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UFCFXK-30-3: Digital Systems Project

The skills, knowledge, and methodology for the development of current-day video development.

by

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# Acknowledgements

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# Abstract

The skills, methods and knowledge required to make a video game for the current day market should be developed by any person looking into getting into the field of game development. This paper outlines and discusses the skills and knowledge required and developed through the project’s development process. This study aims to outline these skills and pieces of knowledge by developing a video game alongside the documentation, including the design and the implementation of code and graphics to create a final project. The video game in development is classified in the genre of Platformer, more specifically an endless runner. The game has many features, such as procedurally generated terrain that adds randomness to every playthrough.

Based on the reviewed literature review, essential academic skills such as logic and problem solving can be exercised by developing a video game discussed in the literature chapter. Anonymous reviews were taken from a collection of the University of the West of England Computer Science students to gain feedback on the project to judge the success or potential for success on the market.

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# Introduction

The development of multimedia more specifically video games are perceived to be complex and require a high-level knowledge of key fields such as programming, modelling and animation. In this paper the required skills and knowledge that are needed to be developed will be discussed and analysed to outline the material that is required to develop a video game as a new developer to prove that the field of game development is not as hard to participate in as other forms of multimedia. This paper will focus on the knowledge required for development including its difficulty in gain the specific knowledge and its uses in other development fields such as software development.

The importance for young people who want to get into the field of development is immeasurable. Young developers bring innovation to the field of software development, so it is crucial that they are able to learn the skills of development as discussed in the literature review chapter. With the use of the research in this paper, there is a large collection of material that can be utilised to aid in the development process for a game. These materials include many peer-revied articles discussing development methods including methods to approach design and implementation. In addition, there are many online materials such as videos, wikis and forums that can be utilised to assist in the development process as well as outline the common methods that assist professional developers.

The aim for this project is to demonstrate that game development at a student level is not only achievable but can be performed to a professional standard. The development of the video game named GoRight a 3D platformer in the genre of endless runner has many requirements that were aimed at and successfully achieved. These requirements that are covered in more detail in the requirements chapter, are the initial aim for the project which includes a functional game that is both enjoyable and easy to play across a collection of platforms. The completed project aims at targeting three main platforms that include mobile operating systems such as Android and ISO but also able to operate on the windows platform as well.

The outcome of the project is a release video game called GoRight This game has the ability to be released on android, ISO and windows and consists of unlimited play potentials due to its procedurally generated terrain. The game consists of the fundamental features of any video game which include a user interface which fits the theme of the game, playable characters that let you interact with the games environment and surroundings. The completed game is a platformer that requires the player to jump over obstacles and avoid falling out of the level which would result in the end of the level.

This paper contains many chapters which cover the contents of the project from the design and methodology to the research of development methods and the implementation of the program. The chapters include the following:

Chapter 2 which consists of the literature review is a collection of the analysis and discussion of different research material such as the different development methods available but also includes research about the skills and knowledge that is developed while learning to produce a video game.

Chapter 3, the requirements outline and explains all of the requirements both functional and non-functional that the game needs in order to be classed as a successful product. This includes requirements about its availability and its design.

Chapter 4 covers the methodology that is used to produce the game. This includes the different design architectures and tools that were used to create the key components such as the modelling and coding of the program.

Chapter 5 outlines and discusses the design of the games characters and gameplay but also incudes the design for programming that took place.

Chapter 6 demonstrates how the implementation of the design and assets to produce the game. This covers the environment the game was built in as well as details on how aspects the game were created.

Chapter 7 evaluates the project to outline and discuss the successes and issues that took place during the time period that the development of the game took place in.

Chapter 8, the final chapter contains the conclusion of the project summarising the projects from the research to the implementation of the project.

# Literature Review

In this chapter, the review and analysis of relevant literature are shown. The literature discussed in this chapter focuses primarily on the technical requirements of this project. It outlines the educational impacts of the project relating to its significance within its field. The development of this application is based on the research that is currently taking place for the impact and attitude to skill developed through video games. The literature that is being reviewed focuses on younger age groups and how video games can influence children into developing interests in skill-based careers and providing an engaging method to learn these methods.

The article (Barr, 2017) uses qualitative interview data to analyse commercial video games used to develop valuable skills. The article uses a collection of interview data to judge whether or not many skills referred to as ‘graduate attributes’ (Barr, 2017) are exercised and developed. These skills were listed as ‘communication, resourcefulness and adaptability. This report is created to develop these and implement other necessary skills that a younger age group would benefit from developing, such as puzzle-solving and understanding how to solve logical issues.

The article uses a data set of a collection of undergraduate students playing a collection of games for 2 hours over 8 weeks. This collection of data was performed on various games in a variety of genres with a focus on their ability to develop specific skills. This literature supports the development of video games and the skills gained by playing and developing. Due to the articles’ clear response proving through the data collected in the interview, the development of video games to develop and exercise skills is proven to have the potential to be effective and positively impact children (Barr, 2017).

In addition to the previous article, the paper (Barzilai and Blau, 2013) discusses the impacts on learning achievements concerning experiences through games. This discussed achievement can be associated directly with the development of games. The paper focuses on the challenges of making connections between knowledge learned in games compared to knowledge learned in school and their relations to engagement and attention. Like the previous article, the data set used to support their point is collecting qualitative interview data on an average age group of “10.10 years”. The difference between the papers is the relation to games and studying and their impacts on each other. For example, the first paper discusses the relation to be learning directly from games. In contrast, the paper (Barzilai and Blau, 2013) discusses learning with a study and play, play and study and play only structure to learning. The relation of this material to the topic discussed in the report supports and justify why video games have become an important topic and debates for the relativity of learning and attention.

The previous topic discussed solidly supports and justifies the reasons behind this paper and the developed software alongside it. The software developed alongside this paper outlines the skills, methodology and knowledge required for the development of video games and the suggestion of introducing game development at a young age in an educational environment. The article (Kafai 2016) discusses game-making approaches and the skills required to make games as a creator, and the skills and abilities learnt from the games. The software development for this paper takes both the skills and methods discussed in this paper to produce and covers the skills that are learned through the development and their relation to other fields of software engineering. Within the paper, the conclusion of “*It is clear from our analyses that video game making can provide a rich context for learning programming*” (Kafai 2016) was made with the consideration of the cultural participation of video games.

The discussion of which development method to perform while producing the software was supported by the paper (Bygstad, 2007). When developing a project of this scale, research for appropriate SDM’s (software development methods) is needed to ensure maximum productivity. The article discusses two development types, one agile method and the other known as a rational unified method. Both methods discuss different disciplines that are further explained in the dissertation. In addition to these two methods, the paper discusses the use of personal development methods tailored to developers by themselves what quantitative data of the SDM usage. The paper showed that 68% of people who were utilised to make the data sets used their SDM process to develop software.

The design of a video game is a crucial portion of the required research when planning and preparing for game development. Depending on the game’s intent, for example, many components need to be considered for personal use or distribution. In the perspective of commercial development, the intent to sell the product, the design, and the category must be carefully planned. The paper (Moore, 2016) discusses an essential feature for consideration when developing a game. The paper details essential game mechanics and features such as the maths and logic of games concerning the inside mechanics such as movement, cameras, and other game objects.

With the game category in development, a puzzle platformer Moore’s paper (Moore, 2016) can be utilised to provide structure and consistency with design. In chapter 4, the article discusses the importance of movement and the player’s interactions with the character within the game. It is stated that limitations must be implemented into the game to fit into the users’ playthrough so that characters perform how the user would expect. The information collected about movement and scale, including speeds of objects to create an immersive environment, can be used and implemented into the development of the program that this literature is based on. Overall, the paper expands into extensive detail about almost every aspect of the design of video games of one specific category. Thus, only a particular aspect of this paper can be utilised in the development of the code. Still, the practice and methodology discussed can be modified and manipulated to fit any category of the game, providing a good standard of design.The paper (Moore, 2016) proves to be beneficial in guiding developers with the standard of design of internal functions and extensively covers level development and User interface design. Concerning level design Moore (Moore, 2016) States, “Whether in 2D or 3D, the playing field for a game has to be appropriate for the game world and enjoyable to explore.” This quote is about the design of worlds, also known as levels. The video game under development has a procedurally generated level. According to the article, this is important to have a large variety of challenges for the player to “explore” to keep engaging their interest. Also, making the levels increasingly challenging can be used as an incentive to increase engagement with the game.

The incentive for companies to develop video games and the incentive for developing this project is lightly discussed by (Fencott, Clay and Massey, 2012) with relation to types of games and their genre. The paper, specifically the chapter about genres, discusses the community of computer games and their separation based on the genre of games. This paper helps outline the market of games with relation to the genre of game. For example, the popular FPS genre consists of the larges group of players in that category with titles that include Call of Duty and Battlefield. This is one of the most popular genres, including open-world games. The market is full of constant new releases. With this knowledge, developing a small puzzle platform comes from the ideology of the small game creator community. As discussed, (Fencott, Clay and Massey, 2012), this community involves the majority of less popular game genres such as puzzle, Platformer, adventure, and more. This is the target audience that the project is developed to reduce the impacts of competition if the project were to enter the gaming market.

In addition to the article previously, the paper (Aguzzoni, 2014) studies the effects of a merger between two large game development companies and its effect on the market of video games. As this project is developed to the stander of commercial distribution, the importance and understanding of the market justify the type of game developed and the platform that the game is developed, e.g., mobile, pc or console. Although the article being about a merger between two game distribution companies, Game and GameStation, the paper discusses the current value of the gaming market being around” £2 and £3 billion in 2006” (Aguzzoni, 2014) with a collection of online sources stating that the gaming market is an estimate of “USD 151.55 billion in 2019”. This is important to the project as it justifies the financial initiative to produce games with the intention of commercial distribution due to the apparent growth in the gaming market, which leads to an increased demand for content.

There are many different development methods that are utilisable for the development of any software including video games the paper (Aleem, Capretz, and Ahmed, 2016) out lines some of these methods as well as good programming practises that should be implemented into any program. The discussion of development types in the paper includes object-oriented programming and event related programming. The method used in this project is object-oriented programming due to how useable and practical it is for the development of video games as stated by the paper. The focus for this paper is towards the development factors that are needed for the development of a successful object orientated program.

Aguzzoni, L. (2014) A Retrospective Merger Analysis in the UK. Videogame Market. Journal of Competition Law & Economics [online]. 10 (4), pp. 933-958. [Accessed 26 March 2021].

Barr, M. (2017) Student Attitudes to Games-based Skills Development Learning from Video Games in Higher Education. Computers in Human Behaviour [online]. 80 (1), pp. 283-294. [Accessed 24 January 2021].

Barzilai, S. and Blau, I. (2013) Scaffolding Game-based Learning: Impact on Learning Achievements, Perceived Learning, and Game Experiences. Computers & Education [online]. 70, pp. 65-79. [Accessed 18 March 2021].

Bygstad, B., Ghinea, H., Ghinea, B. and, (2007) Software Development Methods and Usability: Perspectives from a Survey in the Software Industry in Norway. Interacting with Computers [online]. 1 (20), pp. 375-385. [Accessed 14 January 2021].

Fencott, C., Clay, J. and Massey, P. (2012) The Theory and Understanding of Computer Games. *Game Invaders* [online]., p. 240. [Accessed 14 March 2021].

Kafai, Y.B. (2016) What Making Video Games Can Teach Us About Learning and Literacy. Connected Gaming [online]. 1 (1), pp. 224-225. [Accessed 26 January 2021].

Kangas, M. (2009) Creative and Playful Learning: Learning Through Game Co-creation and Games in a Playful Learning Environment. Thinking Skills and Creativity [online]. 5, pp. 1-15. [Accessed 23 March 2021].

Moore, M. (2016) Basics of Game Design. *Basics of Game Design* [online]. 1 (1), p. 361. [Accessed 24 March 2021].

Aleem, S., Capretz, L.F. and Ahmed, F. (2016) Critical Success Factors to Improve the Game Development Process From a Developer’s Perspective. Journal of Computer Science and Technology [online]. 31 (5), pp. 925-950. [Accessed 28 March 2021].

# Requirements

This chapter will include the requirements of the project with analysis. The requirements will involve both functional and non-functional requirements in relation to the project.

Functional Requirements.

* The software must have an interactive and easy to use menu for navigation.

The design and usability of the software is defined by the users first interaction with the software. This interaction for the projects first time interaction is the menu. For this reason, it is required that the menus be instantly recognised and able to use from the start of the application to ensure that the user does not get confused or annoyed by the system. In addition, the applications menus must flow seamlessly between each menu such as main, game or options to ensure the most usability possible for the application.

* The software must consist of levels that are achievable.

The game is required to be fully playable and completable in relation to its levels. This means that the user should not fail at a level due to an impossible senari9o for example the user should be able to reach every platform that is presented to them and be able to dodge all obstacles. This is to ensure that the user does not fell like the game is unfair and there for unplayable. This can be achieved by ensuring that the procedurally generated terrain does not create impossible routes.

* The software must have a scorekeeping system including a high score on all of the levels

A score keeping system is required within the software to ensure that the user is able to see that progress is being made. It is also required as it provides a sense of competition in the user to best their own high scores. This requirement is crucial to the game as it assists in the repeatability of the game. Leader board could possibly be implemented to share high scores between friends increasing the competition between players.

* The software must have the ability to control the character through the use of user input such as a keyboard and mouse

The ability to interact with the software is a crucial requirement to the system to ensure that the game is playable. This interaction includes the interactions with the previously discussed menus but also extends to include the player-controlled character. The control method can very between multiple devices and methods. For example, the game being on mobile requires to be functional through the user of a finger tap and for a pc version through the use of either a mouse click or the pressing of the space bar on a keyboard.

* The software must have procedurally generated terrain for the user to navigate.

Procedurally generated terrain is a term used to describe level design that is randomly generated as the player continues through the game. This is required as it ensures that the game is unpredictable and different for every playthrough implementing luck into the game play. This is required as it increases the playability and the repeatability of the game.

* The software must have sound and music to complement game play

A compliment of sound and music is required to immerse the player into the game. The sound of the game must be controllable in the settings allowing the user to adjust volumes. The audio added to the game is required to simulate interaction between the controllable character and other objects and terrain within the game.

* The software must include a level end point

The requirement for an end point in the game is made due to the scoring system within the game but also by ensure the game is not endless. An endpoint within the game can be achieved in multiple ways. The first method that is required is a pause menu. Other examples include the death of the playable character through the collision with objects, or falling off the map including other boundaries of the play area.

* the software must have the ability to pause and play the program

A pause ability is required within the game so that the user is able to take a break from the game. This pause must consist of a menu to either exit the game to the main menu as well as the ability to resume the game. When the pause is enabled all actions within the game must pause in place so that the player does not loos the game by pressing pause.

* The software must have an adaptive resolution for devices so that it can be played in all screen sizes and shapes

Having the ability to run on all sizes and shapes of displays for a system is crucial to a system. All attributes and objects within the game must be able to scale depending on the device screen that is being used. This is a requirement as without this feature the game may not be playable on devices that have too large of a screen such as ultra-wide monitors or too small of a screen such as some mobiles.

* The software must contain realistic collisions between multiple objects

Physics within the game is required to ensure that the game is realistic and playable. The collision physics are a large requirement within the game as it allows for the playable characters to interact with objects and more importantly the floor and use the interactions within the game to give the player interaction to the character. In addition, the physics of the game includes the gravity and weight of characters and objects that is used to justify how fast the character falls.

Non-functional Requirements.

* The software must be able to run on low specification devices to ensure good availability

The ability to run on low spec systems will increase the size of the user group for the game allowing for more people with a large variety of devices and specifications to enjoy the game. This requirement can be achievable by implementing the ability to change the graphical quality of the game as well as ensuring that all textures and assets that are used within the game are only as detailed as necessary to save on system usage.

* The software must be stable and contain no bugs that cause a significant effect on user experience.

This requirement is to ensure that the game is always playable. This includes ensuring that the game does not crash during gameplay or hinder the gameplay to cause annoyance to the player. This includes any bugs that will make the levels unplayable or unfair forcing the player to lose due to no other option.

* The software GUI must be easy to understand

The requirement for an easy to understand and quick to learn GUI is very high although not considered one of the most important parts of any video game it has the most important job of first-time interaction. An overly complex GUI can throw off any new users from wanting to attempt to learn a game. With the context of this project the simpler the GUI thew more beneficial and easier it is to read it is for the user. This requirement is what introduces the users to the game and provides an idea or theme to what they are about to play.

* The software must fit into the universal category due to the target demographic being 11-16 years old.

This requirement was put in place due to the requirements of the University of the West of England as well as market research for the type of game being made. In addition to ensuring it works well on all devices its important that the game can be played by all age groups and ethnicities to ensure the maximum number of potential engagements for the game.

* The software must have adaptable settings to increase usability

In addition to the requirement above availability is key when producing a multi-platform application. With the requirement of adaptable settings, the game is able to function on all platforms that it can be exported to which includes PC/ISO/Android. With the adaptable settings platforms such as mobiles which have smaller processors, and less memory will be able to have an adaptive video setting to ensure that there is a balance between quality and performance.

* The software must have a tutorial to describe how the software operates

The program requires a method for a new user to learn or understand the game that they are plying. With this in mind a tutorial that will be used to not only show how the player can control the playable character but also how the game mechanics will function. In addition, the use of a setting menu or graphic that can be added to the game to achieve the same requirement within the program for example a small tap icon could be implemented to suggest the player to tap the screen and explore the reaction in game.

* The software should be access able from a reliable source

A secure place of download is required for any piece of software when ready for distribution. Depending on the platform the game can be released onto popular app stores such as the apple store or google play. Putting the software on these distributions mediums allows for security scanning and verification to ensure that your app is safe for distribution. In addition, if being released as a project like the software being create4d the use of ?GitHub repository could be beneficial as it will provide a platform to access the application directly from the source.

* The software should have compatibility with multiple platforms

Compatibility with multiple platforms is required to ensure that max engagement can be achieved. For the game to run successfully on multiple platforms a large number of features and requirements need to be implemented. Most of these implementations that are required have been discussed in this chapter but include, adaptive graphics and GUI elements as well as its ability to run on low spec.

* The software should have a visual appeal in relation to design

This requirement focuses on the engagement and interests of the user. A fun colourful game with playful characters and objects will be required within the game to make it visually appealing. In addition, it is required that the visual style or theme of the software is consistent.

* The software should be engaging and fun for the user

This requirement means that the software should be playable and enjoyable for the user to achieve the software’s purpose of being an entertaining video game. This requirement can be achieved by ensuring that all of the requirements in this chapter are completed to the best of the developer’s ability.

# Methodology

The methodology that was followed for development of the project was the agile development model. This model was decided upon as it provides clear structure of the order in which components of the project should take place but also supports revisions that can be implemented through the testing of the project.

Figure : Agile Development Model

The image in Figure 1 shows the Agile Development Model thar was followed in the development process this methodology consist of 6 parts, the requirements which are outlined in chapter 3, Design which is discussed in chapter 5, development which is discussed in chapter 6, testing and the creation of a prototype and then feedback from myself or other students.

# Design

The design of the gameplay is a character that is controlled by the player is forced to mover right within a level. While moving right in this level gaps between the terrain will appear as well as obstacles. The players goal is to jump over these gapes in the terrain and obstacles and continue until the player makes an mistake and falls out of the map ending the game.

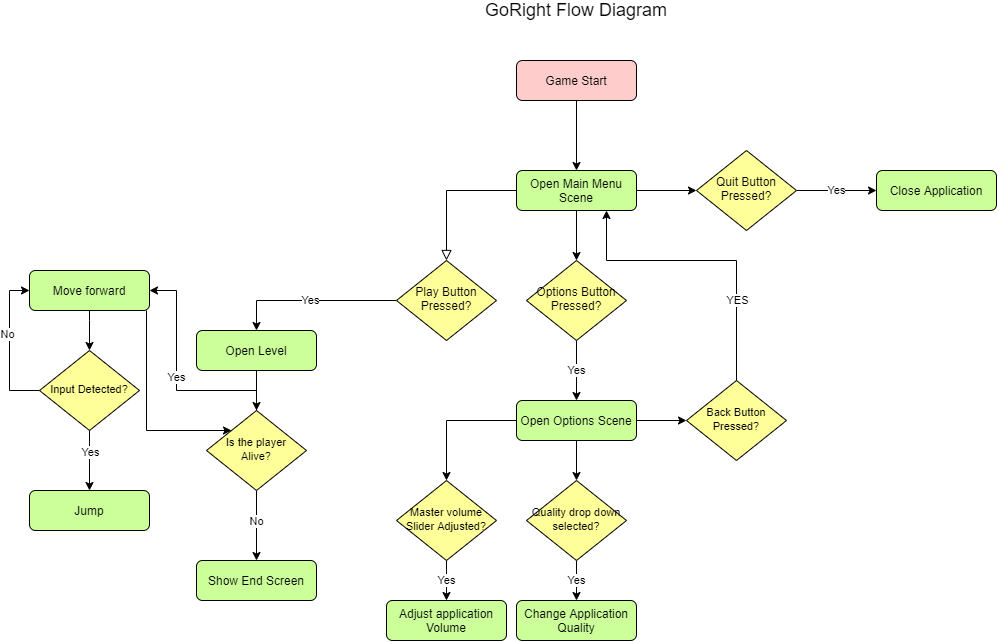
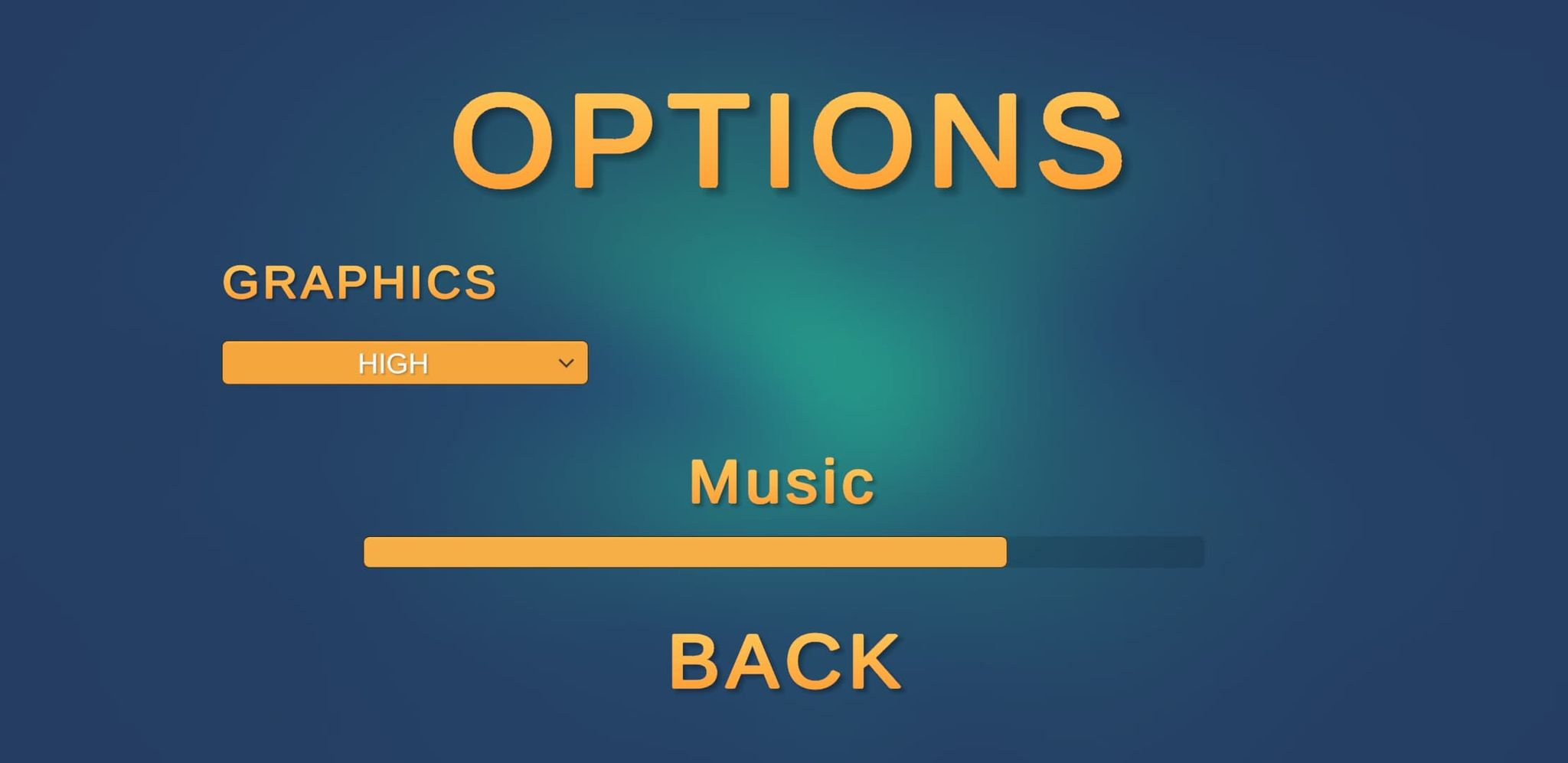


Figure :GoRight game flow diagram

The flow diagram shown in figure shows the flow of the game and the relationship between the actions that the player can perform. The game starts by presenting the player with a main menu. Within the menu the player is presented with 3 option. Option one which is to press play, starts the game and the character starts running. As long as the player is alive the game will continue to run if the player falls out of boundary leading to a death the game will end. if an input on the other hand is detected then the player will jump within the game.



If option 2 was selected within the main menu another menu will appear containing the games setting. The settings consist of a volume slider and the ability to select the quality of the game to better fit the performance of the device it is being used on. This menu is visible in figure.

The designing of all of the assets that are utilised within the game were created in an application called blender (The Blender Foundation, 2001). The program blender is a 3D modelling and animation program that is free to use. The program was chosen for the design of assets as it contains all of the tool’s features that together can be exported and used within Unity game engine. The tools and features utilised for the project consist of its ability to model anything from the beginning up. The designing of the character is the first time that this program was used and was able to produce a high-quality player character within just a few hours of use of the program. This was achievable explicitly by self-learning supported by free documentation for the application as well as tutorials that are available online.

Figure 2 shows the designing environment called Blender (The Blender Foundation, 2001) which is utilised to design the playable character and other assets within the game. The image shows the UV mapping of colour onto a partially completed 3D model of the playable character. UV mapping is the process of mapping a texture to an object using a 2d image. The 2d image used for this model consist of a colour palette that can be mapped onto the surfaces of the model to give the model colour.

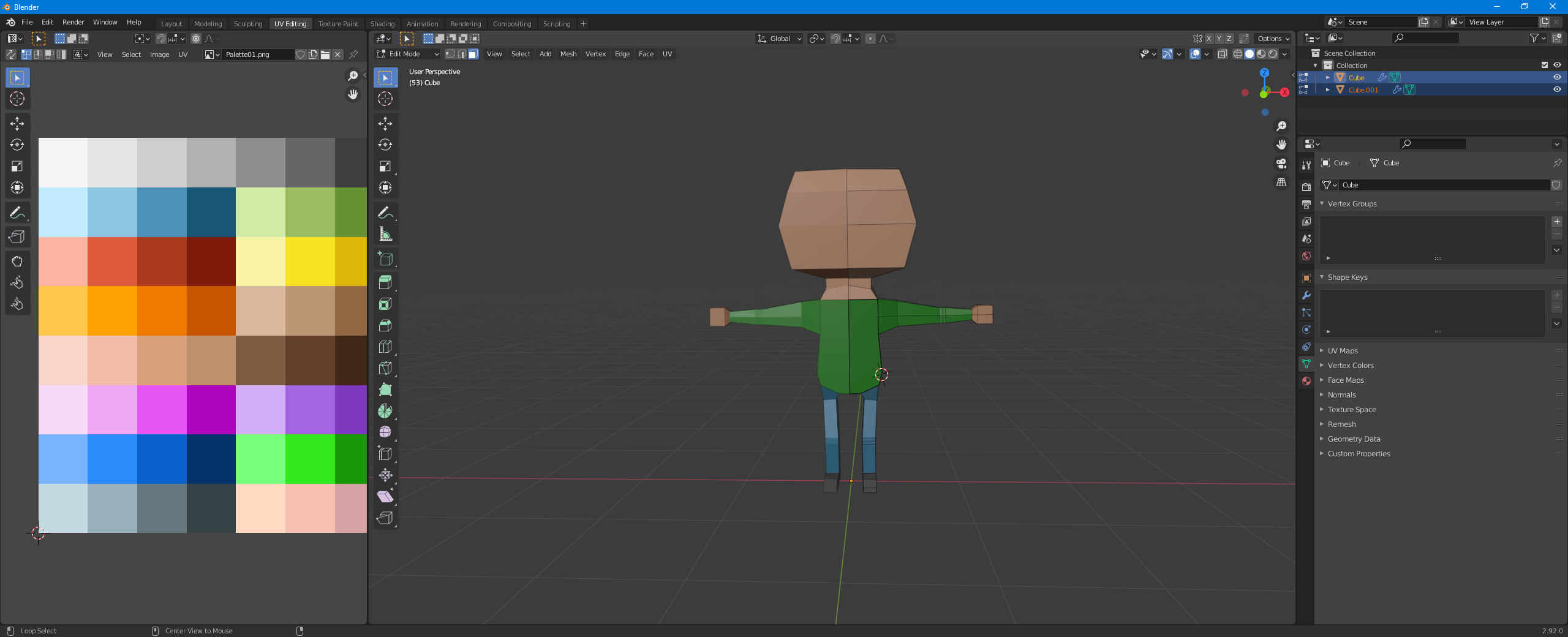


Figure :Blender Developing of the character model

The designing of assets using this application can be quick with more simple models within the game such as the platforms themselves and other decorative objects which includes a barrel , grass and trees which are utilised into the design of the levels.

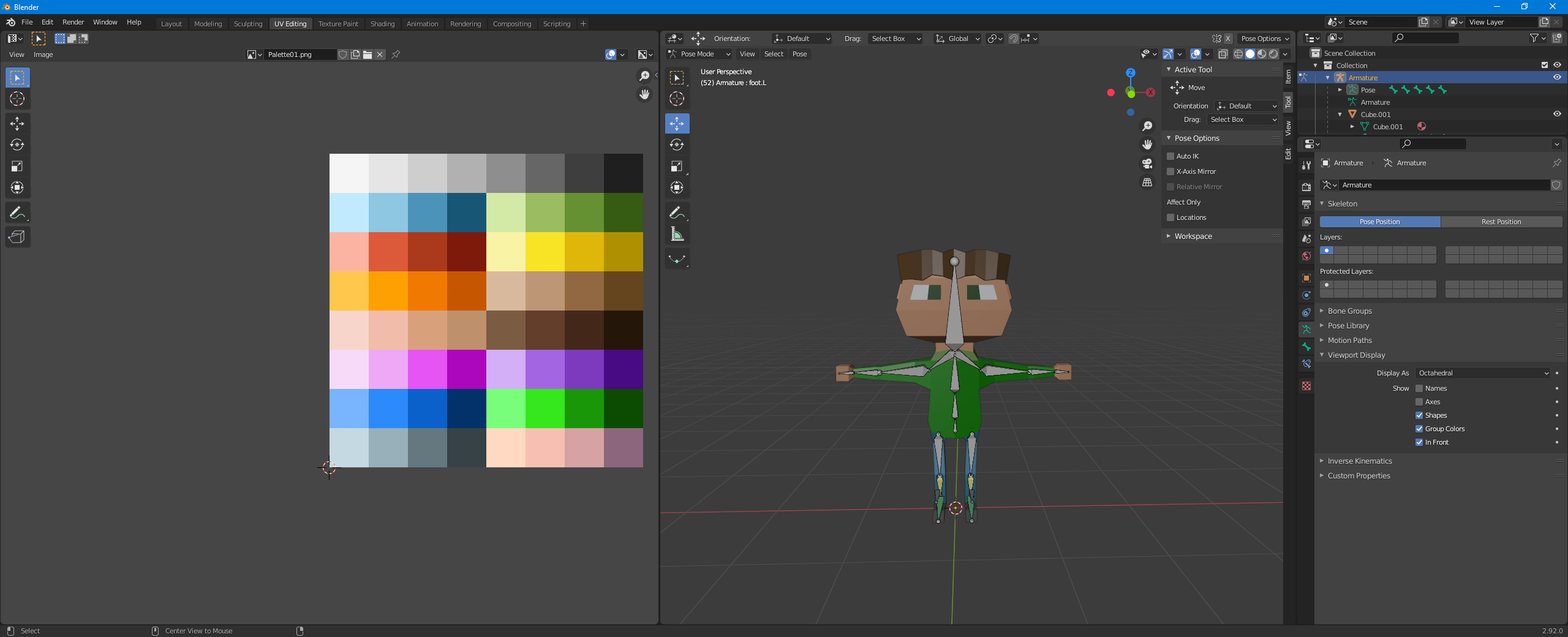


Figure : adding armature to character for future animation.

The program once the model is designed allowed for the creation of armature for the use of animation. Armature is a bone structure that can be allocated to parts of the model to aid in the animation process. This adding armature to a model is known as rigging, each section of the rigging allows for movement and rotation at joints that can be used in animation. In the model in figure 3 the armature is in the same structure as a humanoid with normal human bones and muscle simulation. This humanoid armature can then be manipulated to move parts of the model such as the characters head, arms, or legs. This ability to manipulate the rigging of the player can lead to the creation of animations.

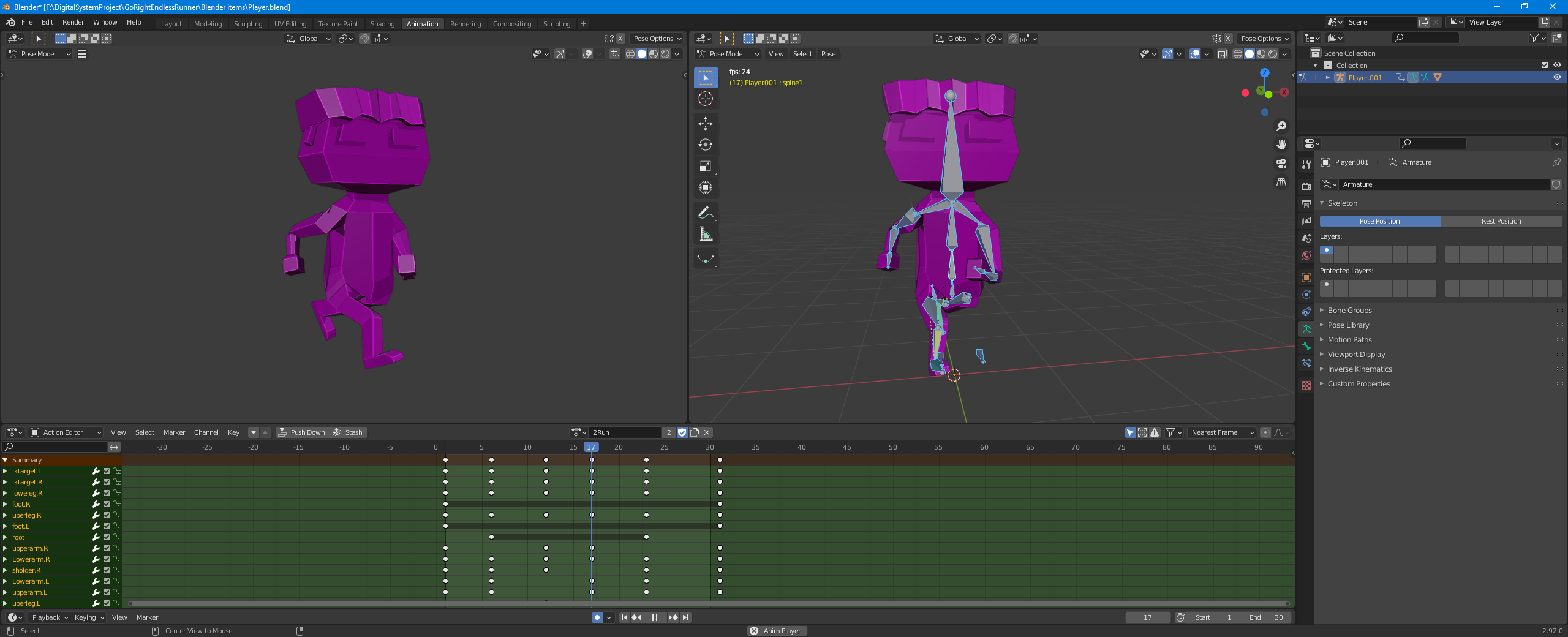
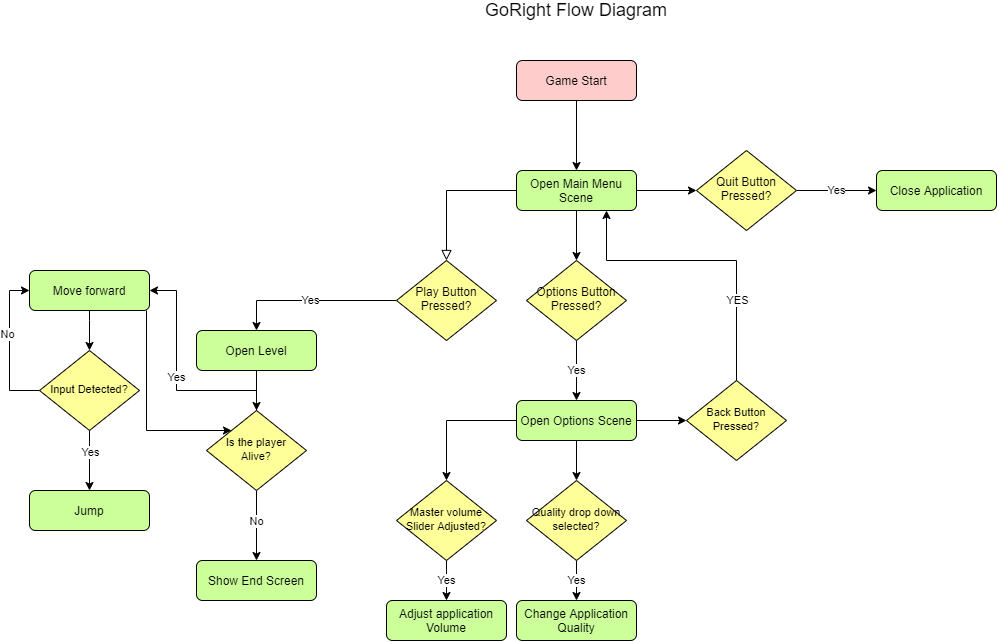


Figure : Animation of run cycle within blender

When designing the character for the game the characters’ ability had to be identified. The characters abilities involve in the ability to stand still, also known as an idle position. The character must also have the ability for movement within the game this involves running and jumping which is crucial for the gameplay. With the requirements of the playable character the animations that are needed can be designed.

In figure 4 the animation process for the run cycle can be seen. This image shows the environment of the program Blender (The Blender Foundation, 2001) in the animation tab. Animation within the program follows the same concept of stop motion meaning that at each frame a part of the character must be moved until a full animation is created. The reason Blender (The Blender Foundation, 2001) was chosen for the animation is used to a feature that allows for frames to be automatically generated. It does this by using a collection of poses positioned at different intervals within the animation and uses an animation smoothing method that fills in the frames between poses to make a smooth animation. The character for its run cycle, had 5 different poses but each animation was 30 frames long, meaning that a total of 25 frames were automatically generated to fill in a transition between the poses.

The learning of the animation portion of the Blender software (The Blender Foundation, 2001) took approximately 2 hours to design a realistic looking but silly running animation. This animation was decided upon as it would best fit the theme of the game being produced.

# Implementation

Description and presentation of the implementation. In this chapter, you need to demonstrate your technical skills and identify how/whether your product meets the aims and objectives of the project.

A short description of the implementation. This chapter should answer the following questions:

* How did you implement the project and why? (demonstrate technical skills; no need to provide code; could provide some screenshots of the product)
* Have the aims and objectives of the project been met?
* Software testing
* Reflection on the test’s results

# Project evaluation

You should use this chapter to reflect on all aspects of the project.

Reflect on the project’s outcome, the difficulties you faced and how you overcame them.

* Discuss **limitations**. Reflect on the tests’ results.
* Any room for **improvement**? Further work?
* **Reflect** on all parts of the project (research, requirements, implementation etc.)
* **Reflect** on the way you used the **supervisor’s feedback** (both from the Project in Progress day and your meetings).

# Conclusion

The chapter concludes your report. It should include a summary of your work focusing on its outcomes (e.g., the final product).

Further work can also be included in this section (instead of the evaluation section)

# References/Bibliography

The Blender Foundation (2001) Blender About Page. Available from: https://www.blender.org/about/ [Accessed 23 April 2021].

# Appendices

Appendices should go at the end of your report. Appendices should be numbered to easily identify them and also point to them from within your main report.