

Game Development with Unity Engine and Google Firebase

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Abstract - Developing a game is a complex process, full of steps in which different team members contribute to the final product in order to be appreciated by the public. To control the steps and maintain everything guided towards the same objective throughout the entire development there are several Tools and Frameworks that help in the organization during the creation flow of games. The aim of this paper is to contribute an easier way to design and implement a fully fleshed working game using the latest technologies and showing that a complicated process such as game development could be done in a much better and efficient way possible, this paper will evaluate process with using Unity and some of the external software with Google Firebase to show how the whole software could be development with some efforts in the right direction.

Key Words: SuperTiled2Unity, Google Firebase, Tiled Map Editor, Unity Engine, Game Development, C# Programming.

1.INTRODUCTION

Game Development has been a major break in the Software Development, where there are not many Software developers who actually choose Game Development as their main path to build their career there are only 2% of actual software developers who choose this path. But there's other side of coin as well where there are not as much game developers but according to Newzoo there are over 2.69 Billion users of Gaming Software widely known as Games.

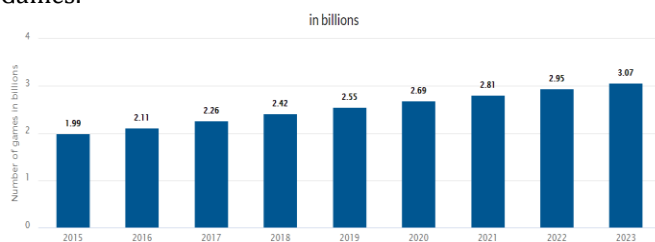


Figure-1-: Bar Graph Showing the population of game software users all over world in amount of billions

It's been a long time since people are enjoying and playing electronic games and companies have been working on various kind of games with multiple teams a single game could take relevantly 2-5 years to build depending upon the team and game complexity. Majorly, game development is divided into few sub-streams

1. Main Development: - Which could be divided into further subparts such as, Content Development, Connection Development between server and client, Story Development, Level Development, NPCs Development, Character Development and much more as required for the game
2. Graphic Designing: - Which involves all kind of graphics you see such as UI/UX Designing, Characters, Level Designing, Animations and much more
3. Audio Implementation: - Audio is usually designed by computer or sung by live instruments but there are multiple open sources where you can get Audios and Sound effects for free.

And there are multiple platforms these games can be played on, there was a time when games could be only played on either their supporting consoles or a Personal Computer, now days these games can be played on multiple platforms and each platform have their own community and each platform has their own sales. From 2014 onwards Mobile gaming has been growing really fast and have revolutionized the whole industry for gaming where there was the only few gaming communities which were growing as mentioned above mobile gaming have established its own spot in gaming, According to Newzoo statics says there's been a really big hype in development side for mobile gaming where the mobile gaming have not beaten the PC but it has beaten one of the most outstanding industries in consoles.

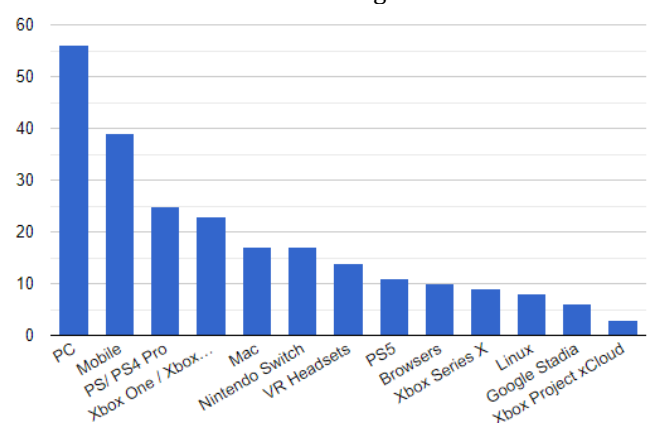


Figure-1-: Bar Graph Showing the most popular platform for game development among the developers

There's been multiple researches on games, how efforts can be reduced on game development this paper is another contribution in that field. With the current technologies its

much easier develop a game this thesis covers few really good examples to implement effortless game development.

2. LITRATURE SURVEY

There's been multiple researches on games, how efforts can be reduced on game development this paper is another contribution in that field. With the current technologies its much easier develop a game this thesis covers few really good shorts to implement effortless game development.

[1] have shown a great example of unity 3d game development they have shown how vectors and 3d lights work and how you can use various features like unity's own dependency injection how you can find a file anywhere you want easily. [2] This study shows how firebase real-time database can compete with the real DBs like MySQL and NoSQL Firebase which uses and how they easily can be implemented. And how they are implemented using JSON and multiple formats to use firestore and firebase according to user needs.[3]Real-time Communication Application Based on Android Using Google Firebase April 2018 have shown a great communication between android application and client they have used the firebase for chat communication how a simple message transfer could be used with Google Real-time Database and how many Users are using the application which is really an great example of using these.[4] Explained how we can implement User Interface easily with unity and how it is so easy to design and implement levels, they have shown that how with some simple scripting and work we can implement the whole game with some efforts.[5] This Study has shown exactly what I am doing for my project using lowest efforts possible on game development, they have used real-time database and unity integration for the development which was a really good implementation.[6] They have shown a really good use of firebase with their application they have implemented the firebase authentication and password reset user management etc. They have shown a really good use of firebase storage for the user data which helped me to realization of using Firebase Auth with Google Sign-In in Unity Engine. Where this study does not involve google sign in exactly, they have used firebase auth implementation where in this project I have used Firebase Auth with Google Sign in library.[7] 2D Game Development using unity by Dave Calabrese has been a great help their explanation of using Triggers and collisions been really helpful for understanding how they can be used and how and 2D game could be developed step by step properly, they also have some great examples on Physics2d Ray-Cast which I have used in detecting empty area between two points of map horizontally I'll be explaining about this further in upcoming sections. This book not just helped me in understanding basics of unity but also how a 2D game should be developed and what program patterns can be used to easier the work used in this project. [8] Google Firebase Documentation helped me to understand needs and working of the official firebase structure google firebase where it is to use but it's very complicated to understand at first once you have a

understanding of whole structure you can do anything in this documentation I have used and studied the official programming patterns and queries which helped me to structure the whole backend of this project in google firebase I have used multiple services such as Firestore, Google Analytics, Google Cloud Functions and last not least Firebase Authentication. These services helped me to structure the whole backend serverless and almost fulfilled every requirement needed for client to work as a proper game.[9] Thesis on unity game development been a really good help since it shows how the whole unity actually works and how both 2d and 3d systems are implemented in it where they start from why you should work with unity to its development, testing tools and publishing. This thesis also suggests using Unity Tile System which I did not use directly, Unity tile system is really advance system which let's you script your tiles and use it according to your needs but, the original system is really complicated to use this study made me realize how can I use the Tiled Map Editor with SuperTiled2Unity plugin for unity which helped me by a lot it cuts down your efforts divided by ten. I will explain more about the tiled map editor in upcoming section. [10] This is the most recent study I found on unity which helped me a lot since I am using the most latest technologies for project, and this project is in the same field as I am contributing in they are trying make game development easier for more people as possible they gave a really good attempt on developing a non-coding interface for game development using unity which was really interesting. Their aim shows that you don't need to write a single line of code for development in exchange of few dynamic abilities but you can develop a fully fleshed game using their studies without even writing a single line of code. They used direct script templates to implement a whole structure of code into a single click where a few values are taken as inputs and they are directly implemented game with few single clicks. I was inspired by this study for this project.[11] Google Sign-In auth this documentation gives a few example and source to implement Google Sign-in in this project where I take the whole data by accessing the data from the google and implement it in the game directly.[12] This official documentation helps to use and simulate the Tiled Maps or game levels into unity directly by importing them like an asset this documentation helped me to understand the internal working of plugin and helped me to write some code for custom importers, ill be explaining about custom importers.

3. REQUIREMENT ANALYSIS

3.1 Unity3D Engine

Unity is the real time game development platform, this is one of the most advanced tools out there for game development along with Unreal Engine, Cryo Engine and others. The Specialty about unity is, it is a cluster development engine it can develop a really advance game alone without having need of any external requirement. Unity is a cross platform game development engine which is developed by Unity Technologies it was first introduced to work in June 2005 at Apple’s worldwide developer conference. In 2018 the unity started supporting more than 25 platforms. The engine can be use=d for creating 2d and 3d games with VR and AR support, as well as simulations and multiple other experiences. The engine has been adopted by multiple industries not just video games but as film studios, automotive, architecture, construction and engineering.

3.2 Tiled Map Editor

Tiled map editor is a classic level editing tool been in development since 1st sept 2009 its been in level designing industries from a long time where it is public funded project it’s been a popular project among game developers from a long time, because of its handy drag and drop design its possible for it to make Orthogonal, Isometric, Staggered, and Hexagonal very easily and efficiently. Types of maps it is a 2d map editor which makes it ideal map editor for this project.

3.3 Super Tiled2Unity

SuperTiled2Unity is a library for communication between Tiled and Unity it is a library which is written in C# code so It could translate Tiled’s TMX & TSX files which are basically XMLs to unity’s Tile Map Integrity which gives you a dynamic interface for your levels and lets you dynamically bend the rules of the maps according to your needs.

3.3 C# Programming Language

C# Programming language was developed by Microsoft in 2000 for as a part of its .NET initiative and after that it was approved as an International Standard by ECMA-334 in 2002 and also ISO/IEC 23270 in period of 2003. It is Multi-Paradigm programming language encompassing static typing. Unity uses C# as it’s operating language in a scripting style where it can be operated/used/tweaked or developed by it.

3.4 Google Firebase

Firebase is a platform developed by google for development of Mobile and web app, firebase majorly focuses on Serverless app development where it provides multiple services such as:

- Google Auth
- Realtime Database
- Firestore Database
- Google Analytics
- Crashanalytics
- Cloud Messaging
- Cloud Storage
- Google Cloud Functions

And many more services to make your work efficient and as serverless as possible even though some of the services are paid but google provides enough services for a small efficient project.

3.4 Google Sign-In API

It is a Google Sign-In API Plugin for Unity Engine which supports Android and iOS this plugin gives an exposure to Google Sign-In API inside unity. This plugin is specifically developed for unity which requires OAuth ID tokens or server auth codes. This project uses google sign in for the authentication and this plugin developed by Google makes it possible.

4. PROPOSED METHODOLOGY

The proposed system to save the most efforts possible focuses on least game designing and most auto-generating levels. Basically, there are 3 levels in this game’s architecture where the first one focuses on resource development in this project ill be going with hyper-casual game methodology where the game doesn’t require any story but some random generating maps and hurdles to generate a whole new experience on each and every attempt,

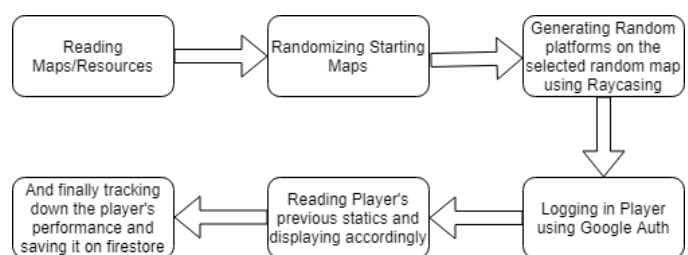


Figure-3: Workflow of the proposed system

The Figure-3 shows the base work flow of the external structure how game is created and loaded.

Approach

The idea is to develop a game with using total auto-generated maps and levels and most of the things possible without having a need of any level designer/game designer there are few criteria to be fulfilled which are as follows:

1. Reading the all maps as game object and saving them for further usage.
2. Loading the map into the game scene and casting a ray on every tile size to check if a tile exists on the position in this case it is 128x128.
3. Getting the empty positions.
4. Generating platforms on empty positions by using an array of sprites which are loaded in the first criteria.
5. And generate next map position it at exactly below the current map so it creates an illusion of forever running platformer.
6. Generate enemies on the randomized rate as well on every platform.
7. And destroy previous map sequentially on every map's exit.

4.1 Game Resource Loader

Game resource loader or game asset loader is an separate script which loads whole game assets on game startup and gives all the resources I need accordingly. Unity have its own resource folder manager which loads all the resources from the resource folder all I need to give an URI and it directly loads the resources its an external part to improve the overall performance of the game and so it doesn't load the resources in-between gameplay.

4.2 Game Map Manager

Game Map Manager works on a algorithm with a collaboration of unity Game Object Triggers.

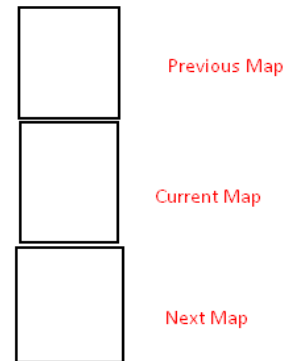


Figure-4: Game Map Manager Structure

Game Map Manager tracks every map's edges when player exits previous map current next map is set to current map and current map is set to previous map so it creates a cycle of forever running maps sequentially, and on every exit from current map the previous is destroyed to save the object memory.

4.3 Game Platform generator

Game platform generator works with Unity's Physics Ray Cast and random numbers, Unity's physics ray cast casts a ray on every single tile of the map then it gives a output if a ray hits the map object if it doesn't hits the object the X,Y points of the position of that ray cast adds to a list lets call it $K = \{p^1, p^2, p^3, \dots, p^n\}$ where k is a list which contains points p of every empty tile per row.

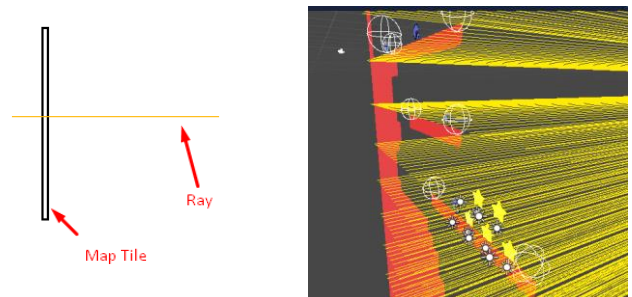


Figure-5: Tracking of empty spaces by Physics Ray Casting on Game map

Once we have the whole generated list of the empty spaces in map we generate the platforms row wise and according to empty space I decide how long should the platform be, algorithm generates a platform size from p^1 size to p^{n-2} totally randomized size it could select any number in between negative 2 because so it doesn't the cover the whole path. So, each tile size of 128x128 generates the platform with p^1 and p^n being the edges of platform. Now, with the edges I put 2 game object points for Enemy Patrolling and I generate the enemy in center of the platform by Platform Width/2 position and that's the work of platform generation.

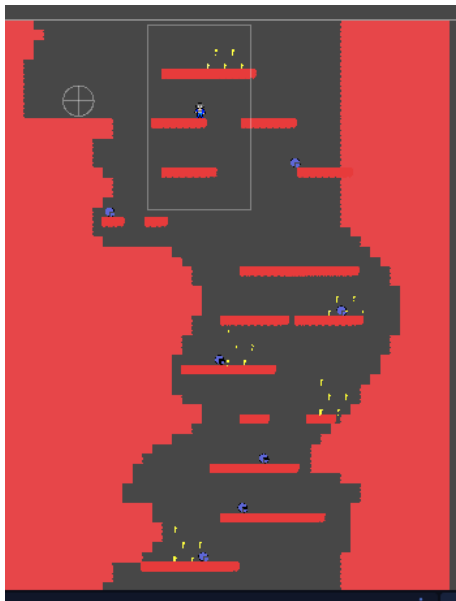


Figure-6: Auto generated platforms according to empty spaces

4.4 Firebase Initializer

The Firebase initializer, initialize firebase services which includes as follows:

1. Google Analytics: Google Analytics gives a precise statistic on users who are using this app on their phone including Time usage, Region, Last login, crash free users and even user loss

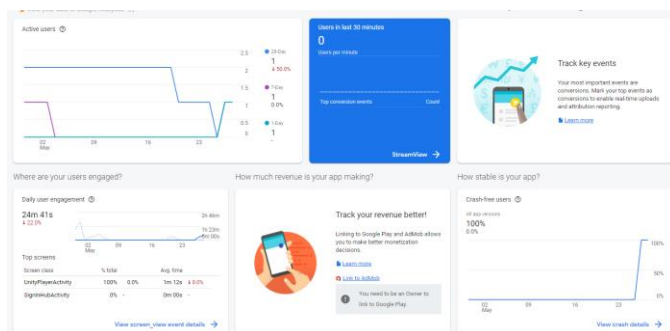


Figure-7: A display of google analytics showing some recent usages of app and some user loss

2. Google Firestore: Google Firestore gives me a direct easy access to google database there's another database which is real time database which could be used to make games because of its low latency, this project does not include an multiplayer version so, it has just implementation of google firestore to store the high score values and recent score values. I have written a whole API which has prebuilt queries to documents directly and the message is sent by single method, a total recent score and high score message is sent and it is saved to firestore as well in a separate document. Where each user's id is

saved as its unique email id retrieved by google sign in.

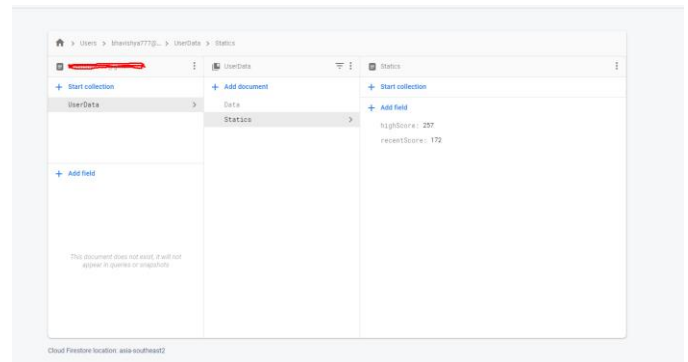


Figure-7: A display of google firestore document showing stored recent score and high score from a random game client

3. Google Cloud Functions: cloud functions are used to implement backend services, in this project cloud functions are used to verify database inputs when a value is passed from the client to firestore through Firebase API cloud function check the value of high score if its greater then it supposed to be it doesn't save the value in firebase at all the game sends the high score to firebase in every 10 seconds in every 10 seconds max value of the high score should be 50 for safe side I have taken max value of 100 if its greater then that it is not stored in firebase at all.
4. Firebase Authentication: In this project it is made sure that any value coming to firebase from the client is from authorized user any kind of value which is coming from outside suppose a man in middle attack will not be used or considered, client has a web key after login google firebase generate an authorization token which is sent to firebase it is auto encrypted and used by firebase itself which makes it safe and reliable for development of apps.

The whole firebase is used as BaaS or Back-end as a service which means the firebase handles the whole backend hosting and additional services which doesn't require this project to hire/handle any additional server all the work is done by some implementation of programs and queries.

5. IMPLEMENTATION

The game's ideology is basically, to generate whole game by lowest efforts possible without requiring any level designer or any kind of strategic story development this project is majorly focused on hyper-casual game concept which is basically leads to Non-Story focused game, a game which could be played for infinite amount of time and that concept is also most famous of addictions there are multiple examples of games like this and some of them has taken over the whole gaming industry. and managing all the backend

work by google firebase services without developing and hosting any server.

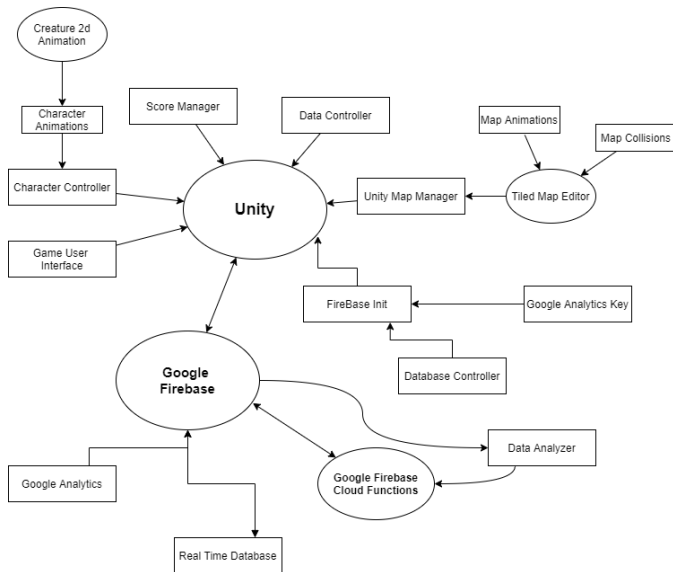


Figure-7: A display of whole project's flow and structure, showing how the different services are connected together with Google Firebase and Unity

5.1 Game Client

- Resources Management: - there are various kind of resources which can be made/managed by the same programmer or developer the maps are made in Tiled by simple drag and drop system with using some sprite sheets or also called tile sets, then there game character, enemy character, music, game currency tokens and all the unity prefabs used in this project.
- Map Loader: - the whole map generating/loading is managed by SuperTiled2Unity which loads the whole map as prefab game object this map is directly dragged and dropped into the game scene first map is placed directly to implement spawn point and main character.
- Platform Generation: - Platforms is generated by detecting empty areas with ray cast algorithm used in this generation is pretty standard by detecting every single area with ray cast

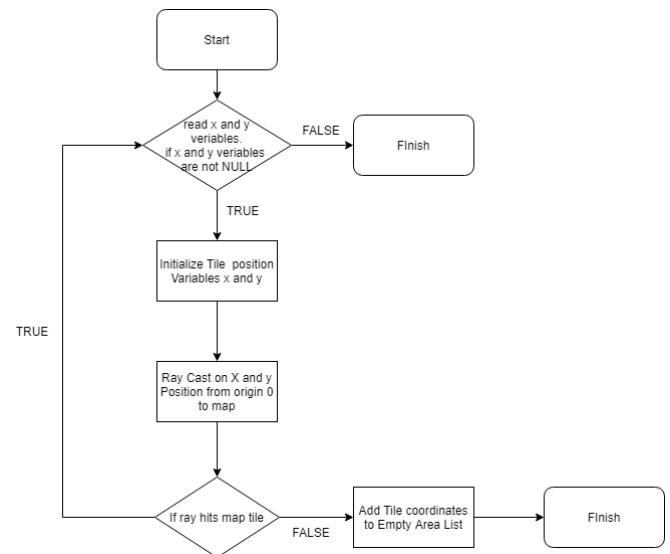


Figure-7: A working flowchart of a empty area list generator for unity tile system using ray casting

This is the working for generation of empty area list, this list of empty area inside of tiled map is used to generate platform size and platform itself.

- Enemy Generator: Enemy generation is based with platform generator with platform size randomization enemy is generated by random rate as well right now in this project enemy is generated on every platform with rate of 40% and there's 2 patrolling points or empty game objects for transform positions to use enemy patrol around the platform. And the enemy is generated at the middle point of platform so its ($x = \text{PlatformWidth}/2$ and $y = \text{PlatformHeight}$).
- Token Generation: - Tokens or Game points or game currency is generated with 3 different patters with a same method as enemy random generations with the rate of 50% they are randomly generated on every platform by using same method as enemies.

5.2 Game Back-end

- FirebaseInit: - Firebase Init is a service which runs on the main thread of the game it is used to initialize firebase in the unity game
- FirestoreAPI: - Firestore API is used to send and receive messages from the firebase in this project there are multiple queries which in this project are pre-made for repeatable usage.
- Google Analytics: - Google analytics grant me ability to track my app user's statistic like country region, usage time, etc.

6. CONCLUSIONS

This research and development was one of the most challenging task for me it safe to assume to reach absolute perfection it requires a lot of efforts but this research was

successful and by using multiple technologies like Unity and Tiled and Creature 2D, firebase, photoshop for sprites it's safe to assume that it is totally possible to develop a game with new technologies and services. Where it has been challenging to make the whole game alone but it was possible and doable to complete the whole game by myself usually a game takes about a team of more than 20-30 people to achieve perfection in game but there are some games which could be possible to develop alone, and that's what this whole research and development was about and what it represents. In the end I was able to develop a full fleshed playable working game which could be enjoyed with people like you and me.

It's safe to assume that a lot of efforts were reduced and a lot of efforts were saved by new technologies.

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