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- ARCPG - augmented reality collaborative playground

ARCPG

Contents

1. Vision

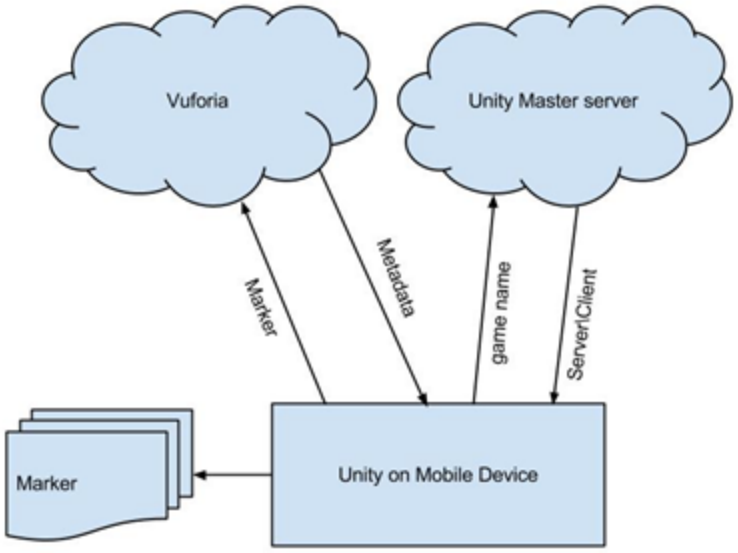
Today, there are a lot of companies that offers the ability to develop augmented reality multi platform applications based on marker recognition in fast and easy way.
However, none of these companies gives the same possibility in developing collaborative augmented reality applications.
My goal is to create a plugin for unity that will provide a way to make collaborative augmented reality applications, meaning, each marker will represent a shared augmented reality virtual world.
The marker will be submitted on the vuforia marker server that will give the ability to share these markers over the internet with everybody.
A simple usage for this package can be a multiplayer AR game that will start when people will point their device on the marker, and will end when they stop pointing.

2. Agenda

2.1. ARCPG Package

Connecting to a collaborative augmented reality playground based on a marker from vuforia server.

Each Marker represents Game in Unity master server.
First user will be the server
Everybody else will share the same augmented playground with the server.
Everyone can manipulate the objects on the playground by using unity's network.



This part is also divided by two because of a UNITY license issue, Therefore I'll give two solution for the ARCPG plugin.
One for the UNITY FREE version and one for the UNITY PRO. Hopefully someday Technion will get the PRO version and future student will have the ability to work on the PRO version.

Another issue i had with the ARCPG package is the multiple users looking on the same picture at the same time but located far away from each other,
what i chose to do is nothing, the game responsible to divide the players by servers i.e. each game have to print many Markers or implement a GUI for choosing the wanted server.
because there may be many clients connected at ones, there may be a lot of hosts that the Master Server have to return to each client therfore the master server should return only the nearest hosts by geoIP (http://freegeoip.net/json/87.69.129.84 for example) to the client. And then in the client device can arrange the hosts by more accurate GPS location service.
The Master Server is an open source code written in C++, so for better performance and for supporting of many games we should rebuild the master server with the new capabilities (Geo location and GPS).

2.1.1. Unity PRO (AssetBundle)

include the full ARCPG methodology, the ARCPG is a separate application that provide an easy way of developing augmented reality collaborative playgrounds. The developer should provide the game as an “AssetBundle” (unity pro only) in a FTP server, a marker and a metadata file that will contain the URL of the AssetBundle to download.
The plugin, on marker detect, will download the correct game and play it.
This part is will not be submitted as a part of this project because there is no Unity3D pro version in the Technion and because of a one major Bug (feature) in unity:

- Unity is dynamically allocated ID for NetworkView’s randomlally, so when 2 or more players are trying to play the same game the ID’s could be different therefore all the data will be confused between different gameObject’s. therefore there should be some master NetworkView that synchronize all NetworkViewID’s of all games.
  it is a problem to have one server for the ARCPG package because there is no predefined server for the ARCPG and everybody can be a server or a client depending on the timing.
- The solution should be as follows:
  - Create one Network view statically
  - When creating dynamically NetworkView sync it thru the Main static NetworkView.

2.1.2. Unity FREE (Static games)

in the free version there is no support for AssetBundle so all the games have to be compiled with the ARCPG package, therefore it is very narrow solution (ill provide only 2 games as a demo , one full and one only for demonstrating that I can load 2 different games). In the future both games can be used as a template for creation of more games for this platform.

2.1.3. App description

The app is a framework for designing AR games and applications, using Qualcomm's Vuforia.
It is based on the idea that a picture is the gateway to a common augmented reality world.
Hence, if two (or more) people look at the same picture, they will all collaborate in the same AR space.
As a proof of concept we provide two games: Snooker and Tanks.
Note that there is no AI, the assumption is that the players play against each other.

Think of it as your travel size collection of board games, tucked away in your cell-phone.

To play, aim the camera at one of the pictures that are provided with the app, get a friend, and have fun!

2.1.4. Code review

The ARCPG package is an extension for the Vuforia Plugin.

- **ARCPGManager.cs** – this is the main ARCPG script that handles all the information and events from Vuforia plugin. Should be under "Cloud Recognition" GameObject supplied by Vuforia plugin.
- **ARCPGTrackableEventHandler.cs** – ARCPGTrackableEventHandler is implementing ITrackableEventHandler interface supplied by Vuforia that responsible for all the event's regarding some specific marker (representing a game).
  This script in the ARCPG package is turning games on and off according to the marker.

2.2. Demo

This part will contain 2 games built on the ARCPG package and concept and one movie player.

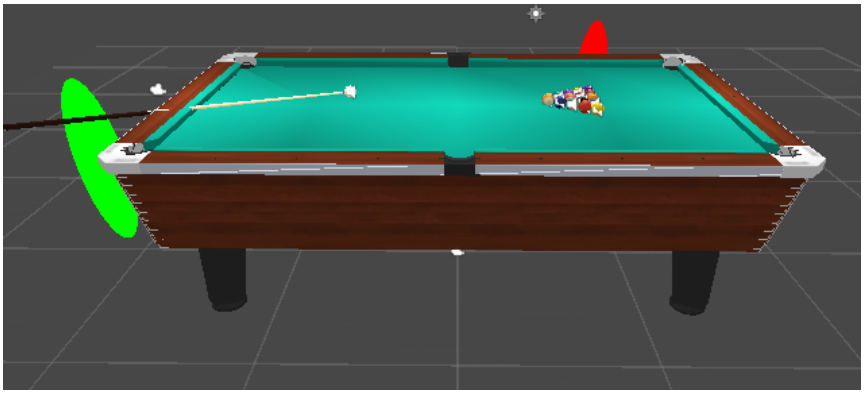
2.2.1. ARPool game

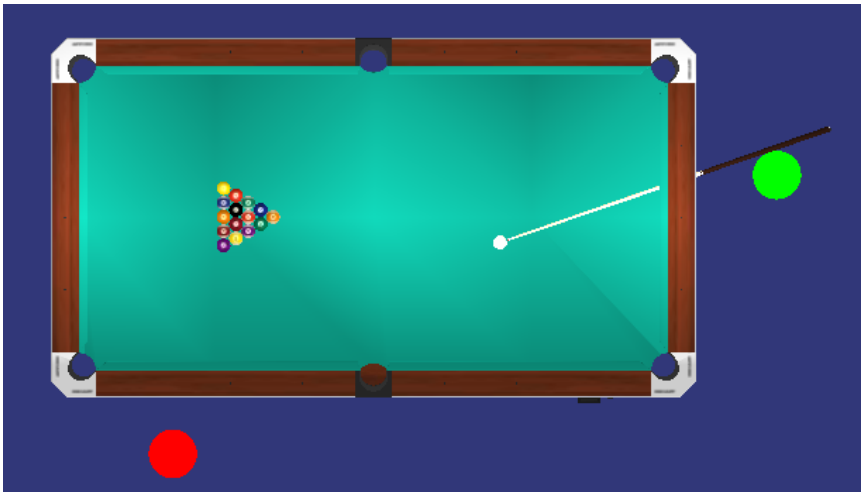
This game is the main game of this project. This game is a multiplayer AR pool game.

2.2.1.1. Rules

- First player who looks on the Marker will be the Server
- All other devices will be players
- If server will disconnect for some reason then first device will be the server and all other will reconnect to the new server.
- The camera dictates the position of the cue, the cue will always point on the white ball from the perspective of the camera.
- If a ball is go thru a hole or is thrown away from the table then this ball

will be excluded from the table and will be shown on top of the screen.

- When player trying to hit a ball the player should touch the screen.
    - The time of the touch is indicating the hit strength
    - the strength could be seen in two ways:
        - The cue will go backwards, the more power there is the more backwards the cue will go.
        - A strength bar on top of the screen.
- There is no rools for the billiard game because this is just a playground for all and not a game.
- There is no whiners.
- If the black ball is thrown of the table all the game will be restarted.
- for each player there is an indicator around the table.
    - A green indicator for your position
    - A red indicator for oponents.
- In computer mode:
    - press ‘C’ button for inspector camera view. this camera shows the table from above, and all players could be seen around the table.
    - 

- 

2.2.1.1. Known issues

- The cue is not very stable, I have added a low pass filter for the cue, but still there is some unsettledness that can be fixed with more time and filter adjustments.
- Physics is not the best for the pool game – need more time to fine the perfect physics for the balls.


Player ping values

2.2.2. ARTank game

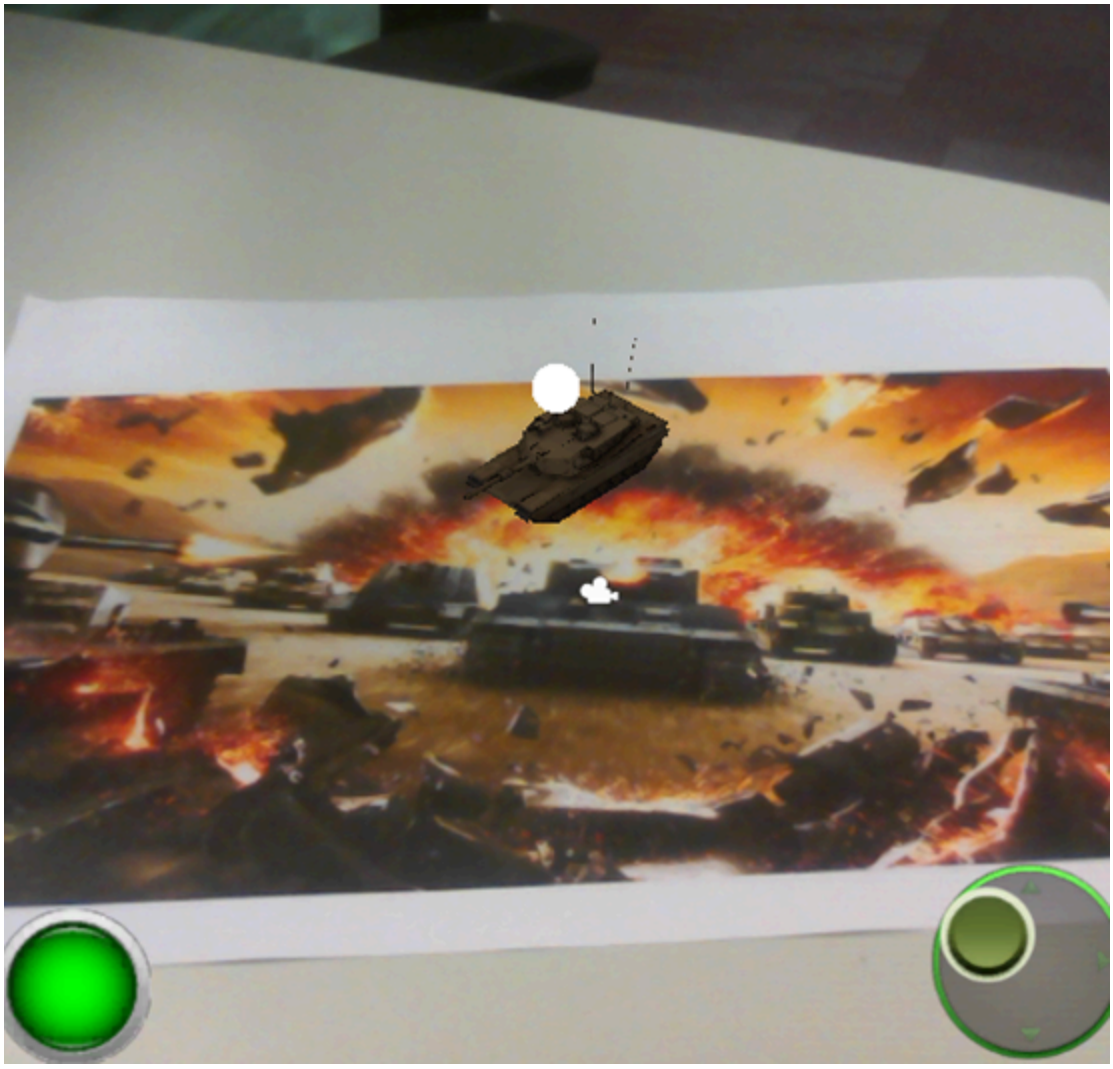
This game is a small presentation of the ARCPG capabilities.

2.2.2.1. Rules

- The first player who looks on the Tank marker will be the server
- All other Devices will be player's.
- push right button corner of the screen for the joystick to show.
- push left bottom corner button for shooting.
- This is a small demo therefore is no winners. this game demonstrates multiplayer capabilities.

2.2.2.2. Known issues

- Gameplay is not the best.
- The Joystick control should be more NUI.



2.2.3. ARMoviePlayer

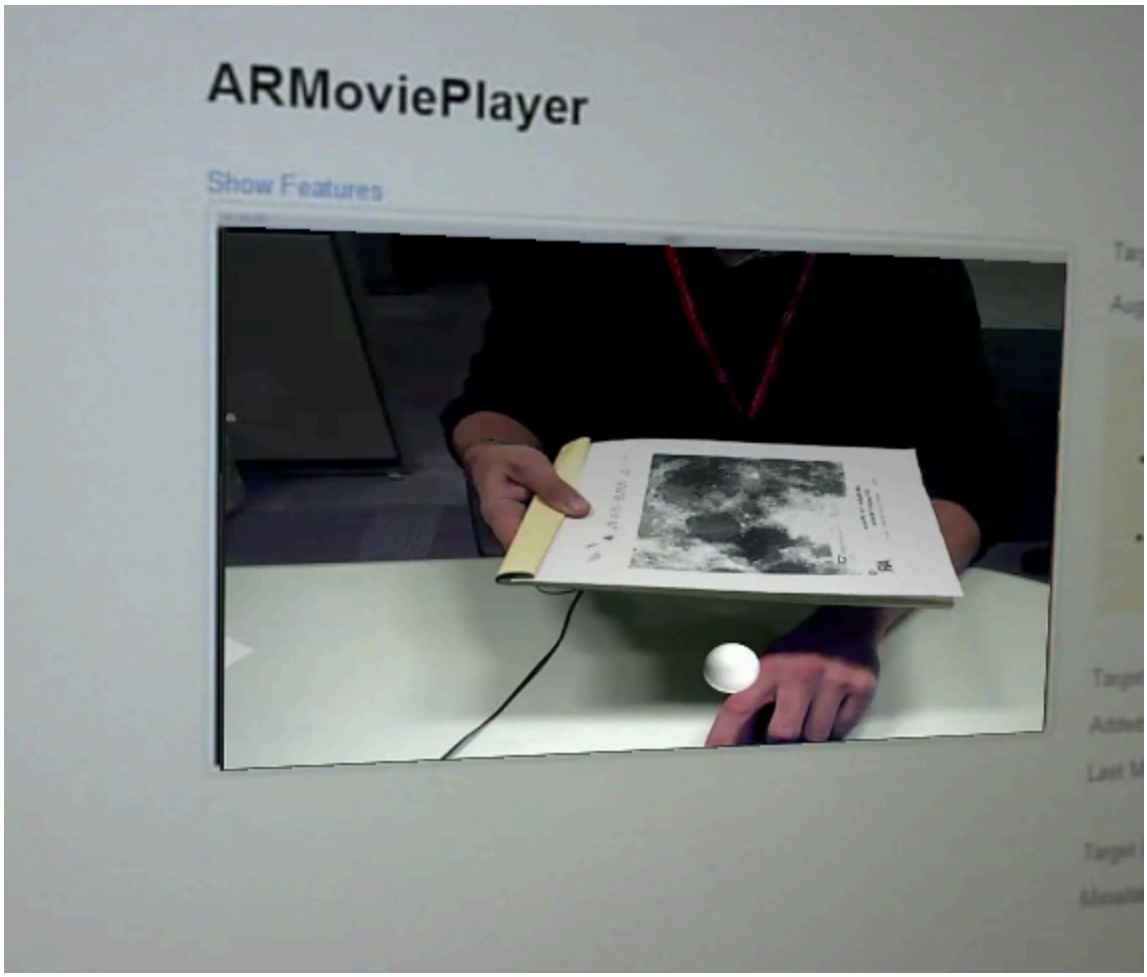
This player is a small presentation of the ARCPG capabilities.

2.2.3.1. Rules

- Push the screen to Play\Pause the movie
-

2.2.3.2. Notes

- **Not supported on IOS and Android devices:** http://docs.unity3d.com/Documentation/Manual/VideoFiles.html
- Can't play online movies from youtube. (there is a package that play youtube movies online for IOS only)
- change aspect ratio of the movie according to the movie.



2.2.4. ARPool Stand alone game (1 point)

this part was added for another 1 point.

 link to google play store

the ARPool game is based on the ARCPG's pool version but now it's a stand alone version.
this version is using the Vuforia's static marker tracking.
i have added some new features to this game for the worth of one academic point.

2.2.4.1. Watcher mode

- The client now can connect as a "Watcher" to the game which will have no effect on the game play. this mode can be useful for playing in public places like Pubs and so on.
    - The watcher is looking on the game from a camera located above the pool table at a fixed distance.
    - When a ball goes thru a hole, a replay of the last hit will take over. (the replay mode will be discussed further)
    - The Watcher can see the real position of all players around the table by looking on the colored capsules (each player have a different color). each capsule representing a player.
    - The watcher doesn't have to point the device on the marker, so if the user is connected as a watcher to the game he will always see the table. this feature allowing any one at any time be a watcher.
    - 

- **Camera movement:**

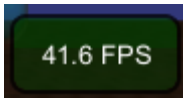
- The “above” camera ,in Watcher mode, is moving in the x,z plane, parallel to the table, according the white ball (will always look at the white ball). this camera easing after the white ball so the camera will not make any fast movements.
- In Replay mode the “above” camera is easing (the y axis) towards the hit and then easing back to the start height. this is done by interpolating the y (Height) points in time in non linear way so it will look more smoothed.

- **Replay hit:**
  - wrote infrastructure for replay any game Objects in unity game. the infrastructure is writing to memory the transforms of the chosen game objects in each frame at 50 fps **not** depending on the game play fps which can vary from 3 to 60 fps, this was done by interpolating the transform of the game objects in time.
    - this is done by writing the transforms to the memory and then adding the missing frames by interpolating the transform array.
  - when replaying the infrastructure is reading the data from memory and simulate the movement on new created dummy game objects, when the real objects are not rendered to the cameras.
  - **Issues i had:**
    - the data is taken at about 50 fps, but this number is depending on many variables so it actually may move from 3 to x fps where x is the max fps supported by the GPU of the hardware.
    - so when writing the data to memory at some fps, and Replaying with another strange behavior may occur.it can seem like slow motion or speed up. so i added an interpolation of all the transforms via time so the movement of the game object will be at the same playing speed and not depend on the hardware.

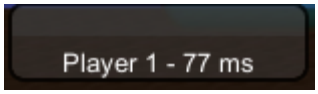
2.2.4.1. Game infrastructure

- **Added “direct the device to Marker” image at start.**
  - each time the player doesn't point to the marker the screen will direction will appear on the screen.
  - this screen has no effect if the player is in watcher mode.
- added “Aim” camera that located on the top of the Cue. in windows platform you can press right mouse button for the screen to pop out.
  - this feature is not working on Android and Iphone due to the lack of support in Target texture.

POINT DEVICE ON:

-
  - the image is 50% transparent so it doesn't hide the device camera on the screen.
- **added new APK for a stand alone ARPool game.**
  - the new icon of the ARPool game. 
  - this game have the same rules.
  - the game is starting with the start of the application (mean that you do not need to point the device for the game to load) so when the application is being started the "connect to or as server" is shown.
  - the game is using Vuforia static marker load and not the cloud recognition, so the recognition is done much faster.
- DEBUG:
  - added FPS window on the right of the screen. 

 the window will turn red a for low FPS (< 30) and more green for high FPS (> 30)

- added average Ping window for each player. 

- **added NAT Punch-Through** service which allowing player to connect via double NAT (2 local networks which connected to the internet via local ip)
    - You can find more interesting explanation on Nat punchthrough HERE.
    - One bug in unity regarding the Nat punchthrough is that unity doesn't consider not connecting as a bug. more information on this issue can found HERE.
    - The Nat punchthrough is needed only in the old ipv4 protocol and not in the new ipv6, therefore in the future versions i would use ipv6, by using Photon's network and not the built in Unity's network.
    - supported NAT

Success Graph

Router Type	*Full cone NAT*	*Address-Restricted cone NAT*	*Port-Restricted cone NAT*	*Symmetric NAT*
Full cone NAT	YES	YES	YES	YES
Address-Restricted cone NAT	YES	YES	YES	YES
Port-Restricted cone NAT	YES	YES	YES	NO
Symmetric NAT	YES	YES	NO	NO

2.2.4.2. Unity3d project infrastructure

- The Unity project now contains two different scenes, ARCPG and ARPOOL.
    - for ARPool open ARPool scene
    - for ARCPG open ARCPG scene

2.2.4.3. Issues i learned after doing this project.

- Marker issue: for playing this game you have to have a marker which is a big issue for people. people want a simple game that they can download from the store and play instantly, but for this game they have to print a marker to play. this issue making this game less accessible for the public.
- The marker technologie is still in development, therefore there are many issues with stability of the position, and the time of the recognition of the marker.
- the unity's network package have many bugs, the most common network package for Unity is Photon.
- Another issue with this project's network is that any phone can act as a Server which have some
    - pros:
        - you do not need an internet connection to play on local network.
        - you do not need to maintain a one huge server for the game which can

be much cheaper.
    - And some cons:
        - if the phone acting like a server is an old and slow phone all the game will be slow.
        - there is no information about the players written anywhere.
    - so the choice is hard. but i would prefer to build a one server for the game that can contain all the data about all the games, and about all the players.
- if the server is slow there are some solutions:
    - instead of using unity's networkView built in transform sync, use RPC's (remote procedure call) for syncing the movement of the balls.
    - for best performance syncing the velocity of each ball and interpolating the error of the position few time a sec.
-

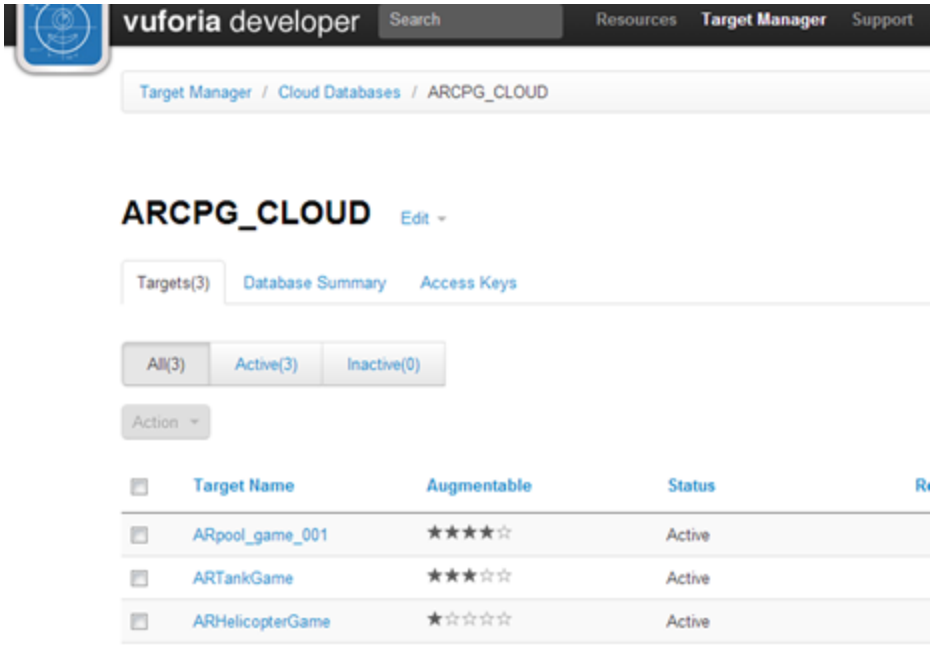
3. Tutorial - build basic game in ARCPG

3.1. Needed

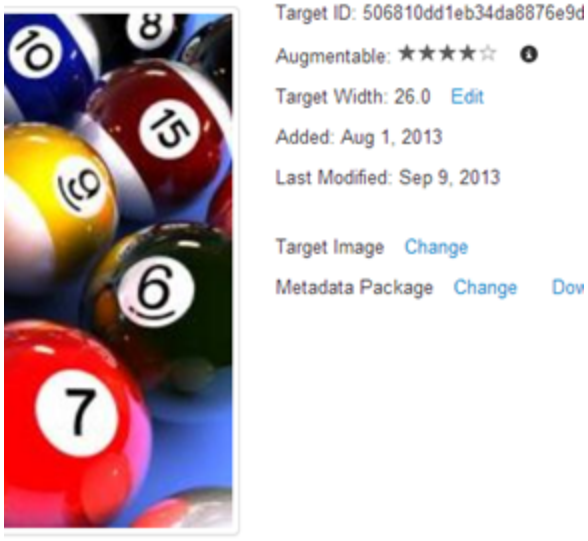
- Unity3D (best if PRO but should work with free version to) - http://unity3d.com/
- ARCPG basic project.
- Vuforia plugin for unity3D - https://developer.vuforia.com/resources/sdk/unity
- Marker – upload a marker to the Vuforia "Target manager" to the "cloud databases" https://developer.vuforia.com/
- Metadata file (JSON) – a JSON file represent your game
- Unity3D GAME – the game.

3.2. basic game

- upload a marker to the Vuforia "Target manager" to the "cloud databases"



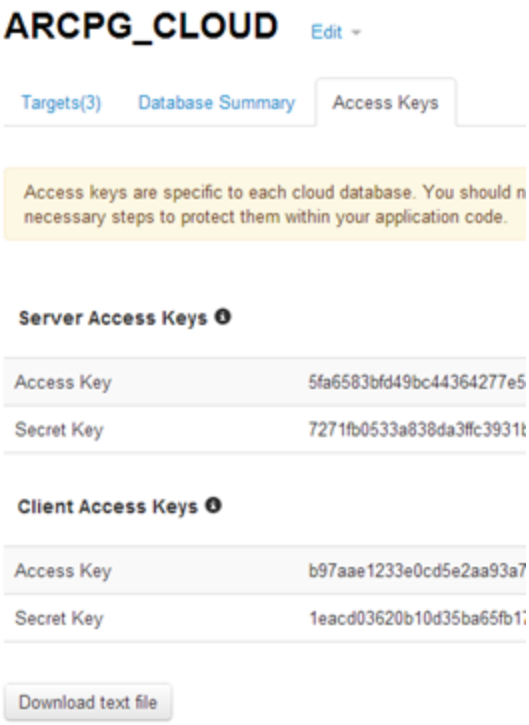
- add the JSON metadata file to the marker



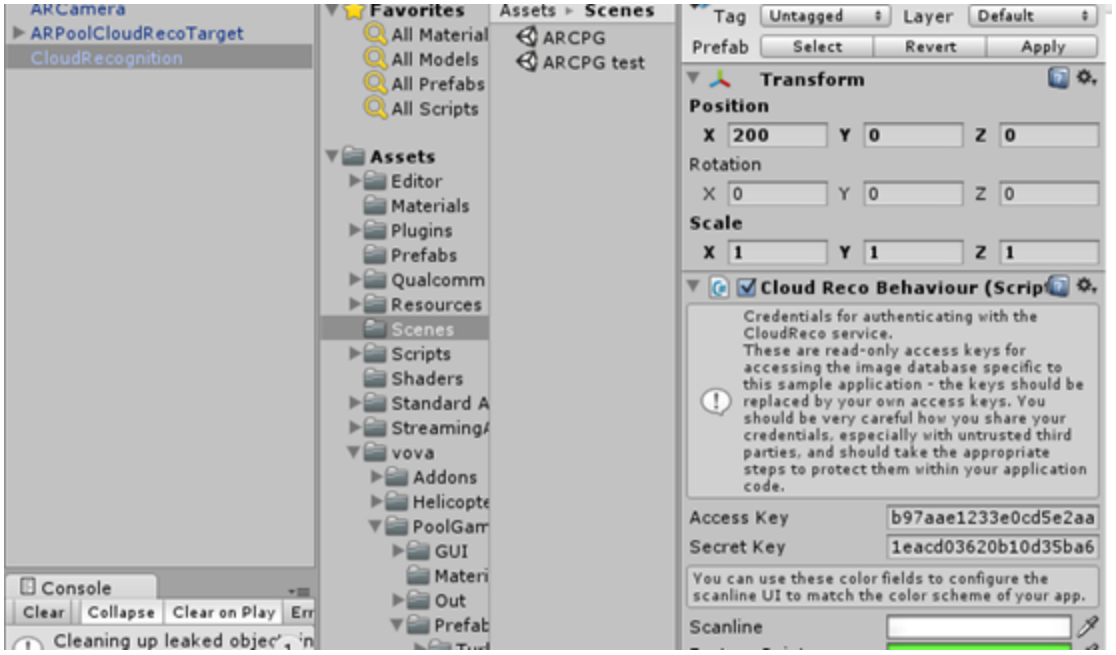
- The JSON metadata file should look like this:
    - JSON sample:{
    - "GameName": "ARPoolGame",
    - "masterServerGameTypeName" : "ARCPG_PoolGame",
    - "masterServerGameName" : "ARPoolGame1",
    - "masterServerGamecomment" : "First ARCPG GAME",
    - "numberOfConnections" : 100,

- "Description": "an Augmented reality Pool game :)",
- "AsetBundle": {
- "Version": "0" ,
- "URL": "file://c:/ARPool.unity3d" ,
- "Name": "ARPoolGame"
- }
- }

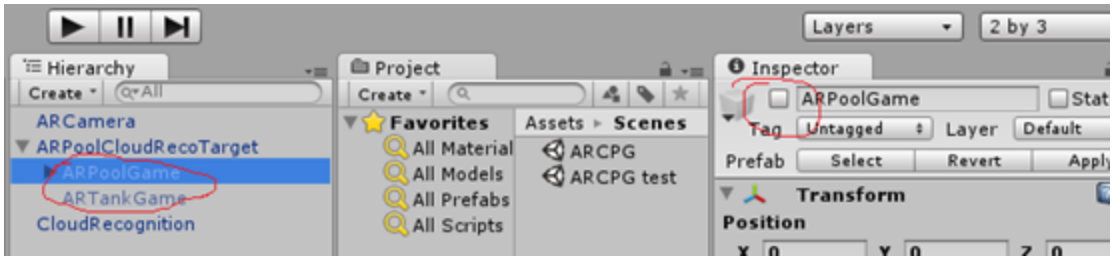
- remember the Access Keys of the Cloud database for the unity project



- Place your Access Keys in the unity project to the “CloudRecognition” GameObject



- Place your game as a GameObject under ARPoolCloudRecoTarget and uncheck it in the Inspector



- Now if you run the ARCPG application and you look on your marker your game should be visible.

4. Future

- Change ARCPG package application to use assetBundle for dynamic game loading from web server.
    - For this part need to solve the dynamic allocation of NetworkViewID issue described in part 2.1.1
- Add slam capabilities for better tracking.

- Use new SDK of vuforia for 3D marker recognition.

5. Demo

5.1. Flow

1	start application on several Android devices	
2	one of the devices looks on the ARPool marker (one of them)	
2	one more Devise is pointed on the same Marker	
3	Play with ARPool game	
4	show the capabilities	each device can look not on the marker and then again on the marker and see the same game
5		looking on deferrent markers will cause different game
6	one of the devices looks on theARTank marker (one of them)	
7	one more Devise is pointed on the same Marker	
8	Play with ARTank game	
9	show the capabilities	each device can look not on the marker and then again on the marker and see the same game
10		looking on deferrent markers will cause different game
11		
12	explain the posibilities of the ARCPG Package	

6. Links

Git: https://github.com/vovacooper/ARCPG
Git Web page: http://vovacooper.github.io/ARCPG/
Vuforia: https://www.vuforia.com/
Google group: https://groups.google.com/forum/#!forum/arcpg

7. Markers


http://humanoffamily.deviantart.com/


2:16
WATCH YOUR
MOVIES
MEDIA
STREAM
BROWSE
ALL VIDEOS
SETTINGS
XBMC
XBOX-SCENE NEWS: XBMC FOR XBOX 2008-08-12 SVN REV14853 'ATLANTIS' ALPHA3 BUILD - T3CH - XBO