

Project Proposal for MSc in Games Technology

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Project Title: CardsAR, a social card game set in shared virtual world using multi-modal smartphone based augmented reality

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Introduction

During the coronavirus pandemic and its related lockdowns in 2020 and 2021, the internet became the predominant method of socialising available to people the world over. People used whatever technology was available to them: laptops, smartphones and games consoles, to play and socialise together online (Washington Post, 2020). In the years since, the world's largest technology companies are investing billions in developing the future of socialising online using virtual reality (VR) technology. This author posits that this vision is incompatible with how millions of people have adapted their lifestyle to incorporate being online in a post pandemic world. This project proposal will highlight the significant benefits of utilising augmented reality (AR) over virtual reality before outlining the design and build plans for CardsAR, a smartphone app that uses AR to build an immersive, inclusive social experience for many.

In 2021 Facebook changed its company name to Meta and declared its intentions to build their "Metaverse" (Meta, 2021). This term has been taken from the science fiction novel *Snow Crash*, in which characters would log into a shared virtual world using VR goggles (Stephenson, 1992). This announcement was controversial among certain groups. Some commented that 'Metaverse' is merely a marketing buzzword with no current real word application. While John Carmack, CTO of Meta owned Oculus VR has often shown his disdain for the term by called it a "a honey pot trap for architecture astronauts" (Carmack, 2021). It is however undeniable that many companies around the world are investing in technology that will help achieve their interpretation of a Metaverse. Epic games, makers of Fortnite and the Unreal engine announced their plans in April 2021 to raise over a billion dollars for investment in "Epic's long term vision for the metaverse" (Epic Games, 2021). Some would argue that games like Fortnite, Minecraft and Roblox each with their own shared virtual experiences are each a type of Metaverse (Jaehnig, 2022). Mark Zuckerberg has described his vision of the Metaverse as the "successor to the mobile internet" (Zuckerberg, 2021) and that it will take place on head mounted displays dedicated to VR. It is the stated belief of the Meta company that handheld smartphone screens are no longer where the future of the socializing on the internet will take place.

However, VR headsets have intrinsic drawbacks that indicate that any social platform build solely for VR would currently be unavailable to many. At present headsets are expensive, single purpose and have substantial requirements on physical space. VR technology may become cheaper and easier to use in the future, but headsets will always envelope a user's vision making them potentially unaware of their real world surroundings. This social isolation may be unacceptable to users who do not want to shut themselves off to the world to play a game. Furthermore, VR technology currently costs users up to four times that of other gaming consoles on the market. These combined factors create a high barrier to entry that make socialising in VR unappealing to many. In contrast, smartphone technology already has wide adoption and can provide immersive, intuitive, and enjoyable virtual socialising through AR.

The central research question for this project is: Can social gaming in a shared virtual world be created with mid-to-high end smartphones? This document outlines a proposed design and build of CardsAR, a game that through multiple forms of input, will let users naturally interact with a deck of cards and with each other in a shared virtual world.

Project Description

Over the last decade great strides have been made within AR and VR development. Progress in VR has been driven by advances in mobile head mounted displays like the Meta Quest (Meta, 2021) and HTC Vive (Vive, 2021). AR headsets have been developed too but has been met with little success in the consumer technology market. The Microsoft-developed HoloLens costs almost three times the price of the most expensive VR headsets and has narrow field of view that limits its use cases. Since its release Microsoft has refocused its HoloLens devices towards business and industry use cases instead of public consumption (Microsoft, 2021). As a result, the most popular uses of AR technology come from smartphone users.

While both AR and VR are conceptually similar, their current use cases are quite different. The most advanced VR headsets such as the HTC Vive Pro and the Meta Quest 2 use in-headset cameras to map the real-world space, allowing games to track player movement around a space. Sophisticated wireless controllers can also add hand tracking to give players realistic in-game hand controls. These methods of control can allow for immersive VR interactive experiences that allow players to move around and interact with virtual worlds as naturally as they do in the real world.

AR games commonly fall into one of two categories ‘city-scale’ or ‘room-scale’ experiences. City-scale games like Pokémon Go (Niantic, 2016), Ingress (Niantic, 2014) and Zombies Run (Six To Start, 2012), are based around moving around the real world. Their gameplay encourages players to explore local places of interest in their town or city. Room-scale games encourage players to play standing up and interact with 3d models projected into the real world. Examples of room scale games include Kings Of Pool (Uken Games, 2019) or Smash Tanks (DUMPLING design, 2017).

Inspiration for this project has been taken from the PC game “Tabletop Simulator” and its VR mode. Like Tabletop Simulator, players of this game will be equally spaced around a circular table; they will have free movement of their camera as well as the ability to pick up and interact with cards on the table or in their hand. This seated and locked position gameplay model could be described as ‘desk-scale’ AR.

One of the primary design goals of this project is to allow enough freedom of movement and communication that no card game rules need to be coded into the game. Interactions common to many card games like shuffle, deal and multi card pickup will be designed into the game. With these available interactions players should have enough control to be able to play card games already known to them, learn a new game from friends, or even create a card game while in the app.

Smartphones do not come with controllers, nor do they have in-built multi-camera room mapping technology. But they do have multiple dimensions of player input that, when used in unison could create an immersive social experience.

Camera movement In VR is tied directly to the movement of the head mounted display. The closest equivalent smartphone replacement for this input method is the movement of the phone as tracked by the onboard gyroscope. This method of input is not 100% accurate so the tracking of the player environment will be used in unison to obtain more accurate positioning..

Replicating the functionality of physical game controllers in augmented reality could be achieved with real world hand recognition or with touch screen gestures. Hand recognition software could be used to detect player hand movements and gestures. If hand recognition is used, the limitations of the platform must be taken into consideration. As the phone will be held while playing, hand tracking will only ever show one hand at a time. It also must be expected that the player hand may not be always visible. Therefore, the in-game hand will be designed as a temporary method of input that can appear and disappear whenever the player moves their hand out of view of the camera. Hand tracking using a single camera source as input will be imprecise. To assist development, third party plugins designed around hand tracking will be used. If this method proves too imprecise for gameplay, swipe/tap gestures on the phone screen could be combined with the location and direction of the camera to allow for contextual controls.

One advantage that smartphones have over VR headsets is that smartphones have front facing cameras. Through this front facing camera the player head position relative to the screen could be tracked to give a 3d parallax effect. An in-game player avatar could also be created and modelled after the players expressions using face filter techniques that apps like Snapchat or Instagram use (Banuba, 2021). The live video feed from the front facing camera could also be added to the in-game world and mapped onto a surface that responds to the players phone position and direction.

In order to optimise development time the project will be developed in the Unity engine. This allows for the use of AR focussed cross-platform plugins that would be too time consuming to design from scratch. Lightship ARDK from the makers of Pokémon GO will be used for real time mapping, device tracking and multiplayer programming (Niantic, 2021). Manomotion SDK will be used for hand tracking (Manomotion, 2020) and Unity's own AR Foundation SDK will be used for face tracking. To simplify development in the early stages of the project, development will be started on iOS and if time allows, Android support will be added later. The primary testing devices will be iPhone 12 Mini (2020), and an iPad Mini (2021). Both devices do not include LIDAR scanners available on higher end iOS hardware, which keeps development focussed on devices with mid-range specifications.

Objectives

To make the best use of the time available. The development of CardsAR will be split into five parts, comprising of a pre-build, three builds and then a post build. The pre-build will be a literature review of similar applications. The first build to establish the game basics and proof of concept feature tests. The second build is focussed on the core feature set. The third build will be for non-essential features and bug fixing. The post build will be focused on user testing and report writing.

0. Pre-Build:

0.1. Literature review of relevant AR apps.

1. Build 1:

1.1. Basic unity setup and device setups for testing.

1.1.1. iPhone 12 Mini Testing

1.1.2. iPad Mini Testing

1.2. Basic multiplayer session setup using Lightship ARDK

1.3. Single hand tracking

- 1.3.1. Skeleton Detection
 - 1.3.2. Gesture recognition
 - 1.3.3. Fine skills test
- 1.4. Device pointing as interaction technique test
- 1.5. Face tracking test
 - 1.5.1. Facial Expression Detection
 - 1.5.2. Face position
- 1.6. Streaming video call test
- 2. Build 2:
 - 2.1. Creation of game space, and player placement.
 - 2.2. Card mechanics
 - 2.2.1. Placement of cards on table
 - 2.2.2. Pick up / Drop Mechanics
 - 2.2.3. Add and remove cards from the players “card hand”
 - 2.2.4. Show single cards to individual players.
 - 2.3. Card Deck mechanics
 - 2.3.1. Shuffle and Deal
 - 2.3.2. Pick up multiple cards
 - 2.4. Player audio.
 - 2.5. Multiplayer session management
- 3. Build 3:
 - 3.1. Android Testing
 - 3.2. Player presence through animated avatars or floating video call screens.
 - 3.3. Refinement of interaction techniques based on user testing
 - 3.4. Improved graphical treatment using shaders lighting and models taken from the Unity store.
 - 3.5. Camera parallax through face tracking.
 - 3.6. Player hand modelling.
 - 3.7. Refactoring of game code.
- 4. Post-Build:
 - 4.1. Play testing and evaluation
 - 4.2. Report Writing

Beneficiaries

There are multiple beneficiaries for the CardsAR project. Primarily, this experience in multiple technologies will not only broaden the authors skillset, but will also be an important step in one’s career development. Further experience with Unity and augmented reality plugins and packages will allow for the author to specialise in augmented reality development post-graduation.

The author is also being partially financed through this part time masters course by their employer, Territory Studio. Territory is a multidisciplinary design studio whose work ranges from creative advertising to motion graphics to post production visual effects for film and television. The studio also has a growing immersive department which has focussed on interactive exhibitions using Unreal engine thus far. In financing the author’s study, Territory is investing in the studio’s technical skillset around mobile based AR and Unity based projects.

The planned development of CardsAR incorporates 3rd party tools that are active in promoting successful use of their tools. Hand tracking toolset Manomotion promoted community projects on the YouTube channel (Manomotion, 2021). Niantic's AR development toolset: Lightship ARDK, was released at the end of 2021. The company promotes their toolset through their website, social media channels, community game jams and yearly awards (Niantic, 2022). If this project is successful, it could be added to each company's community showcase.

Finally, as the project aims to experiment with new methods of game interaction modelling, the user experience (UX) and user interface (UI) research community will benefit from the final results.

Critical Context

Technology like the Leap Motion controller or a LIDAR equipped smartphone could be used to achieve greater accuracy when reading player movement. However this would be in opposition to one of the primary goals of the project, that CardsAR should be playable by as many users as possible. As a response to the high barrier of entry for VR headsets, this project should have a low barrier of entry which will be supported using readily available consumer grade technology.

Since the project uses technology that has existed since at least 2014 (The Guardian, 2014), there exists already a large community of AR developers who may have attempted a similar project to this. The author has been able to find games and demos that contain some of the features planned for in this project but they have been unable to find an example of the project's planned features used together.

CardsAR game will use the device camera to place a 3d table in the game environment on which the card game will be played. Knightfall AR is a strategy game which similarly places a game map on a flat surface in front of the player. From there the player can point their phone at items on the medieval battlefield to direct attacks. (A&E Television Networks Mobile, 2018)

Unlike Knightfall AR, this project will attempt to use hand recognition to play the game. The Manomotion YouTube channel has dozens of examples of hand recognition apps. Specifically, there is an example of a beer pong game which could have a similar interaction model to the proposed card game. Players of the beer pong game can use a pinching motion to hold a ball and then by moving their hand while pinching they can throw the ball. This pinching motion could be used to move cards to and from the table. If hand tracking proves too unreliable for gameplay, the technology could still be used for non-essential features. The Manomotion SDK has support for skeleton tracking that could be mapped to an in-game hand model that players could use to gesture to one another.

It is desirable that the physical presence of players on the game world is communicated to each other. This could happen through in game avatars or projected video call screens. In-game avatars could be designed similarly to Apple's Animoji system (Apple, 2017), where facial movements are mapped to a 3D character. Unity software have demonstrated how to replicate this behaviour in their engine (Unity, 2017).

In the instance that animated avatars prove too difficult, the front facing camera feed could be projected onto a 2D surface in the game world instead. Currently in development, multiplayer

online game Passage employs a similar technique for player presence. As a desktop video game, the player's computer webcam feed is mapped onto a circular disc which acts as the player avatar (Three Division , 2021).

Methodology and Feasibility

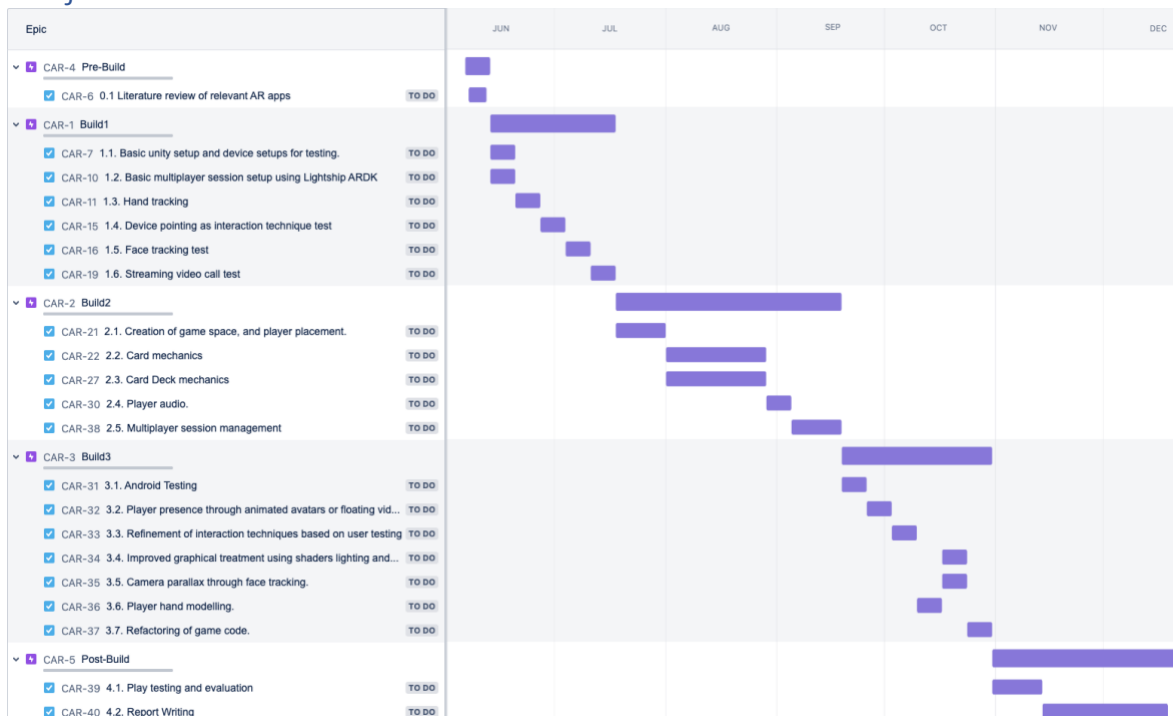
As this project include multiple forms of input with many third party plugins working together, careful planning and testing will be required to ensure that the project goals can be completed within the allotted timeframe. An agile methodology will be followed using Jira software as the project management tool. Each of the stated build goals from the objectives section will be recorded and planned out in a weekly format.

Each feature that uses experimental uses of technology carries a risk of failure. With these features, more reliable back up features will be planned for. At the end of each week, a feasibility check will be undertaken to determine whether a feature should be abandoned or replaced. Regular meetings will also be scheduled with the project supervisor, ensuring the project is meeting its goals within the allotted time period.

Evaluation

After the completion of build three, player tests will be conducted with multiple groups of players. The play sessions will be recorded both in the real world and in game. Qualitative feedback will be gathered from user questionnaires that will aim to measure both how immersive it is and how easy the gameplay mechanics were to use.

Project Plan



Risk Assessment

The following table shows the risk levels and mitigation strategy for each build objective failing.

Objective	Likelihood of failure	Severity of failure	Impact (likelihood * severity)	Mitigation Strategy
0.1 Literature review	1	5	5	Research has already been undertaken to identify the tools needed to complete the project. In addition, a spreadsheet of over 100 games and apps has been created, which will help guide research of similar apps in the marketplace.
1.1 Basic Setup	1	5	5	The author has prior experience with Unity. Online communities for iOS deployment with Unity will be used for any troubleshooting.
1.2 Lightship ARDK Setup	1	5	5	Lightship ARDK has several online tutorials that will be used to set up the initial scene. Niantic forums can also be used for support issues.
1.3 Hand Tracking	4	2	8	Manomotion has several online tutorials that will be used to set up the initial scene. Their forums can also be used for support issues.
1.4 Device pointing	1	5	5	This is a common interaction technique in AR app design. Tutorials for AR game development will be used to implement the interaction technique.
1.5 Face tracking	3	3	9	Unity's in-built face tracking tools and relevant tutorials will be used to test basic functionality.
1.6 Streaming video	1	2	2	The author will use Unity's built-in video player features to enable video feeds. Feature will be kept simple by mappings the call to a static object in the scene.
2.1 Game Space Creation	1	5	5	The gameplay environment will be minimal in build 2 and the Unity asset store will be used for all 3D model assets.
2.2 Card Mechanics	3	5	15	The list of card mechanics will be prioritised ensuring that the mechanics that are essential are developed first, allowing for troubleshooting and improvement
2.3 Deck Mechanics	3	4	12	As with card mechanics, essential deck mechanics will created first. Animations will also only be included if time allows.
2.4 Audio	1	5	5	This will be straightforward audio implementation. Feeds will be unaltered and placed in the game scene with standard 3D audio settings.

2.5 Multiplayer Sessions	2	5	10	Lightship ARDK tutorials will be followed to create multiple session hosting.
3.1 Android Testing	4	2	8	All tools and plugins have been selected for their android and iOS cross compatibility. Testing will also be limited to a Google Pixel devices running the latest android OS.
3.2 Player Presence	4	5	20	How player presence is designed will be based on the amount of time available and the results of testing in build stages 1.5 and 1.6.
3.3 Interaction Refinement	3	4	12	Interaction refinement will be informed by interim testing which will be conducted during and after build 2.
3.4 Graphics	1	1	1	Online book, The Unity Shader Bible (Jettelly, 2022) has already been purchased. Any additional assets used to populate the scene will be purchased from the Unity asset store.
3.5 Camera Parallax	3	1	3	An open source game for camera parallax will be studied in order to develop this feature.
3.6 Hand Modelling	4	2	8	The feasibility of this feature should be decided upon by the end of build 1. The Manomotion community will used to find a rigged and textured hand model compatible with the tracking skeleton.
3.7 Refactoring	1	1	1	Throughout development, the best practices outlined in the software development textbook “Clean Code: A Handbook of Agile Software Craftsmanship” will be followed. This should reduce the need for significant refactoring.
4.1 Play testing	2	5	10	Play testers will be contacted and testing sessions arranged weeks ahead of the window allocated to testing to ensure availability of participants
4.2 Report Writing	2	5	10	Detailed weekly logs will be made throughout development to help aid final report writing.

References

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Ethics Checklist

A.1		
1.1	Does your research require approval from the National Research Ethics Service (NRES)?	NO
1.2	Will you recruit participants who fall under the auspices of the Mental Capacity Act?	NO
1.3	Will you recruit any participants who are currently under the auspices of the Criminal Justice System, for example, but not limited to, people on remand, prisoners and those on probation?	NO
A.2		
2.1	Does your research involve participants who are unable to give informed consent?	NO
2.2	Is there a risk that your research might lead to disclosures from participants concerning their involvement in illegal activities?	NO
2.3	Is there a risk that obscene and or illegal material may need to be accessed for your research study (including online content and other material)?	NO
2.4	Does your project involve participants disclosing information about special category or sensitive subjects? For example, but not limited to: racial or ethnic origin; political opinions; religious beliefs; trade union membership; physical or mental health; sexual life; criminal offences and proceedings	NO
2.5	Does your research involve you travelling to another country outside of the UK, where the Foreign & Commonwealth Office has issued a travel warning that affects the area in which you will study?	NO
2.6	Does your research involve invasive or intrusive procedures?	NO
2.7	Does your research involve animals?	NO
2.8	Does your research involve the administration of drugs, placebos or other substances to study participants?	NO
A.3		
3.1	Does your research involve participants who are under the age of 18?	NO
3.2	Does your research involve adults who are vulnerable because of their social, psychological or medical circumstances (vulnerable adults)?	NO
3.3	Are participants recruited because they are staff or students of City, University of London?	NO
3.4	Does your research involve intentional deception of participants?	NO

3.5	Does your research involve participants taking part without their informed consent?	NO
3.5	Is the risk posed to participants greater than that in normal working life?	NO
3.7	Is the risk posed to you, the researcher(s), greater than that in normal working life?	NO
A.4		
4	Does your project involve human participants or their identifiable personal data? For example, as interviewees, respondents to a survey or participants in testing.	YES
B.2		
2	Will the research be conducted in the participant's home or other non-University location?	YES

B.3 Attachments	YES	NO	Not Applicable
Details on how safety will be assured in any non-University location, including risk assessment if required (see B2)	X		
Details of arrangements to ensure that material and/or private information obtained from or about the participating individuals will remain confidential (see B1.5) Any personal data must be acquired, stored and made accessible in ways that are GDPR compliant.	X		
Full protocol for any workshops or interviews**		X	
Participant information sheet(s)**		X	
Consent form(s)**		X	
Questionnaire(s)** sharing a Qualtrics survey with your supervisor is recommended.		X	
Topic guide(s) for interviews and focus groups**		X	
Permission from external organisations or Head of Department** e.g. for recruitment of participants		X	

Details on how safety will be assured in any non-University location, including risk assessment if required (see B2)

Testing will either be done remotely or supervised in the authors workplace.

Participants will be required to be seated at an empty desk for the duration of testing. During development, the required range of hand and body motions will be identified. This data will inform how much free space each play tester is given at their desk, this information will also be supplied to remote testers, so that they can create a safe play space for themselves.

Details of arrangements to ensure that material and/or private information obtained from or about the participating individuals will remain confidential (see B1.5)

Any personal data must be acquired, stored and made accessible
in ways that are GDPR compliant.

All user feedback forms will be made anonymous and contain no personally identifiable information.

User consent will be sought if the player's voice and face will be recorded for recorded feedback.

If a screenshot included in the report, contains an image of the player, their face will be blurred or obscured to protect their identity. All recorded gameplay footage will be stored on an offline secure drive. Footage that contains identifiable information will either be deleted after the project is completed, or if the footage is shared with the public player faces will be blurred.

All consent forms will be GDPR compliant and users will have the ability to remove their data from play test evaluation at any point.