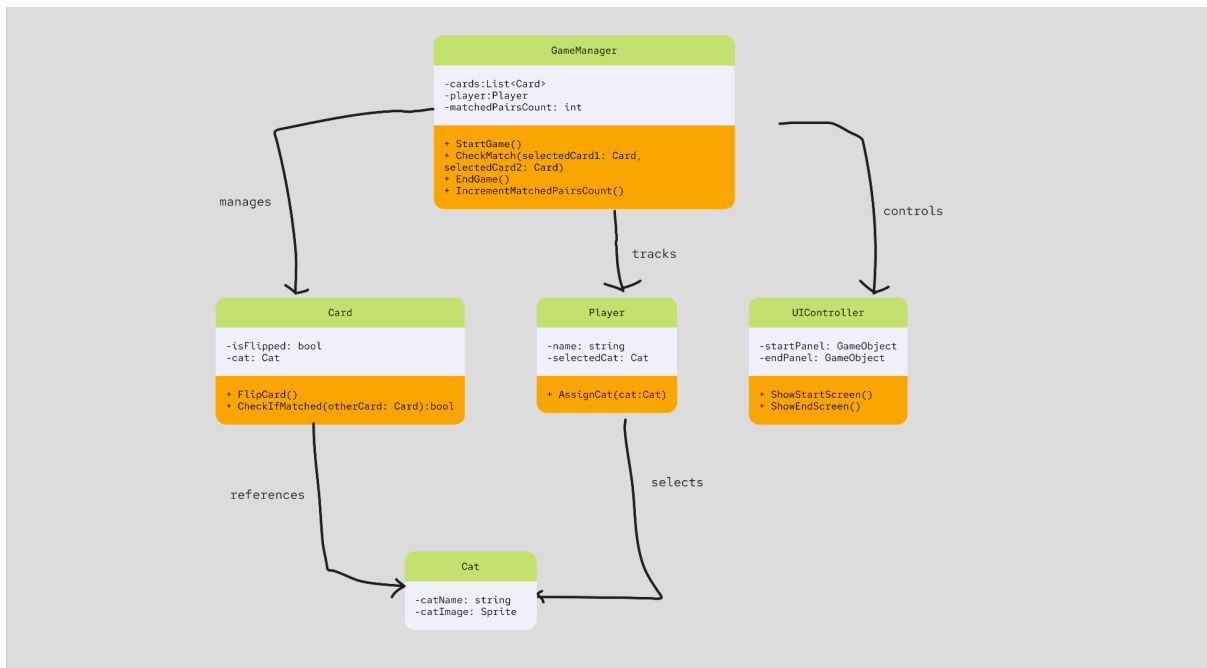
Figure 4: Initial Memory UML Diagramm

The shown UML diagram represents the key components of the Memory game based on the final game approach, where players match pairs of cat characters. The **GameManager** is responsible for initializing the game, tracking progress, verifying matches, and updating the UI. The **Card** class manages the states of individual cards, including flipping and checking matches, and is now linked to cat characters. The **UIManager** handles the display of the start and end screens, tracks progress, and provides user feedback. The **Player** class stores player details, including their progress and move count. Lastly, the **Cat** class holds the details of each cat, with each card representing a different cat character. This updated approach aligns with the final concept, which refines the game mechanics around matching cat pairs rather than the original format.

Toy Hunt Game

The "ToyHunt" user flow, along with the accompanying UML diagram, represents the first attempt at designing a game flow by a first-time game developer.
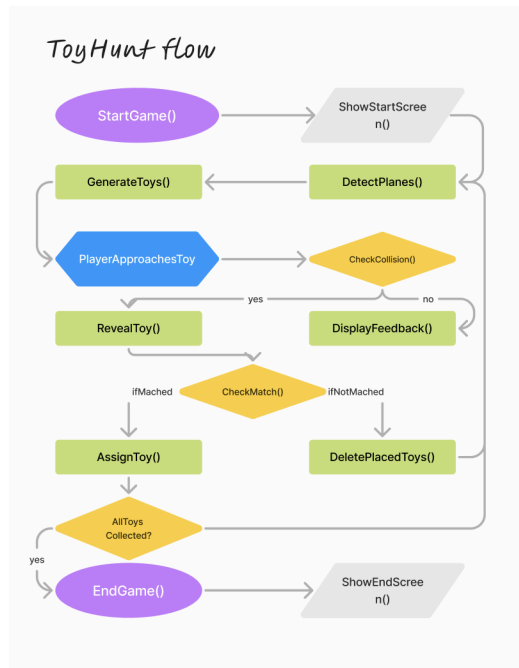
Figure 5: Initial Toy Hunt user flow

The flow begins by smoothly transitioning players into the introduction screen, providing a clear and simple onboarding experience. Once in the game, AR technology generates the environment, placing toys and ensuring proper plane detection. When players move close enough to a toy, an interaction is triggered to determine if it's a match. Matches are assigned, while mismatches provide feedback and remove uncollected toys. The game continues as players work to collect all the toys. Once every toy has been collected, the session concludes with an end screen to wrap up the experience.
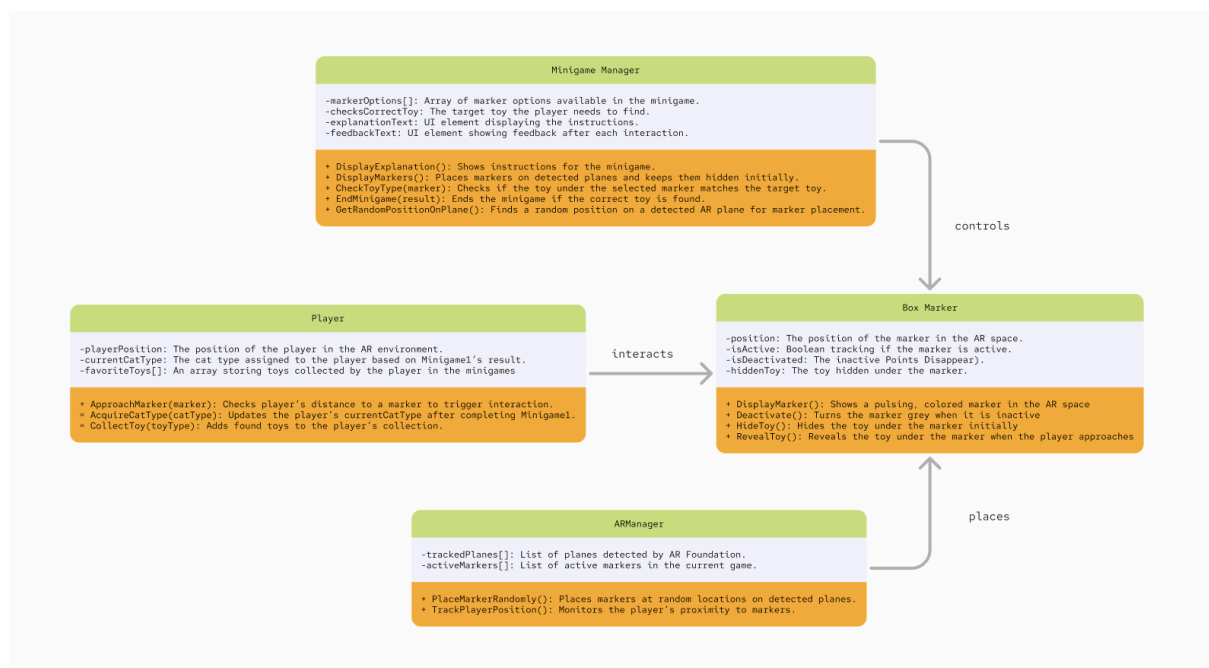

Figure 6: Initial Toy Hunt UML Diagramm

UML designed during the project's early stages, hand in hand with user flow, it served as a blueprint for understanding the minigames technical structure and how its elements interact. The Minigame Manager oversees gameplay elements, such as marker placement, target toys, and UI for instructions and feedback. It ensures smooth coordination between the player and the AR environment.The Player interacts with markers while their position, assigned cat type, and collected toys are tracked. Their role is to explore the space, engage with markers, and collect toys. The Box Marker represents interactive points in the AR space. These markers can be activated, hidden, or used to reveal toys during gameplay.The ARManager handles the technical side, detecting planes in the environment, placing markers, and tracking the player's movements. This diagram effectively captures the essential relationships between components, supporting the design and refinement of the minigame.

Flappy Cat Game

Flappy Cat starts after a few seconds when opening the game, for the user to adjust to the new setting. Afterwards obstacles will be spawned in the distance (**ObstacleSpawner**) and are slowly advancing towards the player (**ObstacleController**). If an obstacle is hit, it will be detected by the **ObstacleController** which notifies the **FlappyCatController**, the overall minigame manager. Afterwards the time will be stopped and a **play again button** will be enabled for the users to try again.

 To move the player object, the device has to be tilted to the left or right. The tilt will only be recognized, if it exceeds a specific angle to avoid misinterpretations. This is managed by the **TiltControl** that is attached to the player prefab.
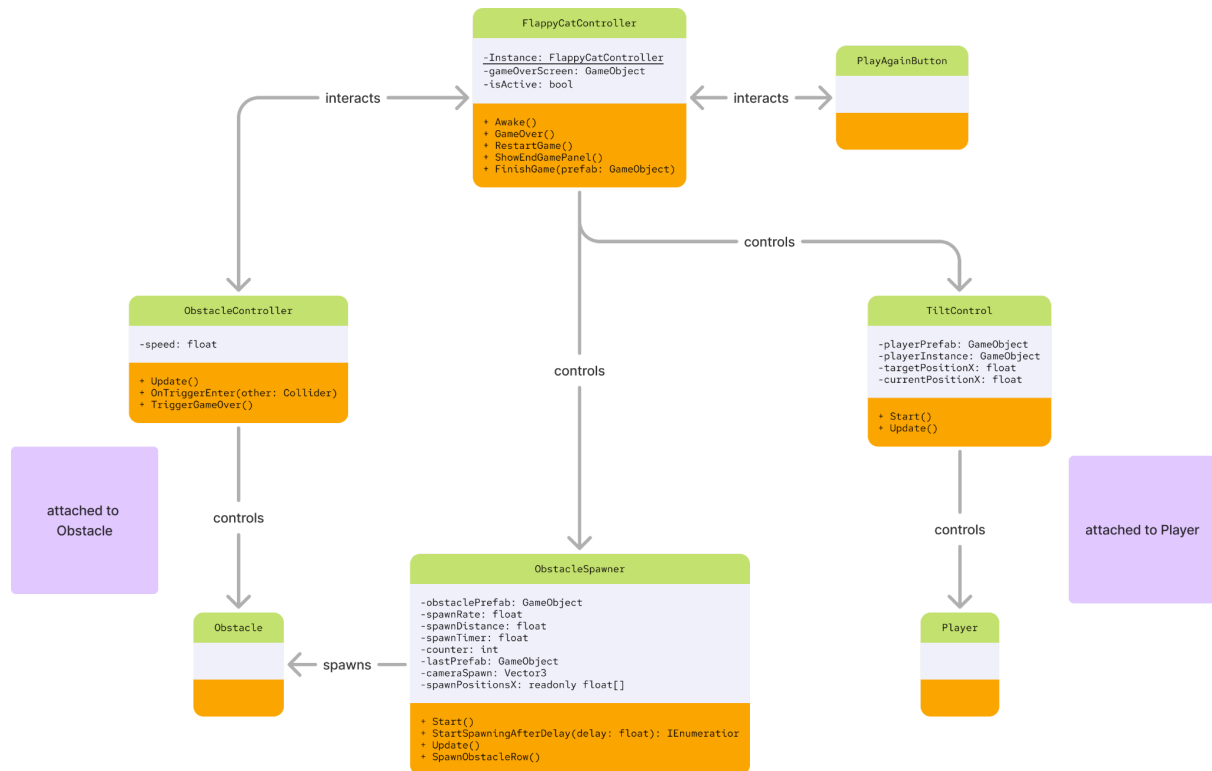
Figure 7: Initial Flappy Cat UML Diagramm

Evaluation

Initial user test

We conducted a first usability testing with three participants who had varying levels of familiarity with AR technology and in playing games. The goal was to identify usability issues, assess user satisfaction, and derive actionable insights to improve the app's comprehensibility and engagement. The testing involved structured observation, survey methods, and detailed analysis of user behavior and feedback. The participants tested the overall game structure, including *Toy Hunt* and *Flappy Cat*. Our third game *Memory* was not ready for testing yet.

In the first step Observations were made during gameplay to identify usability issues. To evaluate system usability, the *Hand-held Augmented Reality Usability Scale* (HARUS) was administered after participants completed their gameplay sessions. This timing was intentional to avoid disrupting the user flow during testing. The data gathered from observations and HARUS surveys were analyzed to uncover usability issues and areas for improvement. Specific challenges in user interaction and navigation were identified, and potential changes were proposed to enhance system usability and player engagement.

During this phase, prefabs and UI components were implemented primarily with functional considerations, as the visual design was not the focus at this stage.

Participants

To ensure the usability testing reflected the experiences of our intended audience, we actively sought participants from our target group. The recruitment process worked well overall, providing a diverse sample in terms of motivation, age, and interests. However, the age range of participants skewed slightly older than ideal for the target demographic.

The participant group included:

- **Player A (Male, 15 years old):** Highly engaged with games, representing a core target user who fits the intended audience well.
- **Player B (Male, 19 years old):** Moderately interested in games, offering insights from a more casual gamer's perspective.
- **Player C (Female, 22 years old):** Primarily interested in cats rather than games, contributing an alternative viewpoint that expands understanding of non-gamer experiences.

The mix of participants provided valuable data by capturing varying levels of familiarity and interest in gaming. This diversity enriched the findings, allowing the identification of usability strengths and challenges across different user archetypes. While participants' motivations aligned with the target audience to some extent, younger users—who likely represent the primary demographic—were underrepresented in this initial round of testing.

Qualitative Insights

Overall Game Mechanics

Players were often unsure of the tasks or objectives upon arriving at the home screen. This confusion led to the need for additional guidance to help users understand how to proceed. The lack of clear onboarding or immediate task instructions hindered players' ability to grasp the game's objectives from the start.

Progress Tracking

The absence of a visible progress indicator left players uncertain about their advancement through the game. Without a visual representation of their progress, users felt disengaged

and unsure of their next steps. This lack of feedback diminished their overall understanding of how far they had come in the game.

UI Design

The design lacked consistency, which affected the visual cohesion of the interface and made navigation less intuitive. Since the testing phase focused on functionality, aesthetic elements were secondary, but this led to challenges in usability. Key actionable elements, such as the start button, were too small and did not provide sufficient visual feedback, causing hesitation among players.

Scanning Mechanic

The scanning mechanic caused confusion, as players were unsure of which images to scan and whether there was a specific scanning order. This uncertainty disrupted gameplay and created friction in the user experience. The lack of clear instructions regarding scanning targets and sequence hindered the flow of the game.

Navigation and Visual Style

The absence of a unified style concept contributed to difficulties in navigation and user flow. Players struggled to intuitively move through the game due to inconsistent visual elements. The lack of clear visual hierarchy made essential actions harder to identify, affecting overall usability and coherence.

Suggested Improvements

- **Clear Onboarding**: Implement a concise onboarding flow to provide players with immediate guidance on tasks and objectives. A tutorial pop-up or step-by-step introduction could improve the first-time user experience.
- **Progress Indicators**: Introduce a progress tracker on the home screen, such as "1/2 games completed" or a progress bar, to help players visually track their achievements.
- **UI Design Consistency**: Establish a cohesive design style with consistent typography, colors, and button styles to improve visual coherence. Increase the size of key buttons, such as "Start Game," and ensure interactive feedback through highlighting or animations.

- **Improved Scanning Mechanic**: Provide clear instructions and visual cues for the scanning mechanic. This includes highlighting images or areas to scan and, if necessary, displaying a step-by-step guide to clarify the scanning order.
- **Visual Hierarchy**: Enhance the overall navigation by creating a more prominent visual hierarchy. Essential buttons and navigation elements should be easily identifiable, and actionable elements should be clearly defined through color schemes or visual feedback.

Toy Hunt

Object Collection and Identification

Players faced confusion about which items were collectible, with some objects not being collectible with the first tap, leading to frustration. To improve this, clearer in-game prompts should be provided, such as "We're looking for cat toys!" or "Already collected." Additionally, feedback like "It's not what we're looking for" or "We already have that" can immediately guide players when they interact with non-collectible items.

The counting system (e.g., 0/2, 1/2, 2/2) is functional but could be enhanced by showing a list of found items (e.g., "Found: Bird ✓, Feather ✓ "), giving players clearer progress.

Instructions and Explanations

The instructions for identifying collectible items were unclear, leading to confusion. To address this, the game should explicitly name items like "feather" and "bird" to better guide players in their search and align expectations.

Object Spawning and Accessibility

Object spawning caused frustration when items appeared in unreachable locations, like inside walls. Adjusting the spawning system will ensure all items are accessible and properly placed, reducing unnecessary obstacles.

Suggested Improvements

- Provide clear, in-game prompts for collectible items (e.g., "We're looking for cat toys!").
- Add feedback for non-collectible items (e.g., "It's not what we're looking for").
- Enhance the counting system by listing found items (e.g., "Found: Bird ✓").
- Revise instructions to clearly name the items required.

- Adjust object spawning to ensure all items are accessible.

Flappy Cat

Explanation Screen and Tutorial

The explanation screen disrupts gameplay by reappearing after selecting "Try Again." To improve the experience, it should only appear once per session, or an optional "View Instructions" button can be provided.

A tutorial before the game starts can demonstrate the tilting mechanic using animations or a 3D model of the cat, helping players better understand the controls and interactions.

Controls and Player Understanding

Players mistakenly thought the controls involved tapping or swiping instead of tilting. To address this, an interactive pre-game tutorial should allow players to practice tilting. In-game cues, like "Tilt your device to move," can further reinforce the controls.

Post-Game Navigation

Players had difficulty navigating after completing a game, often pressing the wrong buttons to return to the home screen. This can be resolved by redesigning the post-game interface with distinct, clearly labeled buttons for "Replay," "Home," and other key actions.

Replay Flow and Continuity

The replay flow is interrupted by the reappearance of the explanation screen. To maintain continuity, this screen should be removed during replays, allowing players to jump directly into the game. A "View Instructions" button can be added for mid-game clarification without disrupting the flow.

Suggested Improvements

- Limit the explanation screen to once per session or provide an optional "View Instructions" button.
- Add a pre-game tutorial with animations or a 3D cat model to clarify controls.
- Include in-game cues to reinforce the tilting control method.
- Redesign post-game navigation with distinct buttons for key actions.
- Improve replay flow by removing the explanation screen after "Try Again."

The overall results indicate that manipulability scored higher than comprehensibility. The average manipulability score of 82.39 was notably higher than the comprehensibility average of 68.47. This suggests that users found the physical interaction with the system to be relatively easy and efficient, while understanding the system interface posed more of a challenge.

	A	B	C	D	E	F	G	H	I	J	K
1	HARUS-Evaluation										
2											
3					comprehensibility						
4	Test Person	mental effort	appropriate inf	difficult to read	responding fas	confusing	easy to read	flickering	consistent		
5		-	+	-	+	-	+	-	+	SUBTOTAL	
6	1	3	5	1	3	2	2	1	4	64,58333333	
7	2	1	4	3	4	1	5	1	4	72,91666667	
8	3	1	3	3	4	1	4	1	4	68,75	
9											
10					manipulability						
11	Test Person	body muscle e	comfortable	difficult to hold	easy input	tiredness	easy control	losign grip	simple		
12		-	+	-	+	-	+	-	+	SUBTOTAL	
13	1	0	2	2	3	2	5	0	5	72,91666667	
14	2	0	5	0	4	1	5	0	5	87,5	
15	3	0	6	0	3	1	5	0	5	87,5	
16											
17											
18											

Figure 8: Table of HARUS results

player A
comprehensibility 64,6% manipulability 72,9%
overall **68,7%**

player B
comprehensibility 72,9% manipulability 87,5%
overall **80,2%**

player C
comprehensibility 68,8% manipulability 87,5%
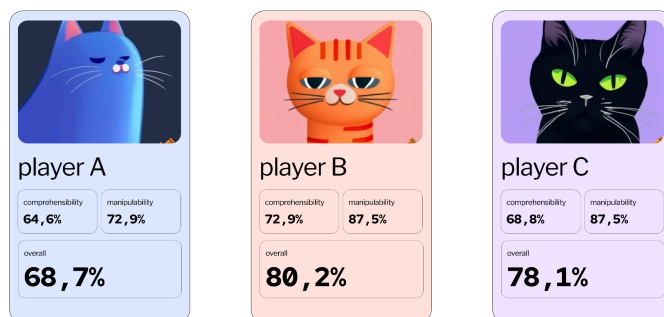overall **78,1%**

Figure 9: Overall HARUS results first User Testing

Several positive aspects were identified:

- **Low physical effort**: All participants reported minimal body or muscle effort during interactions, with no scores above zero for physical strain.
- **Simplicity**: The system received consistently high ratings in the "simple" category, suggesting that users felt the system was generally straightforward to use.
- **Grip stability**: All test subjects reported strong grip, which points to a well-designed and comfortable interface from a physical standpoint.

Despite the strengths, some areas require attention:

- **Mental effort**: There was notable variability in how much mental effort was required by different users. This could indicate that some users struggled more than others to understand the interface, suggesting a need for clearer instructions or a more intuitive design.
- **Readability issues**: Several participants reported difficulty reading certain information on the screen, which could hinder usability. Enhancing font clarity and contrast could help resolve this.
- **Flickering issues**: All users noted flickering problems during their interactions, which could be distracting and negatively impact the overall experience. Addressing these technical issues should be a priority in future iterations.

This survey showed us that to improve the user experience, we should focus on **enhancing comprehensibility** by providing clearer instructions, improving **text readability**, and fixing **flickering issues**, while maintaining the strong **physical interaction design** that users rated positively.

Key findings

The HARUS survey and qualitative feedback revealed that users had a positive experience with the physical interaction, noting minimal effort and good grip stability. However, there were challenges with understanding the interface, including issues with mental effort, text readability, and flickering. Additionally, qualitative insights pointed out confusion around onboarding, progress tracking, and object collection due to unclear instructions and inconsistent UI design.

For our future iterations, our focus should be on improving clarity with better onboarding, clearer instructions, enhanced readability, and addressing technical issues like flickering, while maintaining the solid physical interaction design.

Final user test

The second and final usability test revisited the structure of the first test but focused on evaluating a more refined version of the app. This iteration incorporated feedback and insights gathered during the initial testing phase. Once again, we employed HARUS surveys and direct observations to assess usability and engagement. However, this round of testing was more comprehensive, as all three games—Toy Hunt, Flappy Cat, and the newly

integrated Memory Game—were included in the evaluation. Finalized prefabs and an adjusted user interface were also part of this test.

Game-Specific Improvements:

- Memory Game: This game was fully integrated into the app, featuring time and move counters to add a structured challenge.
- Toy Hunt: Feedback messages were added to enhance clarity. Players are now notified if they click on incorrect objects ("It's not what we're looking for") or items they have already collected ("We already have this one"). Object spawning was also adjusted to ensure items are not obstructed by walls.
- Flappy Cat: Models for the cat and obstacles were replaced with finalized 3D models. Obstacles now spawn at random positions and rotations within a designated line, adding variety. Additionally, the cat was animated with a walking motion, enhancing visual appeal.

Overall Mechanics:

- Help and Explanation Screens: A help screen was introduced, pausing the game in modes where time constraints are critical. The explanation screen now appears only on the first playthrough, with subsequent access available via the help button.
- Audio Feedback: Sounds were partially implemented, including button feedback and audio elements in Flappy Cat and other 3D models.

Participants

For this round, we intentionally recruited a new set of participants to provide fresh perspectives. The group consisted primarily of individuals outside the app's target audience, as finding participants from the ideal demographic proved challenging. This however, ultimately worked to our advantage. One participant, in particular, had no prior experience with games or AR technology and their feedback became invaluable in identifying areas for improvement, ensuring the game could cater to a broader, less experienced audience. The inclusion of the Memory Game added another layer of complexity to the app, making this test an opportunity to evaluate how well players could navigate and engage with the entire system.

The new participants group included:

- **Player A (Female, 54 years old):** Interested in animals but not in gaming, with no prior experience using AR technology.
- **Player B (Female, 28 years old):** Interested in animals and has some familiarity with gaming, aligning more closely with the target audience.
- **Player C (Male, 28 years old):** Has limited interest in gaming, offering insights from a casual user's perspective.

The addition of three new participants further broadened our perspective on the game, bringing fresh insights and expanding the range of feedback. Unlike the initial round of testing, new users experienced the complete game from the Start screen through all three minigames, culminating in the Congratulations screen. This provided them with the full experience of our app and allowed us to gather a more comprehensive overview of its overall flow and functionality.

Qualitative insights

Overall Game Mechanics

Some testers experienced confusion regarding the flow of the game, particularly during transitions between minigames. Many expected the second minigame to start automatically after completing the first one successfully, leading to moments of inaction and hesitation.

Progress Tracking

The absence of thematic transitions and a unified progression structure left players feeling disconnected between minigames. Without a more prominent progress indicator or cohesive narrative linking the minigames, testers were often uncertain about their advancement within the game. This lack of continuity and feedback diminished their understanding of how far they had progressed and what to expect next.

UI Design

The user interface presented several challenges during testing. While some adjustments were made to UI element sizes, the game was still operating with placeholder designs rather than finalized elements. This contributed to a lack of visual cohesion and impacted navigation. Testers found essential actions, such as starting or transitioning between tasks, less intuitive due to inconsistent styling.

Additionally, the scanning mechanic still caused uncertainty, as it felt slow and lacked clear visual or functional feedback, especially for participants unfamiliar with AR technology. These issues highlighted the importance of implementing a more polished and unified final UI design and AR mechanics explanation.

Navigation and Visual Style

While the explanation screens offered contextual task descriptions, they lacked sufficient details about the underlying mechanics, leaving some players unclear on how to perform specific actions. These challenges emphasized the need for smoother transitions and, still, a clearer guidance.

Suggested Improvements

- Thematic Marker Updates: Update marker images to align with the overall cat theme, ensuring a cohesive aesthetic that enhances player immersion.
- Refined Introduction Text: Revise the introduction screens to provide clearer and more engaging explanations of tasks and objectives, particularly for first-time users unfamiliar with AR or gaming.
- Consistent Cat-Themed UI: Align all UI elements, including buttons, typography, and color schemes, with the overarching cat theme. This will create a visually cohesive experience and make navigation more intuitive.
- Enhanced Scanning Feedback: Provide clearer visual and textual feedback for the scanning mechanic. This could include highlighting interactive markers or adding animations to guide players through the process step-by-step.
- Improved Navigation Visuals: Create a unified visual hierarchy to ensure that essential buttons and navigation elements are immediately identifiable. Use consistent colors and styles for actionable elements, and add interactive feedback like highlights or animations to reinforce usability.
- Additional Player Guidance: Expand contextual feedback to help players better understand game mechanics and objectives, particularly in moments of inaction or uncertainty.

Memory Game

Object Collection and Identification

While the mechanics were relatively intuitive, some users experienced brief confusion when pairing cards, particularly when interacting with prototype visuals that lacked clarity. The

post-game actions, such as differentiating between "Play Again" and "Home," were not always clear, leading to hesitation in navigation

Thematic Cohesion

The cat-related theme, while present, felt underutilized in the visuals and mechanics, which reduced the overall sense of thematic cohesion. Players expected stronger integration of the theme, such as cat-themed memory cards, to better align with the overarching concept of the app.

Suggested Improvements

- Finalize the memory card visuals with cat-themed graphics to reinforce the app's thematic cohesion and make the gameplay more engaging.
- Provide clearer guidance for post-game actions, such as differentiating between "Play Again" and "Home," to reduce hesitation and streamline navigation.
- Introduce sound effects for key actions, such as successful matches or time warnings, to enhance user feedback and make the game more immersive.
- Update prototype visuals to improve clarity during pairing actions, addressing moments of confusion caused by indistinct or overly simple graphics.
- Finalize UI elements, such as CTAs (Call-to-Actions), to create a polished and cohesive interface that aligns with the rest of the app.

Toy Hunt

Clarity of ObjectivePlayers

initially struggled to fully grasp the mechanics of the game. While the introduction text explained the task (finding the fish and feather), it did not adequately explain the mechanics, such as scanning horizontal planes and waiting for the AR system to recognize surfaces. This created confusion, especially when box spawns were delayed, leading some users to mistakenly think the game wasn't functioning properly. A user suggested a toast message could provide guidance if no boxes appear for an extended time (e.g., "Try scanning the horizontal planes in your room").

Help Section

The help section was helpful to one user but wasn't prominently displayed or intuitive enough for others to discover when confusion arose. Another participant unnecessarily pressed the reset button due to misunderstanding the need to explore and search for objects, highlighting the need for clearer guidance about the game's exploratory nature.

Technical FactorsSome spawning issues may not be entirely due to the game but rather external factors, such as low-quality phone cameras or environments with too many white surfaces, which can hinder AR plane detection. This caused additional frustration for users who were unaware of these limitations.

Suggested Improvements

- Provide a more comprehensive explanation of the mechanics in the introduction text, including the need for patience while the phone recognizes planes and the importance of exploring the environment
- Implement toast messages that appear if boxes fail to spawn within a reasonable time(e.g., Try scanning the horizontal planes in your room).
- Revisit AR input recognition to reduce delays or missed taps when interacting with objects to ensure smoother gameplay.
- Introduce audio feedback, such as sounds for successful scanning or item collection, to enhance player immersion and clarify when actions are correctly performed.

Flappy Cat

Audio Experience

The inclusion of the cat prefab and accompanying sounds added charm to the game, enhancing the overall experience for most players. However, the volume startled one tester, suggesting a need to adjust sound levels for a more balanced auditory experience.

Progress Tracking

Testers were unsure about the length of the game, noting the absence of a visible progress indicator, such as a timer or score, which left them unclear about how far they had advanced. This lack of feedback reduced the sense of progression and engagement.

Game Mechanics

The tilting mechanic was not immediately intuitive for several players, leading to initial confusion. The restart function was helpful in allowing users to practice, but additional guidance on tilting controls is needed. Testers also mentioned difficulty in estimating distances within the game, which made navigation and gameplay feel less predictable. Additionally, players reported difficulty determining which lane their cat was currently on relative to incoming obstacles, leading to errors and frustration.

- Lower the volume of the cat sounds to ensure they remain engaging without startling players, creating a more comfortable audio experience.
- Introduce a clear counter, such as a visible score or timer, to provide players with a sense of achievement and clarity about the game's duration.
- Expand the explanation and help panels to better illustrate the tilting action required to control the cat. Include more explicit cues, such as "Tilt your device to move" during gameplay to reinforce the mechanic.
- Add visual lanes or markers to help players better estimate distances and navigate the environment, improving their ability to predict and control the cat's movements. Include indicators or highlights to show the cat's current lane in relation to obstacles.

HARUS Survey Results

The second HARUS survey results continue to show manipulability scoring higher than comprehensibility, with averages of 69.44 and 63.19, respectively. However, the significant gap between these two metrics observed in the first test has noticeably narrowed, suggesting improvements in comprehensibility since the initial round of testing. The current results, while still positive, show greater variability, likely influenced by the inclusion of participants outside the primary target audience.

	A	B	C	D	E	F	G	H	I	J	K
1	HARUS-Evaluation										
2											
3					comprehensibility						
4		mental effor	appropriate	difficult to re	responding	confusing	easy to read	flickering	consistent		
5	Test Person	-	+	-	+	-	+	-	+	SUBTOTAL	
6	1	5	5	4	3	5	5	1	3	52.083333	
7	2	3	5	4	5	2	4	2	4	64.583333	
8	3	1	6	3	4	2	4	1	4	72.916667	
9											
10					manipulability						
11		body muscle	comfortable	difficult to h	easy input	tiredness	easy control	losing grip	simple		
12	Test Person	-	+	-	+	-	+	-	+	SUBTOTAL	
13	1	0	5	3	3	2	5	5	1	58.333333	
14	2	3	3	4	3	1	4	0	4	62.5	
15	3	0	5	0	4	1	5	0	5	87.5	
16											

Figure 10: Table of second HARUS results

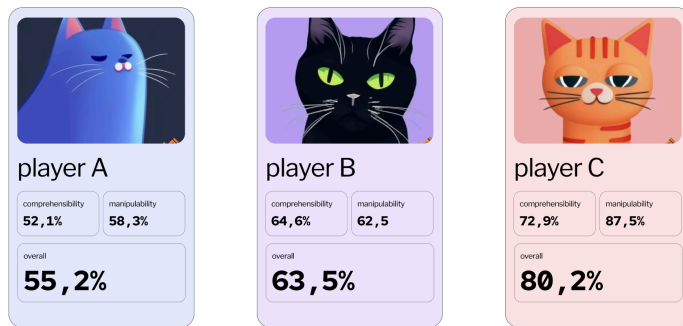*Figure 11: Overall HARUS results for second user testing*

A number of strengths were highlighted:

- Mental Effort: Players generally found the mechanics straightforward once explained, reducing the cognitive load during gameplay. This was particularly evident in the Memory Game, where the time limit added excitement without being overwhelming.
- Easy to Read: Updated UI elements, such as larger buttons and clearer text in the Help sections, were noted for being easier to read and interact with.
- Comfortable Interaction: The introduction of clearer feedback, such as sounds and contextual toast messages, contributed to a more comfortable and engaging experience.

Areas for improvement remained:

- Appropriate Information: Some players struggled with understanding certain mechanics, such as tilting in Flappy Cat or scanning planes in Toy Hunt, due to unclear or insufficient instructions. Providing clearer, step-by-step tutorials would address these issues.
- Responding Fast: Delays in box spawning and tap recognition in Toy Hunt frustrated players, reducing the sense of responsiveness and control.
- Easy Control: Players found it challenging to estimate distances and lanes in Flappy Cat, impacting their ability to navigate effectively. Visualizing movement lanes or providing clearer indicators would improve control.

The second test showcased improvements in reducing cognitive load, enhancing readability, and providing more comfortable interactions through clearer feedback and UI updates. However, challenges with providing appropriate instructions, responsiveness in Toy Hunt, and control clarity in Flappy Cat remain areas for refinement.

The second HARUS survey and qualitative insights demonstrated significant progress in user satisfaction, with improvements in feedback, tutorials, and visuals enhancing engagement. All participants were able to complete the mini-games without external guidance, highlighting the effectiveness of clearer instructions and enhanced onboarding.

Key findings show that while manipulability continues to outperform comprehensibility, the gap has narrowed compared to the first test. Challenges remain in areas such as progress tracking, tilting mechanics, and UI consistency, particularly for participants less familiar with AR or gaming. Future iterations should focus on refining clarity with more detailed onboarding, progress indicators, and improved visual cues, while continuing to build on the strong physical interaction design and immersive elements introduced in this round.

Final concept

For the final concept prefabs from the Unity asset store were used to improve the fun-factor. Additionally we collected sounds from different free websites to increase the immersive experience of the user like e.g. a button-sound.

Overall Home Screen and Navigation

The overall structure of *Cat System Distribution Inc.* begins with a central home screen, acting as a hub for players to navigate between the three mini-games: *Memory*, *Toy Hunt*, and *Flappy Cat*. Upon opening the app, users are greeted with an introduction to the game's premise, followed by the home screen, where they can select mini-games by scanning designated AR markers. Each marker unlocks a specific game, creating a seamless and interactive transition between the app's AR environment and gameplay.

After completing a mini-game, players are presented with a congratulatory message and given the option to click the *Home* button to return to the central hub. From the home screen, players can track their progress, select another mini-game to continue their journey, use the help button to get information on the requirements for game completion, or exit the game completely. Once all mini-games are completed, an overall congratulatory screen is shown, offering users the option to hit the *Play Again* button, which resets the entire game and allows players to start over, or exit the game completely. This navigation system ensures users can explore the game at their own pace, creating a cohesive and intuitive flow while maintaining engagement across the app's features.

Figure 12: Minigame access markers

Memory

The final version of the Memory game differs slightly from our initial concept. Due to time constraints, we were unable to implement the original memory card game concept where different cat characters were shown. Players now need to find pairs of cat utensils rather than matching cat characters.

First-time players are introduced to the game mechanics through a dedicated introduction screen. The game includes two regulators to challenge the player: a move counter and a timer. Players are limited to a maximum of 50 moves, while the timer counts down from 2 minutes and 30 seconds. The goal is to complete the game within these limits.

A help section is available for players to review the instructions at any time. When the help section is accessed, the timer pauses to allow players to read without pressure.

Players can return to the home screen at any time using the "Home" button.

Sound effects and background music enhance the overall gaming experience. Background music sets the mood, while specific sounds are triggered for key events: an error sound plays when mismatched cards are selected, and a success sound celebrates each correct match.

At the end of the game, the congratulations screen displays both the final move count and remaining time, allowing players to see how well they performed. This final concept is designed to provide an engaging and structured memory game experience with clear progress indicators and a rewarding feedback system.
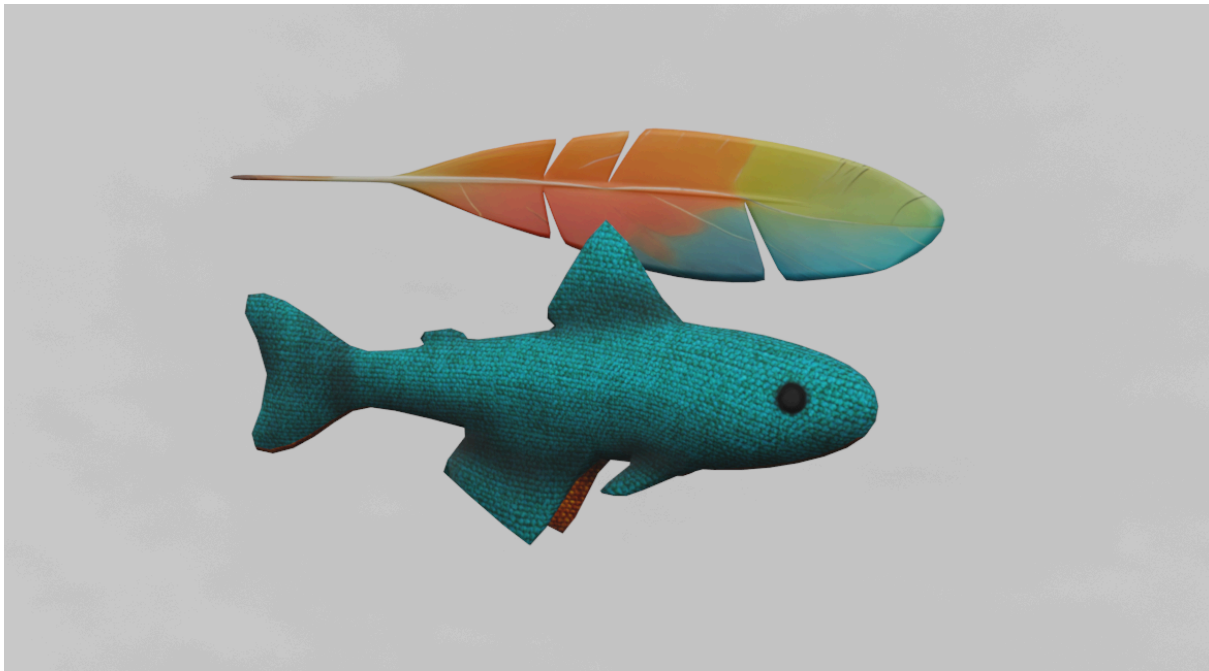
Toy Hunt

The final version of Toy Hunt differs slightly from the initial concept. Initially, we aimed to connect the Memory Game and Toy Hunt, where the first pair revealed in the Memory Game would assign the player a cat with specific favourite toys. In the current version, Toy Hunt uses predefined favourites, but the rest of the core mechanics remain faithful to the original design.

The game utilizes AR technology to detect vertical planes, spawning mystery boxes in real-world spaces. Players interact by tapping the boxes to open them and search for two specific items: the fish toy and the feather toy. To enhance the experience, we created two custom 3D models using Blender for these specific toys, while the remaining 3D models were implemented using Unity Assets. Decoy toys add an element of challenge, while correct selections trigger a purr sound and incorrect ones a hiss, reinforcing the outcomes of player actions. Invisible collision planes and physics-based toy interactions create a seamless and realistic gameplay experience.

First-time players are introduced to the mechanics through a dedicated introduction screen. After the start players have options to return to the home screen or reset planes using navigation buttons. A help button is also available to guide users, but the introduction screen doesn't appear anymore if users play the game again. Feedback is delivered via notifications, such as reminders for already collected or incorrect toys, while a progress counter at the top of the screen tracks toy collection and fosters a sense of accomplishment. Additionally, a help prompt appears after periods of inactivity to encourage engagement.

This final iteration of Toy Hunt provides a dynamic and immersive experience, blending augmented reality with interactive gameplay. It ensures players enjoy a rewarding challenge within the broader narrative of the cat game.

Figure 13: Created custom models in Toy Hunt

Flappy Cat

In Flappy Cat, players take control of a cat that must navigate through rows of obstacles while progressing forward. The obstacles consist of everyday objects, randomized in position and rotation, placed across three lanes visualized like a track field. By tilting the device left or right, the cat can switch lanes to avoid collisions, offering an intuitive and seamless control experience.

Originally, the design envisioned the cat jumping or climbing over obstacles, but this was changed for consistency with the other mini-games. To maintain a unified experience, the game remains in portrait mode, with tilting the device now being the primary interaction. Face tracking was also tested as a way to move the player, but it didn't work out as expected and was ultimately replaced by the tilting mechanic.

When opening the minigame for the first time, an explanation panel appears, where the controls and the overall goal are described and visualized. As the game begins, the cat starts walking, accompanied by a cheerful meow. A counter tracks the number of rows the player successfully avoids, encouraging progression. If the cat collides with an obstacle, a distressed cry is played, and the movement stops. Obstacles are varied and randomized, ensuring that each attempt feels fresh and challenging.

Players can pause the game at any time to access a help panel, where the game's timer stops and resumes once the panel is closed. Additionally, they can return to the home screen mid-game if desired. Upon completing the game, a congratulatory screen appears, celebrating the player's effort and offering the choice to either replay or return to the home menu.

With its smooth animations, dynamic sound effects, and engaging gameplay, Flappy Cat delivers an enjoyable and immersive experience.

UX & UI Design

The app's UX and UI design focused on delivering clarity, ease of use, and accessibility for a wide audience. By combining a minimalist aesthetic with vibrant, eye-catching colors, we aimed to create an engaging yet straightforward experience that feels modern without overwhelming players or appearing overly "gamey." The design emphasizes reducing cognitive load while maintaining a clean, intuitive interface. All UI elements were designed in Figma and seamlessly implemented in Unity. Key assets created in Figma include CTAs, background images (such as the congratulatory screen), and markers, ensuring a cohesive and visually appealing user experience.

We incorporated intuitive navigation elements such as back buttons on every screen, which allow users to easily return to the Home screen or exit the game. This ensures users can effortlessly move between sections without confusion. To further support new players, each game begins with a brief, concise explanation panel that clearly outlines objectives, guiding them through the initial interaction with minimal effort.

While 3D elements were added to enhance immersion, there were challenges in achieving a perfect visual integration with the minimalist UI. This mismatch was addressed by ensuring that the primary design elements remained consistent and simple while balancing the added visual depth. Ultimately, the UX design focused on fostering an enjoyable, seamless, and modern experience that is both accessible and easy to navigate for users of varying skill levels.
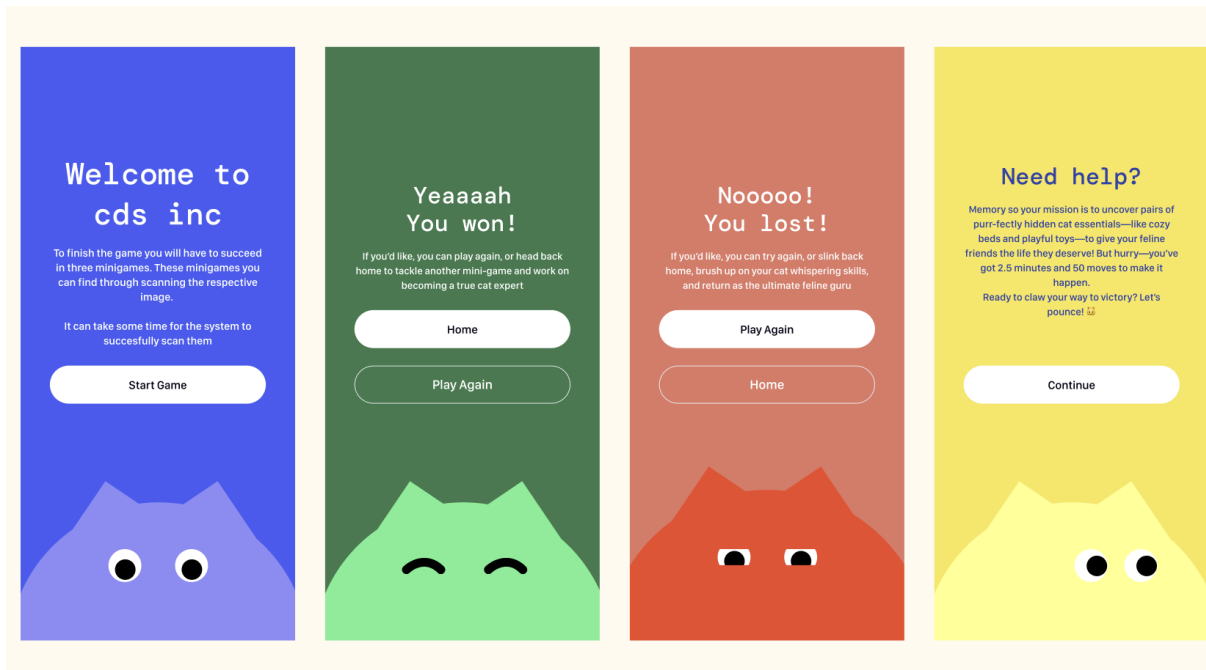
Figure 14: UI screens

Conclusion

Reflecting on our journey, the completion of this project stands as a testament to our teamwork, perseverance, and growth. From conceptualization to delivery, our Unity app represents not only an engaging game but also a valuable learning experience for our entire team.

Meeting Initial Goals

From the outset, we aimed to create an enjoyable, engaging game while developing our technical and collaborative skills. Taking a realistic approach, we focused on leveraging each team member's strengths and skill levels. With clear role assignments and a shared commitment to success, we stayed aligned with our initial goals. However, due to constraints in skill sets and timing, the educational aspect of the game is no longer a primary focus. That said, there remains potential to revisit and incorporate this element in the future.

Positive Takeaways

- **Realistic Approach:** By focusing on each member's abilities, we ensured steady progress while fostering personal and professional growth.
- **Clear Role Assignment:** Specific responsibilities helped streamline the workflow, while open collaboration encouraged shared success.

- **Strong Collaboration:** Regular communication ensured smooth coordination and facilitated teamwork.
- **Simple Folder Structure:** A well-organized structure minimized conflicts during merging and enabled efficient integration of contributions.
- **Efficient Contributions:** Each member found it easy to add and integrate their work, ensuring a steady and consistent workflow.

Challenges Overcome

- **Initial Difficulty with Unity:** Starting with limited experience in Unity presented significant challenges. However, the struggle prepared us to tackle similar tasks in the future with greater confidence.
- **Unity Structure Clarity:** Understanding Unity's internal structure was initially confusing, highlighting areas where more preparation could have streamlined the process.
- **Regular Check-Ins:** While we adapted to individual challenges, more frequent check-ins would have ensured better alignment with project goals.
- **Asset Challenges:** The scarcity of suitable assets required creative problem-solving. Monika's initiative to create two custom 3D models was instrumental in overcoming this obstacle.

Overall Reflections

As beginners, starting from scratch was both a challenge and an opportunity for growth. Despite the hurdles, we are immensely proud to have completed the project independently. The skills we've gained, the lessons we've learned, and the teamwork we've fostered have been invaluable. This experience not only reflects our ability to create a functioning and engaging app but also lays the foundation for future endeavors.

Limitations

The app's marker recognition performance varied under different lighting conditions, impacting the reliability of AR interactions. Additionally, the requirement for AR-compatible devices limited accessibility. The app is currently optimized for indoor environments, which may restrict its usability in outdoor settings.

Future outlook

As we reflect on the development process of our Unity application, we are excited about its potential and the opportunities for further growth and enhancement. Below, we outline key areas for future development:

Gamification Enhancement

Completing this project independently has been a significant achievement for our team. Despite the challenges of starting from scratch as beginners, we are proud of the progress we've made and the skills we've cultivated along the way. Moving forward, we see vast potential to enhance the gamification elements of the app, increasing user engagement and satisfaction. This could include adding dynamic challenges, interactive mini-games, and innovative reward systems.

Knowledge Expansion

One of our primary goals is to broaden the scope of cat-related knowledge provided by the app. Future updates will aim to:

- Expand the depth and variety of cat-related educational content.
- Include actionable tips for users to better understand and care for their cats.
  This expansion will not only enhance the app's value but also strengthen its appeal to a broader audience.

UI Concept and Design

The user interface plays a critical role in creating an engaging experience. We envision the following improvements to refine our app's UI:

- **Standardization and Customization of Cat Objects:** Enhance the design of "cat" objects using 3D modeling to create visually appealing and customizable representations.
- **Redesign for Engagement and Gamification:** Revamp the overall design to align more closely with gamified elements, ensuring a seamless and captivating user experience.
- **Progress Highlights and Rewards:** Introduce features that effectively showcase user progress and achievements, incorporating visual and interactive elements that emphasize rewards and learning milestones.

These updates will ensure that our app remains engaging, educational, and enjoyable, paving the way for a brighter future and sustained user engagement.

Summary

This report outlines the development and evolution of *Cat System Distribution Inc.*, an AR game featuring an overarching structure with three integrated mini-games. The project began with the goal of creating an engaging and cohesive and educational game experience, preparing future cat owners for future adoption and challenges of owning a cat. It addressed challenges such as limited Unity experience among team members, AR implementation constraints, and refining the game mechanics based on user feedback. Each phase of development was marked by collaborative problem-solving and iterative improvements, informed by usability tests and surveys.

The report details the initial conceptualization, design processes, and technical implementation, highlighting challenges such as AR marker detection issues, inconsistent UI design, and adapting to the team's learning curve with Unity. The team designed and implemented a custom UI to ensure a cohesive and accessible user experience across all elements of the game. Usability testing played a crucial role in refining the game's clarity, responsiveness, and overall player experience. Improvements included enhanced progress tracking, refined visuals, cohesive navigation, and better AR reliability.

The final version of *Cat System Distribution Inc.* delivers a polished, immersive AR game that aligns with the original objectives. It integrates smooth user interaction, custom 3D models, UI elements, and intuitive gameplay mechanics across all mini-games. While the game achieved its primary goals, the report identifies opportunities for future iterations, including expanding game content, further refining gameplay mechanics, and optimizing AR interactions to broaden accessibility and elevate the overall experience. This report serves as a testament to the team's collaboration, adaptability, and growth throughout the development process.