City, University of London MSc. in Games Technology	
Project Report	
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Project Title	CardsAR, A Social Card Game Set In A Shared Virtual World Using Multi-Modal Smartphone Based Augmented Reality
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Signed:

Sean Feeley

Abstract

This report details the design, build and evaluation process for an augmented reality (AR) iOS multiplayer card game called CardsAR. The game has been developed in the Unity game engine using Lightship ARDK, Agora Voice SDK and PubNub messaging API. Players in the game are placed in a 3D virtual room around a circular table. 3D avatars of each player are used to show where each device is orientated in the game space. Placed in the centre of the table is a deck of cards that can be used to play card games. An audio call is also started for all players so that they can communicate while playing any card game they wish. The original plan for CardsAR included a video call but this could not be completed because of its reliance on third party tools. AR on smartphones is held back by toolsets that are designed for only the most common feature sets in the marketplace.

Keywords

Augmented Reality, Unity, Game Design, Card Game, Multiplayer

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Chapter 1 – Introduction and Objectives

1.1 Introduction

This report covers the design, build and evaluation of an augmented reality (AR) social game in order to fulfil the Individual Project of the MSc in Computer Games Technology at City, University of London. The project was undertaken over six months from late June to early December 2022. The outcome of the project was an iOS game that could run on iPad and iPhone devices running iOS/iPadOS 15 or above. The resulting game was called CardsAR. Difficulty with the Lightship ARDK and the Agora Video SDK led to significant compromises on the original design. These compromises could have been avoided if the scope for CardsAR was reduced. This would have given time for customisations to be made to the third party tools.

The primary design goals of CardsAR were twofold: to create an AR based card game using the Unity game engine and to provide a social space more engaging than a standard video call.

The game has been designed remote play. Each player logs into the game and is placed in a virtual room that, using AR technology, is anchored to their local environment. In this virtual world they can look around and interact with virtual avatars of other players and interact with the deck of cards placed on a table in the centre of the room.

CardsAR has been designed to eschew the common tropes of AR gaming by including video calling and multiplayer design that not tied to shared physical spaces. This raised significant challenges during development. During the development of the game, compromises had to be made because of the limitations of the third-party tools that were used. It is possible for the original design of CardsAR to be achieved but it would require writing multiple libraries which would have extended development time beyond the scope of this project.

1.2 Motivation

The coronavirus pandemic and its related lockdowns in 2020 and 2021, saw a large increase in online gaming as the predominant form of socialising (gamesindustry.biz, 2020). During this time, social video calling was also heavily relied upon (Yuan, 2020). As working from home arrangements have continued post lockdown video call usage has not fallen to its pre-pandemic levels. The design of CardsAR was motivated by the lack of games that use video calling as an integrated part of their gameplay.

Playing cards in their current form have been in use for centuries (The International Playing Cards society, 2007). Their ubiquity in society makes them an ideal foundation to base this AR game around. If the appropriate set of card interactions are correctly modelled, it allows for players to decide their own games and rules. Players can also drop in and out without breaking any code-defined gameplay rules.

After the first waves of the pandemic, businesses like Meta started to invest heavily in virtual reality devices as a way for users to socialise remotely (Meta, 2021). During a company rebranding video Mark Zuckerberg explained that he saw smartphones as a part of the old

internet and virtual reality headsets as the new primary internet device of the future (Meta, 2021). VR headsets currently have a high cost of entry, both socially and financially. By comparison, far more people have smartphones that are capable of augmented reality (bankmycell.com, 2022). This project is therefore an examination of smartphone technology and its ability to provide immersive virtual reality experiences without the use of a headset.

1.3 Research Questions

The design of CardsAR aims to answer the following research questions:

1. Is it possible to build a tabletop card game using smartphone AR tools?
2. What limitations are there to user interface design when creating an AR virtual world game?
3. To what extent can smartphone AR technology be used to allow players to socially interact in a virtual world?
4. Is this method of socialising online enjoyable to casual game players?

1.4 Original Work Plan

In order to sufficiently respond to these research questions, the development phase of CardsAR was split into three builds.

Build 1 was a research build, where third party tools were investigated, and proof of concept tests were made. The code written in Build 1 was not used in the subsequent Builds 2 and 3.

Build 2 was focussed on designing the core playing card gameplay and player networking.

Build 3 was reserved for refining the look and feel of the game and integrating a video call component to the game.

A detailed list of the work plan is listed below:

1. Build 1 (June 15th – July 30th):
    1.1. Basic unity setup and devices setup 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 using Manomotion
        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 (August 1st – Sept 30th):
    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
    2.6. Refactoring of game code.
3. Build 3 (October 1st – October 31st):
    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.

1.5 Work Plan Changes

Midway through Build 2, two significant issues were encountered that resulted in an alteration to the plans for Build 3. Originally Lightship ARDK was intended to be used for the multiplayer netcode, however the multiplayer sessions in ARDK are limited to players in the same physical space. Since CardsAR is designed to be played remotely an alternative design was used for multiplayer netcode. This is detailed in section 4.1.3.2.
During Build 2 it was also discovered that video calling disabled the AR camera. Therefore, the video call feature had to be reduced to an audio only call.

1.6 Beneficiaries

CardsAR is an experiment in game design that is attempting to use AR technology in new ways. The final product is a valuable proof of concept that will be useful for other AR developers in the game development community. The user experience (UX) and user interface (UI) research community will benefit from the final results as the uses of AR technology extend beyond game development.

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, the experience of designing and utilising multiple technologies has not only broadened the authors skillset, but is also an important step forward in the author's career development as further experience with Unity and augmented reality plugins and packages allows the author to specialise in augmented reality development post-graduation.

1.7 Outcome

The outcome of this project is a build of CardsAR that can be distributed to volunteer testers via Apples Test Flight service. Test Flight allows for builds to be shared through the App store without requiring the normal authentication and evaluation checks that a complete Apple App Store submission requires (Apple, 2022).

Players have also submitted their CardsAR feedback through a Google forms questionnaire. The feedback was collected and anonymised before inclusion into the evaluation section of this report.