H446 OCR Programming Project

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Abrupt Animus

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# Project Ideas

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Idea | Short Explanation | Complexity | Language | Computational Methods |
| Movement first-person-shooter game | A game where the player must simultaneously manage their momentum and there aim | Medium - ample use of math and GUI. Movement must be fine-tuned along with movement-based bug fixes. Player physics, and bullet physics, enemy AI, and modular interconnected components, OOP, libraries | C#, C++, GDScript, Python, easier with engines | OOP, database, modular design, abstraction for the GUI, reusability for functions |
| Game engine | An application designed to help and aid someone in the creation of game or another app | Difficult - lots of math, OOP, GUI, implementing a physics engine, along with functionality for any component, must include compilers and built in libraries to assist in building the game | C#, C++ | OOP, decomposition of functions |
| Programming Language | Writing a language and run it either being compiled, or to interpreted | Easy - filled with trees and if statements, and exception raising, must have built in functions, handle memory and add basic data structures | C#, C++, CPython | Selection, trees, decomposition, and modular design for various parts of the compiler |

## Engine and Language Evaluations

The purpose of an engine within software development is to speed up the development speed. Usually, these contain tools that manage and automate significant background processes, such as the script execution order, a built-in physics engine, and a lighting pipeline. Many modern engines feature a modular design for their workflow, with there being objects which you can attach components to, to add further functionality to the object. Some of these may be colliders, materials, or even scripts.

### Unity – C#

Released in 2005, Unity is an extremely useful engine that has great capabilities for both 3D and 2D, with powerful tools to assist in the creation of apps (mostly games) and experiences. It has a huge community surrounding it, making it incredibly easy to learn, with a wide variety of plugins to aid in the development of certain aspects of the process. The currently supported language used within it is C#, part of the C family. The language is quite easy to learn, having aspects like Python and JavaScript. It also simultaneously has the speed and access of C++, as it is a compiled language. I have some previous experience in using both Unity and C#, but the majority of their functionality is still to be explored. However, Unity recently made some economic decisions that have severely damaged the reputation of the company and software. As such, if I wish to continue the project afterwards, I may end up having to completely transfer the entire project to another piece of software, so this may not be the best long-term solution.

### Unreal Engine – C++

All the way from 1998, this engine is well known for boasting incredible visuals without much effort required from the developer. It is comparatively easier to optimise the application to run faster, as certain mesh optimizations exist natively to Unreal Engine 5 (namely Nanite). Proven its ability repeatedly, the Unity scandal has brought more eyes upon this amazing piece of software. However, due to its fabulous visual capabilities by default, making lightweight applications and games is far tougher, as many layers must be stripped away. Furthermore, it is well known that Unreal Engine is not built for the 2D experience, limiting the type of content that it can create. The language of choice for UE5 is C++, a language notorious for being extremely difficult to learn with low-level concepts such as pointers mixed in with high-level abstractions such as object-oriented programming. I have little-to-none prior experience programming with C++, so the learning curve to use UE5 is far greater than the other options.

### Godot Engine – GDScript

Godot is the game engine equivalent to Blender 3D in the 3D modelling world - a completely free and open-source alternative, which is only getting better and better every update, and will most likely become the industry standard within a decade. It uses a node-based system to construct the world and all objects which is similar to the systems that other game engines use. This intuitive system allows for more flexibility, greatly helping in the learning process. Godot mainly uses GDScript, a custom language which the engine supports completely for all platforms. It also supports C# and C++, but C# is not currently available to be compiled for the web in Godot 4.2 (the latest version of Godot at the time of writing). Godot can also support any other language using extensions to the engine. The worthwhile option would be GDScript, which is similar in syntax to JavaScript and Python, and has many built in functions such as is\_on\_floor() to handle common and simple checks automatically. The number of tutorials that the community and the Godot team themselves have made is vast and is only increasing, as many people flock from Unity to Godot, making it so that learning the engine and its language would be far easier than before.

### Python (using Pygame)

Python and Pygame together allow anyone to easily pick up and create anything and everything that they want. Unlike the other entries on this list, this is not an engine, which means that the creator must program in every feature, from collision handling and response, to manually testing individual locations for objects, instead of placing them in a visual scene and moving them easily. This significantly slows down the development of the application and can be extremely tedious as everything must be done by the developer, reducing the amount of creativity and passion that can be put into the project. While the language itself is extremely easy to learn, the underlying concepts behind game development such as matrix transformations and quaternions are extremely difficult to understand and waste one’s time when implementing them in such a small timescale. Such a project would be better suited to one with a far longer time frame to work within.

### RPG in a Box – Bauxite

Made using Godot, RPG in a Box is a game engine that has everything built within it for you: a voxel editor, fully working dialogue system, a sound effects generator, and even a visual scripting language. While many of the other engines on this list also have visual scripting as part of their arsenal, none use it or recommend it as much as RPG in a Box. It also has a secondary fully working scripting language called Bauxite, which is extremely similar to Lua, a famous programming language that has been used to make amazing games such as Hades. The engine is designed to be as friendly to a normal person as possible, such that no prior experience is required to even begin making something within this engine, but this also happens to be its downfall. Since so many features are required to use the built in system to have full functionality, it becomes harder to implement higher level concepts without effectively writing your own engine.

## Chosen Idea and Justification

The game engine is far too complex and time consuming for the constraint of time, while also requiring more learning than either of the other options. The programming language on the other hand, is simpler and would not allow me to easily incorporate as many computational methods. The movement first-person-shooter game is a great medium between the complexity of the two other options, while also allowing me to incorporate a great deal of creativity and interesting implementations of the course content. Furthermore, I will be using Unity to implement this since I have prior experience using the engine and C# as well, so I can spend more time focusing on constructing the project than learning how to use the program itself. I also get the benefit of using an engine which allows me to focus on unique ideas, rather than implementing standard algorithms and techniques.

# Analysis

## Problem Identification

An up-and-coming group of the gaming community is a collection of speedrunners, craving for fast movement and fluidity to beat the games faster and faster. To satiate this need, I have decided to construct a fast-paced movement first-person-shooter game, demanding both an understanding of momentum and precise aim, to hit a selection of enemies and reach the end of the level as fast as possible. The game will also have a secondary genre of a role-playing game, allowing players to progress and unlock more movement abilities and upgrade already existing ones to navigate the game at faster rates. Applying restrictions to the upgrades players can apply at one time will force them to strategically use their available abilities wisely and changing their style of play based upon the current scenario. For example, puzzle-based sections may better be played using a set of upgrades (typically called a build) that benefits movement and its control. On the other hand, while in combat it could be better to use a build that increases one’s health and damage dealt.

## Computational Methods

|  |  |  |
| --- | --- | --- |
| Method | Why | How |
| Thinking abstractly | Referring to the process of separating ideas from reality, it can be understood in two separate ways: abstraction for the developer, and abstraction for the player. For the developer, abstraction refers to the difference between the code and the hardware, and hence creating a model that will make the best use of the hardware. For the player, abstraction is the difference between the information given to them (such as the GUI, colours of effects) and the actual code and logic behind it all. | Only the bare minimum information is provided to the player, making sure that they only know what the developer wants them to know. Workings of certain mechanics could be summarised within a paragraph or shown through cutscene tutorials. Information on weapon states can be shown with images instead of text. As much as possible should follow the show-not-tell principle and detail does not need to reach that of realism. |
| Thinking procedurally | Otherwise known as decomposition, this is the process of breaking a large problem into sub-problems, making the overall task much simpler. Without the ability to decompose, designing and creating a game would be completely impossible. People already decompose problems to solve them. By splitting a huge problem into extremely simple ones, it makes the entire task far easier and reduces the time wasted in trying to solve a complicated problem. All the saved time will create a better product in the end. | The task of creating a game can be split into the many parts of game development, such as programming, art design, and other things. Within programming, it can be used to split the game into separate modules, classes, and functions. Grouping together related functions with importable modules will reduce the amount of code one needs to write and is better to maintain and debug. It is also far easier to create a function that does only one job and have a separate function call all the pieces when they are required, avoiding code duplication and errors that might occur when doing so. |
| Thinking ahead | When designing programs, rewriting the same code or similar code over and over again can be boring, inefficient, and a pain to debug, while also reducing the readability and increasing how error-prone it becomes. It also becomes far faster to program if all the steps have been planned out beforehand, such as inputs and outputs. Identifying spots where one can cache data to improve data access speeds and reducing memory usage will also allow the game to run faster, while leaving more resources for other parts of the program. Thinking ahead also references planning out the timing of when to implement features and how long it should take to do so. | One can simplify repeatable code by extracting them into functions and their respective calls. Taking this a level up means using classes (and hence Object Oriented Programming) to reduce code duplication as much as possible. This fits in with using Unity and C# since it uses objects as the framework, and so programming using OOP will be far easier and better supported. When multiple objects may access the same data, this data will be cached in a static section of the class, increasing memory efficiency. Techniques like polymorphism and abstract classes will further reduce the need to rewrite code. |
| Performance modelling | In games where skilfully timing and predicting trajectories is the aim, having any source of freezing or lag (when there is a significant difference between the player’s inputs and the outputs displayed on the screen) will result in a sub-par, even rage-inducing experience, due to issues out of the player’s control. While this is the intention for some games, it is not the intention for mine, and as such, code should be written efficiently to improve the player’s experience. Performance modelling will help in analysing inefficiencies and hence places that could be rewritten, resulting in an overall all better game. | While doing the programming can be more enjoyable than other parts of the development process, wasting time testing inefficient and longwinded solutions can be a massive bane that may end up costing you the project. Being able to evaluate the performance of a function or script before it is rigorously tested by modelling it and quantitative analysis will help identify weak points in algorithms and potential places to improve the efficiency, reducing the lag a player might experience. One useful tool to quickly measure a function’s efficiency is Big O Notation, showing how effective the algorithm is as the input size increases. |
| Thinking concurrently | Not every process in a game can run sequentially. Sometimes things must run simultaneously to run properly, such as physics calculations alongside GUI rendering, and especially input sensing, which must be handled concurrently with other inputs, such as moving and firing. Also, waiting for other tasks to finish or acquire data can block the CPU, which is more wasted time, so allowing the CPU to switch to another task while it waits is efficient use of its cycles. | The Unity Engine already manages a multitude of processes concurrently by assigning them to separate threads, which can then be picked up by separate cores. Other tasks such as highly parallelisable numerical tasks and graphical tasks can be offloaded to the GPU, which performs the same code on many different data (SIMD architecture) in a huge array of parallel cores. |
| Thinking logically | Without the ability for the program to change what it performs based upon the inputs, many projects and pieces of software would be virtually impossible to create. The ability to loop code also significantly reduces repetition of code, reducing the error rates from poorly duplicated code, and making it easier to debug. | Making different functions run when different input keys are pressed is the entire backbone of games, and as such, having the ability to change control flow is incredibly important. Not only that, but having code run on certain conditions being fulfilled makes sure that only necessary code is run, and avoids potential crashes. For example, if a raycast (shooting an imaginary ray and checking if it hit any object) hits an object, the pickup animation might be different for different weapons if the object hit was even a weapon in the first place. In certain situations however, using a switch statement is more efficient that using many if statements, since in a compiled language, the compiler simplifies switch statements into a switch table, which is a table of all the relevant memory locations for the different parts of code, and a hashing function is used to map the match to the memory location. This ability is more efficient than evaluating many if statements. Just as integral is the ability to have all the game code, or at least the relevant sections, be rerun at the start of the next frame, allowing for an interactive experience and to make sure that the game can be actually be played. Looping can be used elsewhere within movement calculations and predictions or for iterating through lists and arrays. |
| Backtracking | When programming, it is not always sure beforehand whether a solution will work, or if is worth implementing a certain way. As such, you may have to backtrack to previous working solutions and try a different approach to settle upon a far better solution. Over time, this maintains or improves the code, will also keeping the development enjoyable, and motivation high. | Sometimes, potential optimisations may be more hassle than the old solution and one’s time could be better spent elsewhere. If at the time such a solution does not present itself, you can leave it for the time being and come back to it at a later date, when your brain as refreshed and other parts of the code may be completed. This allows you to come up with fixes that you may not have thought of before, since you can leverage the other code, and a fresh mindset. |

## Stakeholders

A stakeholder is a person/organisation that is interested in a project, in this case, my game. These people have the power to change significant parts of the documents as they are the ones who the developers must consult when implementing certain features and how those features will work. For example, these people might be users of the program, such as the players of a game, or they could be producers and publishers wishing to make money from selling the program.

### SillyAustralian ® - Henry Masters (Founder and CEO)

My main stakeholder is the founder and CEO of the amazing game development company, SillyAustralian ®, Henry Masters. Masters is a huge fan of precision platformers with lots of challenge, as they prioritise a skilful experience that one can get better at, constantly keeping them within the flow state. Some examples are Celeste and Super Meat Boy, both being loved by players of the precision platformer genre. However, they also like role-playing games (RPGs), such as the hit 2015 indie game, Undertale from the brilliant mind of Toby Fox, and The Legend of Zelda: Breath of the Wild from well-known console and game production company, Nintendo Co., Ltd.

Recently, the company is wishing to start adding a secondary part to their business by publishing other small games under big names and help with the marketing of the experience to allow the developer to reach a larger audience than they may have gotten without going through the publisher. As such, they are willing to provide feedback on the actual code of the game, making sure it is optimised for various devices which may or may not have the greatest hardware, preferring efficient solutions as well. This leads to them requiring a game that runs fast and smoothly as their top priority, since the game should be accessible to as many people as possible, and they are willing to have compromises on the visual clarity of the game and the background story of the game as this does not contribute to the gameplay experience. They would also very much all the code to be easily maintainable, as they wish to continue developing the game after with their own software team. This means that I have to use many easy-to-read notations and naming styles.

### DrunkDriving ™ - Amarveer Flora (CEO)

My secondary stakeholder, handling the playtesting of the game and complexity of the playstyle is Amarveer Flora, the CEO of DrunkDriving ™, along with a small selection of his employees. Also a fan of difficult combat in games such as Elden Ring and Dark Souls, they have experience with massively multiplayer online role-playing games (MMORPG) such as Hypixel Skyblock and Black Desert Online. Similarly to these games, they also like the simple but logical gameplay that comes with automation games like Beltmatic and the Minecraft modpack, Techopolis 2. Importantly, they have great experience with shooter games like Overwatch 2, Fortnite, and Call of Duty, while having great reaction times. This makes them a great stakeholder to test the game for bugs while being able to play at the recommended difficulty of the game. They similarly prioritise the player’s gameplay experience, but they are more focused on the bugs and the instability of the game. Having many bugs in common gameplay will lead to an unfair and dissatisfactory play, so their priority is fixing as many of the bugs as possible, such that a player does not ever experience a frustrating playthrough. They are also willing to get rid of certain features such that the core gameplay elements are kept, and so they will be secondarily overseeing the features added to make sure priority is given to the features the player will interact the most.

## Research

### Titanfall 2 (AKA TF|2)

Released on 28th October 2016 by Respawn Entertainment and published by Electronic Arts, Titanfall 2 is movement shooter, where the player swaps between moving around as a human character called a pilot and playing within a Titan, where the style of play completely changes. As a human, the player has access to wallrunnning, sliding, double jumping, and other abilities depending on the level. As a Titan, the player is able to gain great combat abilities, specific to the kit that they choose to apply to the Titan, all of which overpowers a human in every aspect. However, the movement capabilities of the Titan are reduced, leading to the only shared ability between all Titan kits to be the ability to move around. Some kits can fly, others can dash, but most of them have no extra movement capabilities. The 20-foot-tall war machines also struggle to get in some places, and as such the player will need to frequently exit them to reach other places or remove large volumes of health from enemy Titans via hijacking. This excellently illustrates the design philosophy for each of the levels in TF|2 – ‘211’: two parts pilot combat, one part pilot movement/puzzle solving, and one part Titan combat.

When designing levels, the team at Respawn Entertainment made each of them based upon on a different feature. For example, in the level Cause and Effect, the player swaps between the past and the present, managing enemies in both timelines, and using the changes between the two to help in accessing different areas. This planning technique is something that would be wise to follow, but since levels are designed to be completed in speed (and making long levels can be difficult) it might instead be smarter to split a theme across multiple levels, which are typically called zones. It should not be overdone however, as the feeling of ‘wanting more’ is always better than the feeling of boredom.

### Half Life (and other Source Engine games)

Half Life was the inspiration for many of Titanfall 2’s puzzle design, where there is a minimum amount of momentum required to traverse and solve the puzzles. Released in 1998 as Valve Corporation’s first game after 2 years of work, Half Life set the standard for what an amazing story-based first-person shooter game should be. It carefully and cleverly introduced the player to all its mechanics, and showing the depth that they could be used. Across the 19 chapters, and approximately 12 hours of immersive gameplay, Valve crafted an experience that tells the story of the creation of a dystopia, and Gordan Freeman (a young scientist) along with his attempts to stop it.

Valve built their debut game on GoldSrc – an extremely modified version of the Quake Engine and the Quake II Engine from id Software (the developers estimate that the resulting code is over 75% their own). The Quake Engine had a feature within its movement calculation code called ‘air acceleration’, which as its name suggests, allows the player to accelerate in midair. Normally, this wouldn’t matter, since the drag from moving forward and the deceleration that you experience when touching the floor is enough to cancel all speed increase. However, with a special movement technique called air strafing and bunnyhopping, it’s possible to gain speed, essentially to as fast as you want. Valve later modified and upgraded this to make the Source Engine which debuted alongside Half Life 2 and Counter-Strike: Source, and later on the Source 2 Engine with Half Life: Alyx. Since all the later engines were based of the previous engines, they all contain the same similar movement code and hence speedrunning techniques, which is incredibly useful for speedrunners since they can reuse their own skills.

The Half Life franchise is also well known for its incredibly realistic AI, which is especially well demonstrated with the Overwatch Soldiers from Half Life 2 and the following games in the series. The soldiers are capable of replicating and enforcing blitzkrieg-style military tactics against the player and making smart decisions in the usage of their weapons. There is also a clear hierarchy present within each team, and the behaviours of the different soldiers are cleverly explained behind the story of the game.

The Combine AI functions as a multi-part system, with each enemy following a set of logical steps, then reporting back to a manager system, which assigns the respective enemies the appropriate roles based on the number of targets. Each soldier will then maintain that slot until their schedule finishes, which is a set of tasks assigned to it, such as finding cover, or firing at the player. This complex system allows for the tactics that the enemies should enact, while also keeping the situation manageable for the player, since the system will not allow more than 2 enemies to attack the same target simultaneously, which makes it a brilliant basis to design the enemy AI for my game as well.

### Omori

An absolutely phenomenal role-playing game (RPG) by OMOCAT using RPG Maker MV, Omori tells two interconnected stories of two connected teenage boys, dealing with both friendship and guilt. The bulk of the game is spent interacting with characters in both the storylines and completing quests for all of them. Dialogue systems in games can be incredibly complex and important, giving one an insight into how the characters of the game are feeling, and the possible options can change based on what the player has done. If the player has completed a quest, the system must be able to detect the change to the relative variables and change accordingly.

The importance of dialogue in a game comes not from the words, but the feelings they invoke and pass on to the player. After all, if the only things a character says is just describing the current situation, better world design or even a signpost is what you need to have ‘dialogue’, instead of implementing such a complicated system. However, the inverse is not true – a signpost can not represent emotion as well as a set of characters, no matter whether they display the emotion or not.

Omori’s system links together facial emotions and text effects to further accentuate the feelings of the characters. I, on the other hand, do not need to invoke emotions through facial expressions, nor do I need such extravagant text effects such as shaking and waving. However, applying colour, italicising and bolding text is useful in pointing out the most important things to the player while they are skimming through the text, while also helping them retain those specific pieces of information. In the game that I am making, the player will be under a lot of stress, so being able to skim dialogue quickly is important.

### Conclusion

From my research into these different games, I have decided on different elements of these games that would fit well into this game. From Titanfall 2, the main inspiration for this game, the way it splits the game into long chapters will be utilised. The ability to run along walls will also be used. However, the majority of the movement will be taken from Half Life and the various other source games since this is the basis for even TF|2’s own movement. I will also be utilizing part of the design philosophy (211), splitting part of the levels into both combat and the parkour section where the player has to get around to different locations.

From Half Life 2, I will be utilising part of the enemy’s AI system, although it will not be implemented to that extent. Rather, the manager AI will only exist to alert other enemies’ part of the same group of the player’s existence. This is necessary to keep the project within a reasonable timeframe.

Omori will be the inspiration for the dialogue system, although only text will be on it: no images or animated faces since the dialogue is only a secondary aspect of the game, not meant to detract from the main shooter aspect of the game, since the RPG aspect is just a sub-genre.

### Interview

For this interview, I needed to gain an insight into the exact features that the stakeholders wanted, and as such I convened with both. First, I prepared some questions, spread across different categories:

* Movement
  + What should be the basic movement options?
  + Any special movement options?
  + Should movement be location specific?
* Combat
  + What should the basic combat abilities be?
  + Should the player have multiple weapons, and if so, how many?
* Audio
  + Should there be sound effects?
  + Should there be a soundtrack?
* Systems
  + Dialogue
    - What should the system be capable of?
    - Should there be quests?
  + Saving
    - Is this system needed?
    - Should it be slot-based?
  + Currency
    - Will the game have any currency?
    - What should the currency be used for?
    - Is this a necessary system?
  + Any extra systems?
* World
  + Should the game be split into levels?
  + Should enemies be placed in predetermined locations in the world?
  + Should the world be modelled, or just prototype models?
* UI
  + Should there be a main menu?
  + Should there be a pause menu?
  + Should there be a HUD?

Upon asking these questions, I was able to obtain the following responses from both my stakeholders:

What should be the basic movement options?

The player should be able to move both slowly and quickly in all directions on the floor. They should also be able to jump off the floor. They should also be able to crouch, both as a hold key and a toggle.

Any special movement options?

Special movement options should be the ability to run along walls, an ability to grapple to any surface in the world, an ability to slide when the player is running fast enough. Being able to jump in mid-air and multiplicatively increase their speed is also useful.

Should movement be location specific?

No, the movement should be useable anywhere, with only the ability to run along walls being specific to walls only and not the ceiling.

What should the basic combat abilities be?

The player should be able to fire bullets from a gun, and be able to reload the gun, if infinite ammunition is not an option. Zooming in would also be useful so the player can have higher precision when firing. The player needs to also be able to swap their current weapons with the ones on the ground or dropped from enemies if possible. Finally, an optional add-on is the ability to quickly perform a melee upon any enemy using the current weapon in hand.

Should the player have multiple weapons, and if so, how many?

The player should have access to hold onto multiple weapons but should only be able to use 1 at any given moment. A nice middle ground between too many and too few is 4 weapons. This should work well with the fact that weapons should be of 3 types: blades, explosives, and bullets.

Should there be sound effects?

Yes, the game needs to have sound effects to indicate if an action has taken place. However, you don’t need to design the effects, just put in the systems to add them in place.

Should there be a soundtrack?

No, the game does not need to have a soundtrack, it should just use the same system as the sound effects, but you need not implement it.

What should the dialogue system be capable of?

It should be able to display text on the screen at a minimum and have easy syntax so that we can have people writing the dialogue with no other knowledge of how the rest of the game works. Optionally, it can include things like choices for the player and animation keys for characters to face other characters.

Should there be quests?

No, a quest system is not needed and is also optional in combination with the dialogue system’s choices.

Is the saving system needed?

Saving is integral for any player in any game and should be one of the higher priority systems that would be implemented.

Should it be slot-based?

Many games do use a slot-based system where u can only have a limited number of saves at a time. We are not a fan of this system however and would like the player to be able to make an infinite number of slots, with its own data.

Will the game have any currency?

The game should have the capability for currency, granted to the player upon killing enemies, and performing other important actions.

What should the currency be used for?

The currency should be used to buy upgrades to the player, such as more health, and more health regeneration.

Is this a necessary system?

No, it need not be implemented at all and is completely optional. This system should be implemented last

Any extra systems?

It would be interesting to have a system to challenge the player into getting through a level as fast as possible or perhaps deciding to survive as a pacifist. This could be a scoring system. It would be interesting to make the game dynamically make itself harder as the player plays as a pacifist more and more: this could tie into some story behind the game, such as calling it a glitch meter and making the player a robot.

Should the game be split into levels?

The game should be split into multiple different levels and have the capability to set up more levels as much as possible.

Should enemies be placed in predetermined locations in the world?

This is both yes and no. For replayabilty, the enemies should have partly random spawn locations, but these should all be within predetermined locations, so that speedrunners can enjoy speedrunning the game more, while still having a level of difficulty to the run.

Should the world be modelled, or just prototype models?

Leave everything as simple objects, and we shall replace them with our own models once you pass the project to us (SillyAustralian). This covers all graphical elements; they need only be placeholders.

Should there be a main menu?

Yes, the player needs somewhere to start the game and decide which save to play, along with managing settings or quitting the game.

Should there be a pause menu?

The player should be able to pause the game, stopping all actions including the game’s physics and enemy attacks. This menu should allow the player to manually save and load, if implemented, and allow them to change their settings and finally quit to the main menu or quit the game.

Should there be a Heads-Up-Display?

Absolutely! The HUD is very important for the player to see some information about data about themselves that they need to keep track of. This can include the player’s health and their currently equipped weapons, along with information related ot that weapon.

## Essential Features

### Movement

#### Walking/Strafing

Walking is the basic movement action that the player can enact and will need this to start of many other actions. Comparatively to other ground-based movement, the speed of this will be situated in the middle of the rest.

#### Sprinting

While walking can be all one might need, getting to places faster is important to avoid getting hit in combat, or complete certain puzzles within the required timeframe. Sprinting will increase the ground acceleration that is enacted, and the player will also have a higher top speed compared to walking.

#### Jumping

Another staple of the movement actions, jumping allows the player to easily gain vertical momentum, and it can be developed by allowing the player to jump while in the air, or jumping off walls.

#### Crouching (both toggle and hold)

Crouching will shrink the player’s hitbox vertically, granting access to smaller passageways, and providing a potential advantage in combat, since the area that enemies can attack the player in is far smaller. To balance this out, crouching will force the player to move much more slowly and will be the slowest ground-based movement option.

#### Sliding

When above a certain speed, using the crouch button will instead lock the player into a sliding state. Sliding should first increase, then decrease the player’s speed, encouraging you to leave your slide earlier to gain speed. The target direction will be the current direction of movement, but input will only allow slight nudges in direction, rather than a controlling factor, allowing the bare minimum control. Friction while in a sliding state will also be a lot lower than other states.

#### Wallrunning

A much more advanced movement option, this makes the player stick to walls and allow them to move along it. This opens the possibilities of combat terrains and puzzles and is usually included in movement-shooter games. The player can also jump off these walls, which may lead to a variety of solutions to different situations the player may encounter.

#### Grappling

While not as common in other games, grappling is still fun to use, but is also far harder to control, since this requires one to plan trajectories. It is also much harder to implement but is still well enjoyed by many players in the game’s it shows up in, such as the multiplayer mode of Titanfall 2, or as a basic movement option of Ghostrunner.

#### Double Jump

This is a far more common ability, where while in air, the player can press the jump button again to gain an extra boost vertically, akin to a jump on the ground. Without this, the player is only permitted to jump while touching the ground.

#### Boosting

Like a dash that might appear in other games, a boost is a multiplicative increase to the player’s speed and will allow them to gain speed much faster than attainable through other methods. Due to the potential of exponential speed, both a maximum limit for boosting must be set, while also implementing a heavy cooldown for using it.

### Combat

#### Fire

On the combat side, firing is an essential action. Without this, it would not be called a movement-shooter. Firing will be a catch-all term for using weaponry, such as slicing with a blade, shooting a weapon, or throwing a grenade.

#### Zoom

While a player may not use this as much when they are moving around a lot, it is still a staple of the shooter genre to include some sort of zoom capability on weaponry or on your visuals to be able to see long distance clearer. This may have a side effect of encouraging a stealthy and cautious playstyle instead, but this could be negated by having more difficult sections later in the game.

#### Swap weapon

From the beginning of first-person shooters, the usefulness of having multiple weapons and the strategy that appears from doing so was always an incredible lure into the games of the past. This inherent feature stuck through the generations and remains as an expected feature in a shooter. However, starting from Halo, the number of weapons one could carry could be limited, due to the limitations of the controller at the time. As such, another trend of having a limited number of weapons that the player could equip at one time rose in popularity. It’s an incredibly easy way of bringing depth into any shooter, by making the player have to choose which weapons, they want to use, and by having a limited ammo capacity, also making the player choose if they can wait to get ammo, or if they need to change weapons now.

#### Quick melee

While unlikely that the player might repeatedly get within close range of any of the enemies, there must be a close, high damage option for the player to enact. The melee is a powerful move, that depending on game-to-game, can be one of the highest damage options available. This ability allows the player to use any weapon to inflict a strike onto an enemy, no matter the usual use of the weapon.

#### Pick up weapon

Since the player can run out of ammo, it is likely that they will end up without any weapons with ammo in them, other than blades. As such, it is possible for the player to pick up weapons dropped by enemies or placed in boxes throughout the level to counteract this difficulty.

#### Reload

Guns do not have a limitless capacity of ammunition, and to help players to immerse better with the game, the player can reload the magazine in the currently active weapon if applicable to do so. This can add a further layer of strategy to the game, as a player can decide to reload in the middle of a magazine before entering a gunfight, or not do so if they fear they will get hit in a moment.

### Sound Effects

The brain is very good at linking different senses together for the same piece of information. Having different sound effects (sfx) link to different actions will act as either a confirmation that the action has been processed, or it may warn the player of danger.

### Saving

Saving is needed for longer games, since players can get incredibly frustrated with losing progress every single time they close the game. As such, saving has been implemented in many major games as a basic feature. Different games do the system slightly differently, usually splitting into 3 different types. The first is where the player has many slots and can save the game into any of these save slots and have multiple different places they can pick up from. This can also be used to have entirely different playthroughs existing at the same time. The second method has only one save slot but saves progressively by making a new save every single time. This only allows for one playthrough, but many checkpoints that the player can load back into. The third method is the one that I shall implement, where a mix of the other two types is used. Specifically, the player will have multiple slots, where each slot denotes a playthrough. Each slot will have multiple versions based on manual saves or automatic ones based on checkpoint.

### Multiple Levels

Having many different levels will increase the playtime of the game and introduce variety, so that the player doesn’t get bored with repeating the same level with no differences. These levels will be split into zones/chapters where levels in the same zones/chapters will have the same thematic style and mechanics.

### Glitch

The glitch meter is a measure of how aligned to the default programming the player is. Pacifism goes against the original programming: this decreases the glitch meter. Killing follows the original programming: this increases glitch meter. Secrets decrease the glitch meter, as they reveal the true nature of things. A lower glitch meter would represent the player character questioning the morality of what they have always been taught and programmed to do. It will cause:

* Decrease in health regeneration speed.
* Increase in damage taken.
* Player will see hallucinations.
  + Grants the ability to attack friendlies.
  + Enemy civilians may be on your side.
  + Characters in names and signs may move around.
  + Relates to PTSD type event at the beginning of the game – the only cutscene of the game.

A higher glitch meter represents the player character believes what they have been taught and programmed is the right thing, leading to:

* Increase in health regeneration speed.
* Decrease in damage taken.

This works with the moral of the game - doing the right thing is almost always harder than doing the wrong thing, and sometimes prejudice will perpetuate persecution.

### Scoring System

Each level is scored based on:

* Time to complete.
* Enemies killed.
* Secrets collected.
* Inverse of death count.

Further point bonuses will be granted for:

* Using less weapons (melee only)
* No deaths
* Pacifist (only applied on the final level if the player has killed zero enemies across the whole save)

This should encourage players to return to the level and get a higher score, potentially seeing the flower planting system. The score will be displayed in a room, and the player can interact with each of the elements to show the score for each category.

### Merit

The currency of the game is called merit. It can be obtained by picking it up from within the level (such as the bodies of friendly soldiers) and from the score at the end of the level. Killing increasingly difficult enemies will lead to more merit, although to stop merit-farming tactics, it will be limited to this equation:

.

Merit will allow the player to buy upgrades for their player character and unlock more weaponry/ammo types to use in the pre-level inventory setup. However, ability unlocks will be based upon the level progress, since it will be tied to the story.

### Dialogue System

While it should not be used extensively as it may break the flow of the game, this system should be complex enough to handle all dialogue requirements it needs.

It must:

* Allow for one to easily add multiple languages
* Allow for timing cues
* Allow for branching options
* Allow for quest completions
* Allow for different dialogue based on external events
* Allowed to change variables
* Prompting characters to face different characters
* Allow for changing text colour (this should allow for accessibility changes)

### Death Screens

To encourage the player to use healing items and use better movement to avoid taking damage, too much damage will result in the player’s death, and a screen will need to pop up allowing the player to load the most recent save, and potentially showing a useful tip on the screen to avoid death the next time. The screen could also give other statistics such as how many the enemies had killed.

### Graphical User Interface (GUI)

Many users are not exceptional at navigating and using command-line interfaces, and the human brain can process images faster than it can process words, and using the mouse is more accessible than using text arguments. As such, I will be implementing both a GUI for menu navigation, and a Heads-up Display (HUD), which will communicate information to the player while playing the game. Some elements of the HUD may be in text and numbers, while other will be in graphical solutions such as bars and images.

## Limitations

Within every project, there are limitations that one must consider, since not everything that one would like to do can be accomplished. Sometimes, trying to implement everything you want will in fact ruin the final project. Instead of trying to break all the constraints, one must instead make considerations and work around these considerations. If possible, some of the limitations could be considered challenges and you should work to break it down and produce a better product, but the costs of doing so must be accurately estimated and the reasons must be weighted accurately against the problems it may cause.

|  |  |
| --- | --- |
| Limitation | Why? |
| Time | Time is the most obvious limitation – the never-changing constraint that will limit how far I can progress with the game. With infinite time, everything in the game could get infinitely refined, and many features could be added to the game. However, infinite time is not something we have the luxury to. In fact, the entire project must be done within the space of 8 months. Therefore, there will be features that would be desirable but can’t be implemented and some features which will not be as refined as preferable. |
| Budget | The budget for this entire project is nothing. This is a severe limitation meaning that nothing can be outsourced, and while usually you could hire better programmer, and an entire sound design team, nothing of the sorts can be done here. This will have repercussions for the software limitation as well and means that if there are any textures or models I want to use, they must be free or made by myself. |
| Hardware | Maintaining the performance of the game is very important because not everyone has access to top-notch hardware, and the game must run extremely well since speedrunners wish to have zero-latency from sending their actions to receiving feedback on the screen. Therefore, the game must be made as simply as possible, with as much optimisation as well. However, I am also unable to test on different types of hardware, and so the best I can do is testing on Windows on my own system. Furthermore, the game will be only for the PC, since I do not own a console, nor can I get the game files onto a console if I owned one. |
| Software | Software is also a constraint since I can’t acquire all the professional applications, and some applications I can’t run due to my own hardware. Since the budget is zero, all software and third-party resources must all be free, or hand made. |
| Proficiency | While I have used Unity and C# in the past, they were all for basic projects that were copied from tutorials, and as such I will need to learn more of the quirks of the engine and its language, which will take even more of my time to build the game. |

## Solution Requirements

While it would be ideal to have all of the essential features included in the game, not every single one needs to be implemented to the same level of usability as others. Based on the limitations, some features may need to be cut from the game, as is typical within the industry.

|  |  |
| --- | --- |
| Requirement | Justification |
| Movement and Combat | Both movement and combat are single-handedly the most important requirements to exist for this NEA, since they define the primary genre of the game. Without either of these features, it would be incorrect to call the game a movement-shooter. |
| Saving | Every single modern game that is released nowadays has saving since no player is ever expected to finish an entire game in one sitting. To maintain the player’s retention, they must be able to return to most of their progress still available to access. |
| Multiple Levels | For such a fast-paced experience, the game would be unsatisfying and not an adequate experience if not for multiple levels. This will extend the playtime of the game and allow the player to better integrate with and learn the mechanics of the game better. |
| GUI | A GUI is integral for the user to be able to interact with the game, since many engines do not allow the player direct access to a console/terminal for a command-line-interface. A CLI is also far more difficult to use and is less accessible to the average gamer, making this a requirement of the final project solution. |
| Death Screen | This also includes the player being able to die, and this is incredibly important for gameplay. Death is the risk factor, and it is what the player is intending to avoid as they are rushing around and firing at the other enemies. With no risk, there is no need for the player to attempt to play the game as intended. Once death has been achieved, it is important that the player is able to go back to their previous save or restart the level to continue playing. Any hints on how to avoid death are an optional extra to add to the death screen. |

### Hardware and Software Requirements

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| --- | --- |
| Requirement | Justification |
| Computer Hardware | The game is intended to run quickly, with as minimal delay/lag as possible, therefore the GPU requirement is only the need for integrated graphics, or a simple graphics card such that one can have an enjoyable experience, while the CPU requirement is for a chip that can adequately support its GPU. On the side of system memory, the game will require a minimum of 2GB of RAM, so the system would be recommended to have 8GB of RAM, so as not to cause disk thrashing with other programs that the user may have loaded in, which only less that 2.5% of people who play games do not have access to nowadays. |
| Peripherals | The game will have support for both a mouse and keyboard combination (kb/m), or a controller as an input device, but nothing else, as it would be difficult to port all of the controls that would be needed to play the game to another appropriate input system, such as touch controls. The kb/m and controller input schemes are also the most commonly used ones, as evidenced by all the games in my research having support for both of them. |
| Operating System | My project will only be available upon a 64-bit Windows system since that is the most widely used type of system for playing games, coming in at 96.78% of all gamers on the Steam platform according to the Steam Hardware Survey of August 2024. |
| Storage | One would need as much storage as is required to contain all the files of the game and have at least a few gigabytes leftover for a swapfile/pagefile, in case the computer needs to use virtual storage. |
| Software | Many games use the same set of C++ Redistributables and depending on the individual’s proficiency in playing games, they may or may not already have the relevant packages installed. This also includes .Net 4.0, the appropriate drivers for their device and the XNA Framework Redistributable. Furthermore, if the user wishes to use a controller, they will need the right software to connect the controller to their computer, which is usually Microsoft’s XInput, but may also be DInput (an older version for support for more buttons). The appropriate software and drivers are dependent on the user’s own controller. |

## Success Criteria

|  |  |
| --- | --- |
| Criterion | Justification |
| Strafing Movement | Strafing is the barebones required option for moving, allowing access to 2 dimensions, and even the third dimension when slopes are introduced. |
| Jump | While strafing can allow the player to move vertically, it is dependent on the level geometry, and it would instead be a better option to allow the player the ability to jump while on the ground, and maybe even a double jump while in midair. |
| Crouching | To avoid the enemy gunfire or to enter certain sections of puzzles in the game, crouching is a criterion as it allows the player to decrease the surface area that is exposed. |
| Firing weapons | As mentioned, the player must be able to fire weapons to retaliate and survive for longer against their enemies. It is also part of the genre’s title and would be fraud to use the genre ‘movement-shooter’ without the ability to shoot. |
| Can take damage | While the player can damage others, in turn, they too must be able to take damage, allowing an even playing field and forcing the player to take better and safer movement routes, or prioritise more dangerous enemies. |
| Ability to go back to a save on death | Once the player’s health reaches below 0, the only logical option is for the player to die, which reinforces the risk with taking damage. The player must then be able to continue playing which in a singleplayer campaign, is usually done by reloading a previous save. The death screen will contain a button to do so, by selecting between a variety of saves. |
| Saving | This allows the player to retain their current progress for later, such as when they close the game, or if they suspect that they might be in a tricky situation. |
| Loading | Conversely, one must be able to load the save that they made to bring meaning to the saving feature and re-enter the state that they were in when making the save. |
| Menu with buttons | The GUI is the most accessible method of navigating through menus and interacting with the game. Out of all of these, the button is the most intuitive and useful of selecting options, instead of a scrollable menu. |

# Design

## Decomposition

### Combat

#### Weaponry

##### Swapping

Being able to swap out your weaponry on the fly is what encourages players to try new things in the game. This swaps the currently selected weapon with the weapon that the player is looking at.

##### Guns

1 of the 3 types of weaponry is guns that allow the player to deal damage from range, firing bullets that damage upon clicking the button via a raycast.

##### Melee

The second type is melee weaponry which deals high damage from close range, like bats and blades, requiring a collision check instead.

##### Grenades

The last type is grenades, which are lobbed, following a physical arc and dealing explosive damage based on its range.

#### Player

##### Movement

###### Horizontal

All movement that uses the basic strafing keys are handled similarly within the same function, moving the player in the direction of the keys relative to the current facing angle in the horizontal plane. This will all be held in one function, that references other functions to access the relevant acceleration values for the different movement types and the speed limits.

###### Vertical

This encompasses jumping, gravity and the lack of control the player should have when moving in air. While the player is not on the ground, gravity will constantly accelerate them downwards. Jumping allows one to get over an obstacle by adding vertical velocity, but it is also possible to ramp off slopes and get far more verticality that way. Due to this, one will have lower control of the character once in the air, needing them to plan their original trajectory. Ramping will be automatically handled by the physics system that is built into Unity 3D, while both jumping and gravity will be separate functions. Jumping will be triggered upon the input being pressed, while gravity will be triggered every frame.

###### Wallrunning

Wallrunning is a special case of movement since the plane of movement then becomes that of the wall you are running on, and the player can only move forward on this wall, fall off or jump off. This allows them to stick to the wall and is an entirely separate movement option than the others.

#### Entities

All entity types are shared between allies (friendlies) and enemies, bar the civilians which are only on the enemy side, as is in line with the setting of the game.

##### Drones

An enemy that flies around and maintains a height-advantage on the player where possible. Depending on their type, they may act differently, such as shooting from afar for ranged drones, or moving towards the player for explosive and melee drones.

##### Soldiers

An enemy that moves around only on the ground and will drop weapons and ammo when killed. Will stay away from the player but will attempt to maintain line of sight.

##### Tanks

Large and slow ground-based vehicles that deal heavy explosive damage occasionally. Have exceptional range compared to any other type of troop.

##### Civilians

Cannot deal damage and will run away from enemies.

### Environment

#### Ground

Allows for all basic movement and disables gravity while the player is stood upon it. It also prevents the player from falling out of the bounds of the level. Moving up a slope will convert some of your horizontal velocity to vertical velocity as per the physics dictate.

#### Walls

The player can wallrun upon them but loses all other types of movement except jumping. Also disables gravity and prevents access to certain places.

#### Pickups

Items will be scattered around the level, such as coins or weapons that the player can pick up and use, encouraging exploration and challenge.

#### Interacts

Objectives for the level can be anything and are interacted with. Other things like doors and upgrades can also be interacted with.

### UI

#### HUD

The heads-up display shows important information to the player, such as their health, what the active weapon is, how much ammo that weapon has, and outlines for enemies for clarity. It cannot be interacted with but is a necessary part of gameplay.

#### Menu

##### Title screen

Loads on startup, allowing access to the options menu and save menu, along with exiting the game. Displays the name of the game

##### Options

Changes settings such as game volume and mouse sensitivity.

##### Pause

Pauses the game and allows the player to return to the main menu. Does not save the current state of the game.

##### Pre-level inventory

Provides a GUI for the player to assign upgrades appropriately and select the contents of their weapon slots.

##### Save menu

Displays all the save slots, each displaying 4 things: the slot number, the save history menu, the time spent in the save, and the name of the level.

##### Checkpoints

Will automatically save the progress of the player in the game at these points, creating an autosave.

###### Load game

Once a save has been selected, it will load the attributes into memory and load the level

### Dialogue

#### Interpreter

Reads the .dlg file and translates the instructions to instructions/lines for the manager to assign.

#### Actors

Will look towards appropriate actors according to the interaction and message sent by the manager.

#### Managers

Handles the receiving of instructions from the interpreter and assigning the appropriate actors their roles, or sending the subtitles/choices to the subtitles text box

## Structure Definition

## Algorithms

### Movement

procedure SetPlayerDimensions(height, radius)

previousHeight = playerCollider.height

playerCollider.height = height

player.transform.position = player.transform.position - Vector3(0, (previousHeight - height)/2, 0)

endprocedure

This changes the dimensions of the player which will be shaped like a capsule (a cylinder with hemispheres at either end) to be set to the parameters of height and radius, allowing for the scaling of the player character and crouching, then moving the player character down the difference in height.

function CrouchControlState()

holdCrouch = playerInputs.Player.HoldCrouch.inProgress

if playerInputs.Player.toggleCrouch.triggered then

if toggleCrouch == true then

toggleCrouch = false

else

toggleCrouch = true

endif

endif

if holdCrouch == true then

lastHoldCrouchState = true

return true

else

if lastHoldCrouchState == true then

toggleCrouch = false

endif

lastHoldCrouchState = false

return toggleCrouch

endif

endfunction

Since the stakeholder requested both the ability to toggle crouch and a crouch that must be held using two separate keys, this function decides what the appropriate crouch state is, based upon the values of the keys pressed and their previous values.

procedure Gravity()

if NOT isGrounded then

movement = movement – gravity \* Time.deltaTime

endif

endprocedure

So long as the player does not have contact with the ground, they feel a constant acceleration of gravity downwards - a necessary factor of a movement-shooter game where the intuitive physics is key.

procedure Crouch()

if lastMovementState != movementState then

if movementState == PlayerMovementState.crouching OR movementState == PlayerMovementState.sliding then

SetPlayerDimensions(crouchingHeight, playerRadius)

else

SetPlayerDimensions(standingHeight, playerRadius)

endif

endif

endprocedure

When the player has just changed their movement state, and that state is from standing to crouching, or vice versa, it calls the relevant function with the correct dimensions. Having this be a simple function reduces the chances for any bugs which fulfils the primary requirement for Amarveer Flora, and also makes it highly maintainable, simultaneously participating to the needs of Henry Masters.

procedure Movement()

acceleration = baseMovementAcceleration

target = player.rotation \* inputDirection

alignment = Vector3.Dot(groundVelocity.normalized, target.normalized)

if groundVelocity.magnitude > maxSpeed then

acceleration = acceleration \* groundVelocity.magnitude / maxSpeed

endif

direction = target \* maxSpeed - groundVelocity

direction = Vector3.ProjectOnPlane(direction, groundNormal)

direction = direction.normalized \* acceleration

direction = direction - direction \* frictionMultiplier

movement = movement + direction \* Time.deltaTime

endprocedure

This is the main movement code, converting the player’s rotation and inputs into a movement in that direction, adding the movement to a global movement variable. This way, all the movement, both horizontal and vertical is all applied simultaneously and does not cause any errors with the physics system that Unity uses which contributes to Amarveer Flora’s primary need of as little bugs as possible.

procedure Jump()

direction = Vector3.up \* jumpForce

if velocity.y < 0 then

direction.y = direction.y - velocity.y

endif

if isGrounded == true then

movement = movement + direction

else if airJumpsLeft > 0 then

movement = movement + direction

airJumpsLeft = airJumpsLeft - 1

endif

endprocedure

One of the other primary movement options that the stakeholders requested was jumping, which is also vital in a game centred around movement. This code also handles the ability to double jump, and any potential amount of jumps the player could have by having 2 variables – airJumpsLeft tracks how many more times the player is allowed to jump in the air before they must touch the landscape of the level. Once they do collide with the level geometry, then airJumpsTotal resets airJumpsLeft to the appropriate value so that the player can restart jumping in mid-air. This is handled by the following code:

procedure CollisionDetected(collision)

if collision.contacts.Length > 0 then

for i = 0 to collision.contacts.Length - 1

slopeAngle = Vector3.Angle(contact.normal, Vector3.up)

airJumpsLeft = airJumpsTotal

if slopeAngle > maxSlope then

wallNormal = contact.normal

Wallrun()

else

isGrounded = true

groundNormal = contact.normal

endif

next i

else

isGrounded = false

groundNormal = Vector3.up

endif

endprocedure

This handles all responses to collisions, such as deciding if the surface touched is a wall or walkable floor and setting isGrounded to true for the gravity calculations. This is better than this other algorithm (see below), which has to make an extra check on the physics system, rather than leveraging the automatic function calls it makes. It also only checks if one is on the floor, rather than doing 2 jobs with the same checks.

function GroundCheck()

return Physics.CheckSphere(new Vector3(player.transform.position.x, player.transform.position.y - groundDistance + (0.99f \* player.transform.localScale.x \* playerCollider.radius) - (player.transform.localScale.y \* playerCollider.height)/2, player.transform.position.z), player.transform.localScale.x \* playerCollider.radius \* 0.99f, playerLayer)

endfunction

This function creates a sphere that has the same radius as the player and is positioned at the player’s feet, checking if there is anything intersecting that sphere. This is more expensive than the above solution, and so will not be used.

procedure Boost()

movementState = movementState.boosting

inputDirection = playerInputs.Player.Movement.ReadValue()

boostMovement = player.rotation \* inputDirection \* groundVelocity.magnitude \* (boostMultiplier - 1)

movement = movement + boostMovement

endprocedure

An optional feature that the founder of SillyAustralian wanted included, boost takes the current player’s velocity and multiplies it by a factor, another potentially upgradeable value for the player. It then adds this value onto the player’s current velocity, meaning it could be used by a player to instantly turn around and move in the other direction.

procedure Look()

lookMotion = lookAction.ReadValue<Vector2> \* mouseSensitivity / 20

playerBody.rotation = playerBody.rotation \* Quaternion.Euler(Vector3.up \* lookMotion.x)

verticalRotation = verticalRotation - lookMotion.movementY

verticalRotation = Mathf.Clamp(verticalRotation, -90, 90)

transform.localRotation = Quaternion.Euler(verticalRotation, 0, 0)

endprocedure

The final movement algorithm is the one that handles the player’s ability to look around in 3-dimensions. It converts the player’s horizontal mouse movement to a horizontal rotation and their vertical movement into an up-down looking motion.

### Enemy Entities

procedure FixedUpdate()

velocity = rigidbody.linearVelocity

if state != enemyState.None then

if target != null then

RotateToTarget(target.transform)

endif

if state == enemyState.Combat then

movementTarget = target.transform.position - (target.transform.position - rigidbody.transform.position).normalized \* midRange

ApplyMovement(movementState)

Combat()

else if state == enemyState.Searching then

if (searchingTarget - rigidbody.transform.position).magnitude < 1 || NOT searchTargetSet then

SelectTarget()

searchTargetSet = true

ApplyMovement(searchingTarget)

Searching()

endif

endif

lastPosition = rigidbody.transform.position

endprocedure

This controls the enemies next actions, depending on the state of the enemy. The enemy shall have 3 states that it references within its code: None, Searching, and Combat. None is the state that shall be used to deactivate the enemy’s AI when it is not in use, such as before a combat scenario, while Searching is for when the AI is active, and looking for enemies. Finally, Combat is for the time once an enemy has been discovered, and hence the AI should fight it.

function PIDUpdate(timeStep, currentValue, targetValue, lastPosition:byRef, lastError: byRef, storedIntegral:byRef)

error = targetValue - currentValue

force = proportionalGain \* error

derivative = 0

if derivativeType == DerivativeType.Error then

if error - lastError != 0 then

derivative = (error - lastError) / timeStep

endif

else

if currentValue - lastPosition != 0 then

derivative = (currentValue - lastPosition) / timeStep

endif

endif

derivative = derivativeGain \* derivative

storedIntegral = Mathf.Clamp(storedIntegral + error \* timeStep, -maxStoredIntegral, maxStoredIntegral)

integral = integralGain \* storedIntegral

lastError = error

return force + integral + derivative

endfunction

Positional movement by Non-Player-Characters (NPCs) is controlled by a PID controller. PID, standing for Proportional-Integral-Derivative, aims to get a current value to a target value, while making sure that it does not get stuck in a loop, oscillating around the target value. This is achieved with the derivative term, which resists the change, slowing down the overshoot that would occur, eventually making sure that the target value would be reached. The only situation where this wouldn’t occur would be if the system was experiencing a constant force, such as gravity, in which case it would end up settling around a value that was offset from the target. The integral component will sense this error and slowly accumulate it to push the current value back up to the target.

procedure ApplyMovement(target)

movementX = PIDUpdate(Time.fixedDeltaTime, rigidbody.transform.position.x, target.x, lastPosition.x:byRef, lastError.x:byRef, storedIntegral.x:byRef)

movementY = PIDUpdate(Time.fixedDeltaTime, rigidbody.transform.position.y, target.y, lastPosition.y:byRef, lastError.y:byRef, storedIntegral.y:byRef)

movementZ = PIDUpdate(Time.fixedDeltaTime, rigidbody.transform.position.z, target.z, lastPosition.z:byRef, lastError.z:byRef, storedIntegral.z:byRef)

movementTotal = new Vector3(movementX, movementY, movementZ)

if movementTotal.magnitude > maxMoveSpeed then

movementTotal = movementTotal \* (maxMoveSpeed/movementTotal.magnitude)

endif

rigidbody.AddForce(movementTotal)

endprocedure

Since PIDUpdate only works on a single value, it is repeated 3 times for each of the respective dimensions with the appropriate values, and then the magnitude of the final vector is clamped to the maxMoveSpeed so that the entity does not move extremely fast.

procedure Searching()

for i = 0 to rayCount - 1

hitInfo = new hitInfo()

rayDirection = Quaternion.AngleAxis(-45f + rayAngle \* i, Vector3.up) \* Vector3.forward

rayDirection = rigidbody.transform.position \* rayDirection

if Physics.Raycast(rigidbody.transform.position, rayDirection, hitInfo:byRef, DetectionRange, playerLayer) then

state = enemyState.Combat

UpdateManager(enemyState.Combat)

target = hitInfo.collider.gameObject

break

endif

next i

The enemy searches via shooting multiple rays out from its front within 45 degrees either side of the direction it is facing in. It sees what is a slit of vision and if the player collides with any of the rays, then the player is set as the target, changing the mode to combat.

procedure SelectTarget()

found = false

point = GetClosestPoint(found:byRef)

if NOT found then

searchingTarget.y = rigidbody.transform.position.y - DetectionRange

return

endif

entityToPoint = rigidbody.transform.position - point

if entityToPoint.magnitude > DetectionRange then

searchingTarget = point - entityToPoint.normalized \* Random.Random(0, DetectionRange)

return

endif

accessible = false

while NOT accessible

searchingTarget.x = Random.Range(-DetectionRange, DetectionRange)

searchingTarget.y = Random.Range(-DetectionRange, DetectionRange)

searchingTarget.z = Random.Range(-DetectionRange, DetectionRange)

searchingTarget = searchingTarget + rigidbody.transform.position

hitInfo = new RaycastHit()

if Physics.Raycast(rigidbody.transform.position, (searchingTarget - rigidbody.transform.position).normalized, hitInfo:byRef, DetectionRange) then

if (hitInfo.point - rigidbody.transform.position).magnitude < 1 then

continue

else

searchingTarget = hitInfo.point

endif

endif

accessible = true

endwhile

endprocedure

Selecting an appropriate target for the enemy to move to while it is searching is a difficult procedure. One option is to make the enemy to move along predefined paths, but for better gameplay interaction, the enemy itself chooses a random point that it can see and moves towards this target. The target is confirmed to be within the enemy’s vision by firing a raycast from the enemy to the target and confirming that it does not interact with anything.

procedure RotateToTarget(target)

targetDirection = target.transform.position - rigidbody.transform.position

dirInQuaternion = Quaternion.Euler(targetDirection.normalized)

rigidbody.transform.rotation = Quaternion.Slerp(rigidbody.transform.rotation, dirInQuaternion, RotationSpeed \* Time.fixedDeltaTime)

endprocedure

The final algorithm that the enemy needs to use is a method to rotate towards its target, so that it is facing the right way when it needs. This is done by spherically interpolating between the direction towards the target and the current direction of the enemy. This makes the enemy move in a manor more visually appealing, rather than snapping towards the target.

### Weapon and its Interaction

procedure Fire()

Instantiate(bullet, barrel.transform.position, barrel.rotation)

endprocedure

Arguably the easiest function in the entire game, it fires in a bullet by spawning in a new bullet. Nothing can go wrong here.

procedure BulletCheck()

RaycastHit hitInfo = new RaycastHit()

if Physics.Raycast(

origin: transform.position,

direction: transform.rotation \* Vector2.up

hitInfo: hitInfo:byRef

) then

hit = hitInfo.collider.gameObject

entityClass = hit.GetComponent<Entity>()

if entityClass != null then

hit.SendMessage("Damage", damageAmount)

endif

endprocedure

On the other hand, the bullet itself makes sure that it hits a target and that it deals damage to a target. It does so by checking if there is an object that can be damaged in its path, and hence telling it to damage itself with SendMessage().

procedure SwapWeapon(inputType)

if slotsFilled > 0 then

direction = inputType.ReadValue<int>();

CurrentWeapon(activeWeaponSlot).SetActive(false)

CurrentWeapon(activeWeaponSlot).transform.position = weaponStow.position

activeWeaponSlot = Wrap(activeWeaponSlot + direction, weaponSlots)

if SelectFireWeapon() == null then

activeWeaponSlot = Wrap(activeWeaponSlot - direction, weaponSlots)

endif

CurrentWeapon(activeWeaponSlot).transform.position = weaponHold.position

CurrentWeapon(activeWeaponSlot).SetActive(true)

endif

endprocedure

Swapping a weapon requires checking if there are any weapons to swap to in the first place, but once checked, all that must happen is that the current weapon is disabled and moved out of the way, and the new one is moved into the right spot and then enabled. CurrentWeapon() is a function that returns the appropriate weapon based upon the slot. This is because all the weapons are stored as individual variables and referred to via a switch statement.

function GetSwapSlot(wasUsed:byRef)

if slotsFilled < 4 then

wasUsed = false

return activeWeaponSlot + 1

endif

wasUsed = true

return activeWeaponSlot

endfunction

This function attempts to retrieve the slot that the player needs to access to pickup a weapon. If they do not have all their slots filled, then the next one is supplied. Otherwise, the current one is returned so that it can be swapped out and changed for the new weapon.

procedure Interact(inputType)

RaycastHit hit = new RaycastHit()

if Physics.Raycast(

origin: playerHead.transform.position,

direction: playerHead.transform.rotation \* Vector3.forward,

hitInfo: out hit

) then

if hit.collider.gameObject.tag == "Weapon" then

AddWeapon(hit.collider.gameObject)

endif

endif

endprocedure

Interact() allows the player to sense and pickup a weapon and is required due to the input system. Sensing is done via a raycast from the centre of the player’s vision. And checking the hit object’s tag.

procedure AddWeapon(hit)

wasUsed = false;

activeWeaponSlot = GetSwapSlot(wasUsed)

if wasUsed then

CurrentWeapon(activeWeaponSlot).transform.SetParent(null, true)

CurrentWeapon(activeWeaponSlot).transform.position = weaponHold.position

CurrentWeapon(activeWeaponSlot).transform.rotation = weaponHold.rotation

else

SetWeapon(Wrap(activeWeaponSlot + 1), hit)

endif

CurrentWeapon(activeWeaponSlot).transform.SetParent(playerHead.transform, true)

CurrentWeapon(activeWeaponSlot).transform.position = weaponHold.position

CurrentWeapon(activeWeaponSlot).transform.rotation = weaponHold.rotation

endprocedure

To pick up a weapon, first, you must check if there is a weapon you must get rid of, which has to be enabled and unparented from the player. The picked-up weapon is parented to the player, and then placed into the holding spot.

### Dialogue

procedure PreprocessSections()

fileLines = dialogueFile.text.Split("\n")

for i=0 to fileLines.Length - 1

line = fileLines[i]

if line.StartsWith("[") AND line.EndsWith("]") then

dialogueSections.Add(line[1..^1], i)

endif

next i

endprocedure

Dialogue will consist of sections which the text can jump to, and these need to be preprocessed before hand by scanning through every single line of the text file and searching for lines that both start and end with “[“ and “]”, which is the markers for the dialogue. These lines are added to a dictionary for fast lookup.

function RequestNext(isDialogue, language, lineID)

connection = isDialogue ? ddm.OpenDialogueDb() : ddm.OpenActorDb()

lineRequest = connection.CreateCommand()

lineRequest.CommandText = $"SELECT {language} FROM {(isDialogue ? "Dialogue" : "Actor")} WHERE id={lineID}"

response = lineRequest.ExecuteReader()

response.Read()

line = response.GetString(0)

connection.Close()

return line

endfunction

Similarly, the object needs to request a new line by requesting the appropriate ID from a database. All the above code are required to send an SQL query to a database.

function ConvertLine(line)

copy = line

firstItalics = true

firstBold = true

for i=0 to line.Length

if line[i] == '\\' then

i++

else if line[i] == '<' then

hexColour = line.Substring(++i, 7)

copy += "<color=" + hexColour + ">"

i += 6

else if (line[i] == '>') then

copy += "</color>"

else if (line[i] == '\_') then

if firstItalics then

copy += "<i>"

firstItalics = false

else

copy += "</i>"

firstItalics = true

endif

else if line[i] == '\*' then

if firstBold then

copy += "<b>"

firstBold = false

else

copy += "</b>"

firstBold = true

endif

else

copy += line[i]

endif

return copy

endfunction

Parsing the retrieved line from the database is required to put it into a format read by Unity 3D, which uses RichText to display its text in UI elements. It simply runs through every character in the line, and replaces it with the appropriate tag. For tracking whether a piece of text is bolded or italicised, a boolean is used for each individually.

procedure ReadNext(line, lineTree)

while NOT line.EndOfStream

char token = ReadChar(line)

if token == '#' then

ReadID(line, lineTree)

else if token == '@' then

ReadIf(line, lineTree)

else if token == '-' then

ReadJump(line, lineTree)

else if token == '|' then

ReadChoice(line, lineTree)

else if token == ':' then

token = ReadChar(line)

if token == ':' then

ReadSeparator(line, lineTree)

endif

else

throw new System.Exception($"Tokenizer: The starting character '{token}' was not recognised.")

endif

endwhile

endprocedure

function ReadNumber(line)

num = ""

while NOT line.EndOfStream

character = PeekChar(line)

if int.TryParse(character.ToString(), \_) then

num += ReadChar(line)

else

break

endif

endwhile

inted = 0

int.TryParse(num, inted)

return inted

endfunction

### Save System

procedure Save(data, type, saveSlot)

type = new CultureInfo("en-US", false).TextInfo.ToTitleCase(type)

path = Path.Combine(Application.persistentDataPath, "Saves", "Slot" + saveSlot.ToString(), type)

fileMatch = "Slot" + saveSlot.ToString() + type + "\*.dat"

array matches[] = Directory.GetFiles(path, fileMatch)

Array.Sort(matches)

fileNum = 1

if matches.Length > 0 then

lastFile = matches[^1]

lastFile = Path.GetFileNameWithoutExtension(lastFile).ToString()

fileNum = Int32.Parse(Regex.Match(lastFile, pattern).ToString()) + 1

endif

path = Path.Combine(path, "Slot" + saveSlot.ToString() + type + fileNum.ToString() + ".dat")

stream = new StreamWriter(path)

json = JsonConvert.SerializeObject(data)

stream.Write(json)

stream.Close()

lookup = GetLookup()

lookup[$"Slot{saveSlot}"] = path

keys = lookup.Keys

values = lookup.Values

lookupWriter = new StreamWriter(Path.Combine(Application.persistentDataPath, "SaveLookup.txt"))

for i=0 to key.Count - 1

lookupWriter.WriteLine(keys[i] + "," + values[i])

next i

lookupWriter.Close()

endprocedure

function LoadSave(path)

sr = new StreamReader(path)

data = JsonConvert.DeserializeObject<SaveData>(sr.ReadToEnd())

sr.Close()

return data

endfunction

function ListAllSlots()

lookupPairs = GetLookup()

if lookupPairs == null then

return new List<SaveSlot>()

endif

if NOT Directory.Exists(path) then

Directory.CreateDirectory(path)

return new List<SaveSlot>()

endif

slotList = new List<SaveSlot>()

for i=0 to directories.Length - 1

directory = directories[i]

folder = directory.Substring(path.Length).TrimStart(Path.DirectorySeparatorChar)

savePath = lookupPairs[folder]

slot = new SaveSlot(savePath)

slotList.Add(slot)

next i

return slotList

endfunction

## Usability

### Game Design

For the designs of certain sections, these have been created within Adobe Photoshop so as to make the creation of elements as fast as possible, and then recreated within Unity as interactable elements. The designs were verified and improved upon by my primary stakeholder, SillyAustralian.

#### First Designs:

##### Main Menu:

A close-up of a sign

Description automatically generated

*SillyAustralian*: This design is very simplistic and does not fit the tone of the game. Abrupt Animus is supposed to be a stark and emotionally powerful game, and the use of white for the background does not make sense in this case. Perhaps it would be better to change this to a grey, and then hence the text to white.

##### Save Slot Menu:

A white background with black text

Description automatically generated

*SillyAustralian*: Similarly with the advice for the Main Menu, the background has to be changed to fit the feel of the game. Other than that, for the save slot menu, we were hoping to implement the slots as a sideways-scrolling menu instead of a list. This way, we could display some more superficial information about each save file so the player can easily recognise which save was the one they wanted. Could you instead make the slots to be black boxes that have the slot number, the current level, and the time spent in that save?

##### Game HUD:

For the Game HUD, since the elements have been placed in many different positions across many different games of the same genre, I decided it would be better to give both my stakeholders the form to complete and pass to some of their top executives. As such, I was able to receive 6 responses in total, which decided the position of these elements. The survey also contained any optional extra elements that could potentially be added.

A screenshot of a graph

Description automatically generated

This ended with a tie between bottom left and top left, and I decided that keeping all the elements at the bottom of the screen would leave more space on the top of the screen, encouraging the player to look up and forward, and not at the ground. Hence, the health bar would be placed in the bottom left.

A screenshot of a graph

Description automatically generated

It was a clear winner that the weapon slots, meaning the currently equipped weapon and the next and previous weapons, should be placed in the bottom right, which separated the health bar and the weapon slots. This may be beneficial for the player since it does not confuse them when they need to only look at their health, which is the most important information to the player in the game.

A screenshot of a computer

Description automatically generated

As for extra elements, response 3, 5, and 6 were not helpful, since these options were not in the original request for the game, nor was there time to implement such features. Response 2 had the potential to be useful, if time permits the inclusion of a quest system, but it is highly unlikely that would be the case. Finally, response 1 and 4 both indicated that the ammunition in the weapon should also be displayed on the HUD, and as such, these features would be displayed on the HUD, resulting in the below design:

A screenshot of a video game

Description automatically generated

##### Choice:

##### A screenshot of a video game Description automatically generated

*SillyAustralian*: This design is almost ready right from the start, however, it would be better if it wasn’t completely opaque, so that the player can also plan their next moves once they have finished their choice. There also needs to be a border around the choice box to clearly mark it off from the rest of the screen and make it clear.

##### Subtitles:

##### A screenshot of a video game Description automatically generated

*SillyAustralian*: The subtitles suffer from the same issues as the choice menu, and as such the same changes need to be applied.

##### Pause Menu:

A black background with white text

Description automatically generated

*SillyAustralian*: When in the pause menu, the player should still be able to see some of the game world, so this menu should not be a stark background, but instead it should be slightly transparent. Furthermore, this needs to have the buttons arranged vertically, with the same box background behind them.

#### 2nd:

#### Main Menu:

A screenshot of a computer

Description automatically generated

*SillyAustralian*: This is much better than the previous design, however it is now difficult to see where the buttons are. Furthermore, we wish to attract the player to playing the game, not exiting it. Maybe try changing the buttons to be vertical and adding a white background to them.

##### Save Slot Menu:

A screenshot of a game

Description automatically generated

*SillyAustralian*: The text ‘Game Slots’ is far too close to the actual slots, so we would like this moved upwards. Furthermore, it seems that the buttons to make a new save and load the current save are missing, so if you could add that at the bottom of the screen, that would be much better.

##### Pause Menu:

A screenshot of a computer

Description automatically generated

*SillyAustralian*: The only change here that is needed is that the normal game HUD needs to be turned off when the player is in the pause menu, so only the gun and environment needs to remain.

#### 3rd:

##### Main Menu:

A screenshot of a computer

Description automatically generated

*SillyAustralian*: This is getting closer to what I had imagined in my head! Just two final points from me:

* We, as a company, have decided that we would also like the version number of the game, so could we have this in the bottom left?
* There is too much negative space at the top of the screen, so maybe we can push all the current elements upwards?

##### Save Slot Menu:

A screenshot of a game

Description automatically generated

*SillyAustralian*: The buttons for the loading and creating of saves requires a background, just like the ones on the Main Menu design. There also needs to be a backdrop to the slots menu and the button panel at the bottom to make them pop out.

*Me (Eshan Fadi)*: Just thinking from an implementation point of view, I’ve realised that there would also need to be a button for reloading the save slots, so should I add that to the button panel on the left side?  
*SillyAustralian*: Hmm, I see. In that case, you should put the reload button on the right, since the ‘New Game’ button should be in the centre.

#### Final Agreed Designs:

##### Main Menu:



##### Save Slot Menu:

A screenshot of a game

Description automatically generated

##### Game HUD:

A screenshot of a video game

Description automatically generated

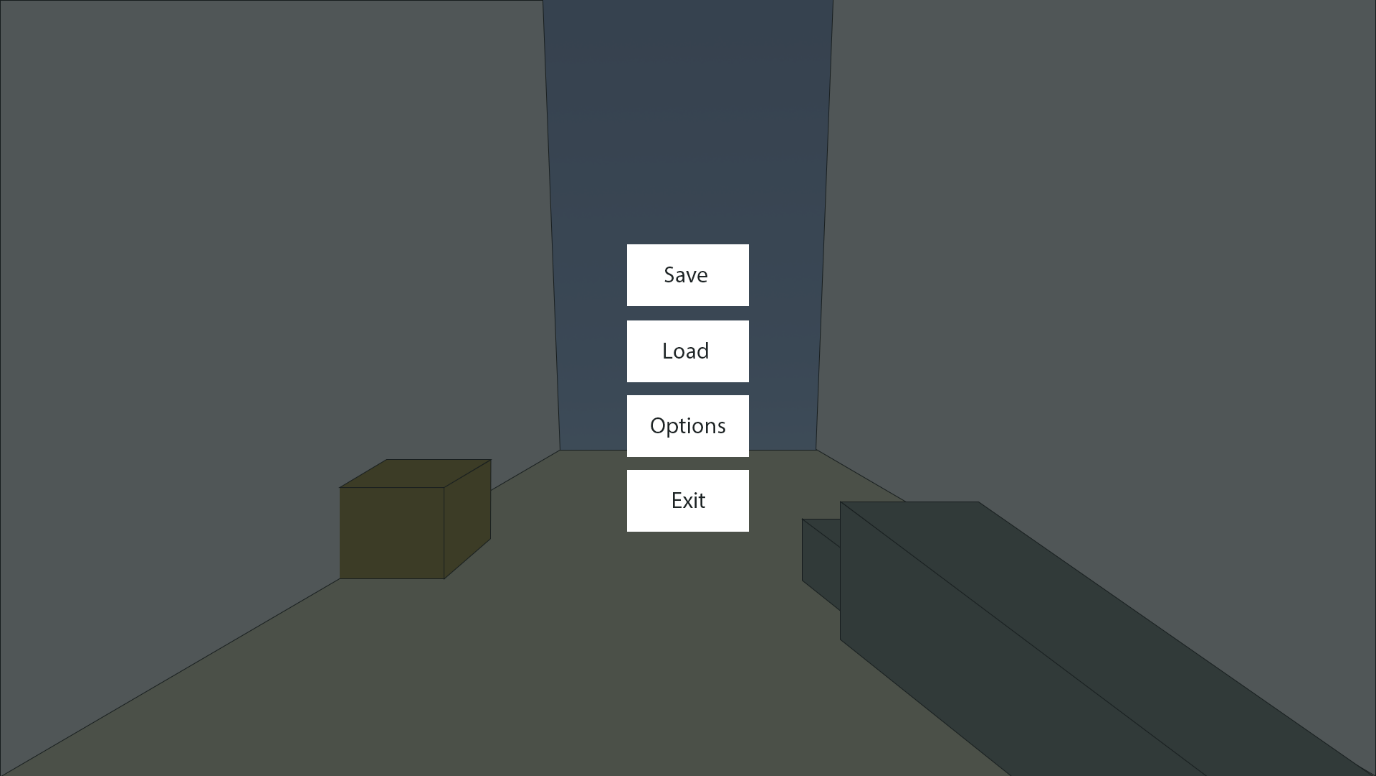
##### Choice:



##### Subtitles:



##### Pause Menu:



## Variables and Data Structures

|  |  |  |
| --- | --- | --- |
| Type | Name | Justification |
| Movement | | |
| Float | maxSpeed | Limits the player’s speed so that they don’t go too fast and break the game |
| Vector3 | movement | Contains the total movement of all the different movement functions, which is then applied together at once |
| Float | standingHeight | The height of the player when standing |
| Float | crouchingHeight | The height of the player when crouched |
| Bool | isGrounded | Used by the gravity and jump functions to check if the player is touching the ground |
| Float | maxSlope | Used by the collision detection function to partition collisions into floors and walls |
| Float | gravity | How fast the player should accelerate downwards |
| Float | jumpForce | The speed the player leaves the floor when jumping |
| Int | airJumpsTotal | An upgradeable value that makes sure that combined with airJumpLeft, controls the ability to jump in midair |
| Int | airJumpsLeft | Makes sure that the player can’t jump away too far |
| PlayerMovementState | movementState | The current state the player is in such as walking or crouching |
| PlayerMovementState | lastMovementState | Used by the crouching function to check whether the player has changed to crouching from a previous state to then change the player’s dimensions |
| Float | friction | A percentage of the player’s speed that is taken away per frame while on the ground |
| Float | drag | Same as friction but for in the air |
| Bool | holdCrouch | Stores the state of the key responsible for the crouch that must be held |
| Bool | toggleCrouch | Stores the state of the key that can toggle crouching |
| Bool | lastHoldCrouchState | Used to detect a change in the state of holdCrouch |
| Dialogue | | |
| Database | Dialogue | A database is the best way to store similar/linked versions of the same piece of data such as different languages of text and select the right language at the appropriate moment. See below for in depth. |
| Save System | | |
| Text File | Save Lookup | This needs to be used to quickly load the last used save on a slot |
| TMP\_Text | scene | A reference to the text object on the GUI that is the scene name of the save file. |
| Dictionary<string, string> | lookup | A usable form of Save Lookup for the code to use |
| List<SaveSlot> | slots | Used in the slot displaying system by the GUI after retrieving a list from the SaveSystem |
| Class | SaveSystem | A static class with functions handling saving the player’s data, loading that data into the game, and listing out the saves for external systems. |
| Class | SaveSlot | A temporary container used for the save slot GUI with basic information about a save slot to minimise memory usage. |
| Entities | | |
| Class | Entity | Handles health and damage |
| Class | PlayerEntity | Inherits Entity, allows the player to improve their maximum health |
| Class | EnemyEntity | Inheriting Entity, it implements AI searching, moving, and attacking, along with communicating with a commander. |
| Class | Drone | Inherits EnemyEntity, modifying functions to move in 3 dimensions instead of one the ground. Has far detection range and high speed but weak |
| Class | Soldier | Inherits EnemyEntity, moves on the ground with low detection range and average movement abilities and health |
| Class | Tank | Inherits EnemyEntity, moves on the ground with extremely far detection range and high health but extremely low speed |
| Weapons | | |
| String | WeaponType | An ID for the weapon, allowing it to be loaded by the save system |
| Int | TotalAmmo | The total number of shots left before more ammo needs to be picked up |
| Int | AmmoInClip | The total number of shots left before the weapon needs to be reloaded |
| Class | Weapon | An abstract class that mandates a method Fire(), a weapon type, the ammo left in a weapons clip, and the total ammo a weapon has |
| Class | Gun | A ranged weapon that fires bullets, dealing damage |
| Class | Blade | A melee weapon using a collider to deal damage |
| Class | Explosive | Deals damage to all entities within its range |

### Enumerators

Enumerators are more human readable way for the states of an object. Instead of having:

if gameState == 0 then

print(“Game has ended”)

else if gameState == 1 then

print(“Game is running”)

. . .

You could instead have an enumerator which names the states and makes it easier to read and remember. It’s far easier to remember if the state is equal to running, instead of remembering that the state is equal to 5, which is running. This is hugely beneficial for maintainability which is what the primary stakeholder required – that the game was easily maintainable and could be improved by other people.

#### PlayerMovementState:

* Idle
* Crouching
* Sliding
* Walking
* Sprinting
* Boosting
* Wallrunning

#### DerivativeType:

* Velocity
* Error

#### MemberState:

* None
* Searching
* Combat
* Dead

### Databases

This project uses a few databases throughout the game to store certain predefined constants. For saving and changing variables, other types of files are used as appropriate to the industry standard, such as level data being stored within the player’s save file instead of a database.

#### Dialogue:

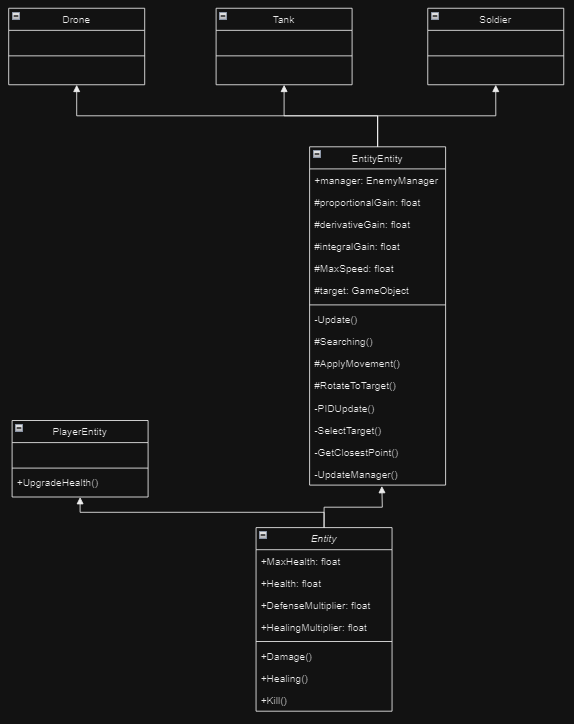
This database contains 2 tables that are not linked to each other through any keys: *Actor* and *Dialogue*. The *Actor* table contains only a primary ID (of type INTEGER) and the respective name of the actor to be used within the subtitles of the system. The *Dialogue* table also contains a primary ID (also of type INTEGER) and the line of dialogue in the next field. However, the field name is the name of the language that you wish to use, allowing SillyAustralian’s company to add support for many other languages if they wish to, and the underlying system will need to have support for this.

#### SceneInfo:

This is a flat file containing information about every scene

## Class Diagrams

### Entities



The Entity class system primarily manages the health and damage of the entity it is attached to. However, *Entity* is an abstract class used only as a framework for the PlayerEntity and EnemyEntity. The only extra functionality the player needs is to upgrade their maximum health, while EnemyEntity adds far more functionality to the base class. For enemies, it also provides the functions for its AI and communication systems. While called EnemyEntity, it will also be used for friendly entities, since they have the same use and intent, with only the range of acceptable targets being changed, such as from the Empire to Varsia (the two countries involved in the war).

The main movement the AI will use will be a PID controller, which is used in industrial applications to bring a robot system back to the target without getting stuck in a cycle. It will also be looking for entities opposing it within a cone, limited by its maximum detection range. This tried and tested method is perfect for the enemies.

### Weapons

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Weapons are how the damage will be dealt to both players and entities in an interactable form. *Weapon* itself is an abstract class that makes sure all following weapons have the correct fields that the save system uses to save their data, while also making sure that weapons have the same public Fire() method that will be used allow scripts that interact with the weapon to use them. This system is also useful for when SillyAustralian wishes to add in more weapons, as OOP makes it easy to add in more weapons, while retaining the previous features, and also combining different weapons for more effects.

## Iterative Tests

## Post Tests

# Development

## Evidence

### Input Detection

To handle the detection of many different actions from many different input sources, I will be using Unity’s built-in Input System package. Within this, I can set up different input maps, such as ‘Player’, and each of these maps have different actions, such as ‘Fire’, and ‘Jump’. I can easily assign to each of these actions multiple different input types that activate them. Actions are a special version of an event, which is a way for functions to be run when something happens. So, when the user presses one the inputs, the related action emits a signal to all the event’s subscribers (the term for functions listening for the event), which all activate simultaneously. This is how the game senses the inputs.

Since multiple input maps can have actions that are enabled with the same inputs, only one input map must be enabled at any time, and the same instance of the input map must be used across all scripts. To follow this criterion, a script called PlayerManager.cs exists, of which one of its functions is to instantiate a new set of inputs and enable the Player input map the moment the game starts. The reference to this map is public, meaning any class wishing to get the inputs of the user needs only reference this variable. Similarly, if the map needs to be changed, such as one used to handle UI, any script can do so, and it will permeate across all, making sure that no unintended actions occur when the player is intending to do something else.

### Movement

Movement is the most important aspect, and as such, a lot of time has been spent implementing many aspects of the movement. I originally started with a rigidbody method. This works in tandem with the built-in Physics system of Unity where all movement inputs are applied with forces to the player. First, we define many variables that are required, such as the maximum walking speed, the friction, and the current movement state, among others.

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When the object is initialised, we need to fetch the player’s rigidbody, along with enabling the player’s inputs. Also, at the start of the game, since the player is not moving, they are idle and so this must be set as well.

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After that, we begin the code for what happens every frame (in Update() ). This includes retrieving the player’s velocity and copying it to an internal variable, along with deciding what the player’s movement state is. Then we need to take the movement inputs, decide the required movement amount, then apply friction. Furthermore, we need to make sure to limit the player’s speed, and then finally send the resulting change to the Physics system.

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You have to make sure to take the absolute of the ground velocity’s magnitude (horizontalVelocity.magnitude) when comparing it to the maxWalkSpeed. FrictionMultiplier() is a relatively simple function, as it is only an if statement. Multiplying the output to a vector will result in the remaining velocity if friction was applied.

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Similarly, ClampSpeed() is also simple, this time being a switch case statement, since all it checks against is the enumerator I made earlier.

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AI-generated content may be incorrect.

It uses the built-in function Vector2.ClampMagnitude, which scales the first argument (a Vector2) such that if it is higher than the second argument, it makes the vector smaller until it reaches the second argument. In case the state reached is not recognised, by default the vector is returned to not mess with it.

Finally, Movement() is the most complicated function out of all of these. So long as the player’s wants to move, it will calculate how fast they should be accelerated, and the resulting displacement changed in the time of the last frame. However, it may be that the player wants to move in a direction that they are currently not moving in, and as such these 2 directions need to be smoothly interpolated.

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The function internally calls CalculateAccelerationMultiplier() which also uses the enumerator in a switch case statement to return an appropriate acceleration. This also calls a function that is an equation for how much speed should be gained.

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This works completely fine, and there were no bugs with this setup, and as such I attempted to speed this up. This is because Mathf.Pow is an extremely slow function for my needs, due to there being lots of overhead in case it needs to handle non-integer powers. Since I only need to do a predetermined, integer amount of exponentiation, I can rewrite my own quick function to do this with multiplication, which is much faster.

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At this point, I was ready to move onto Jumping, and hence Gravity. Both of these required knowing about if the player was on the floor or not: one can not jump if they are in the air (note I am implementing only jumping right now, double jump comes later), and it is faster and a better experience to only apply gravity when the player is not on the ground, otherwise the physics system will have to work overtime trying to make sure you don’t fall through the floor.

Since finding out if the player is on the ground requires interacting with the Physics system, many of the following built-in functions will be from the Physics library, such as the first typical method of using Physics.CheckSphere(). This queries the physics system on whether there is a collision within a specified sphere, defined by radius and centre.

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This code seemed to work fine, as when it was run, it did return true when the player was on the ground. To test if it worked when not on the ground, I needed to implement jumping, which should consist of applying a force upwards on the player if they are grounded. With this, we define a new float called jumpForce which we can control in the inspector of Unity.

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Upon binding this function to the Jump action being performed with playerInputs.Player.Jump.performed += Jump;, pressing the jump key does indeed cause the player to start rising at a certain speed. Unfortunately, you can still continue jumping infinitely, showing there is indeed a bug with GroundCheck(). Upon closer inspection, the query is sensing that it is inside of the player, and hence that is why it is returning true all the time. Consulting the Unity documentation, CheckSphere() has an overload that takes an optional layer mask, which will exclude objects on those layers from being sensed.

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A screen shot of a computer

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A screen shot of a computer code

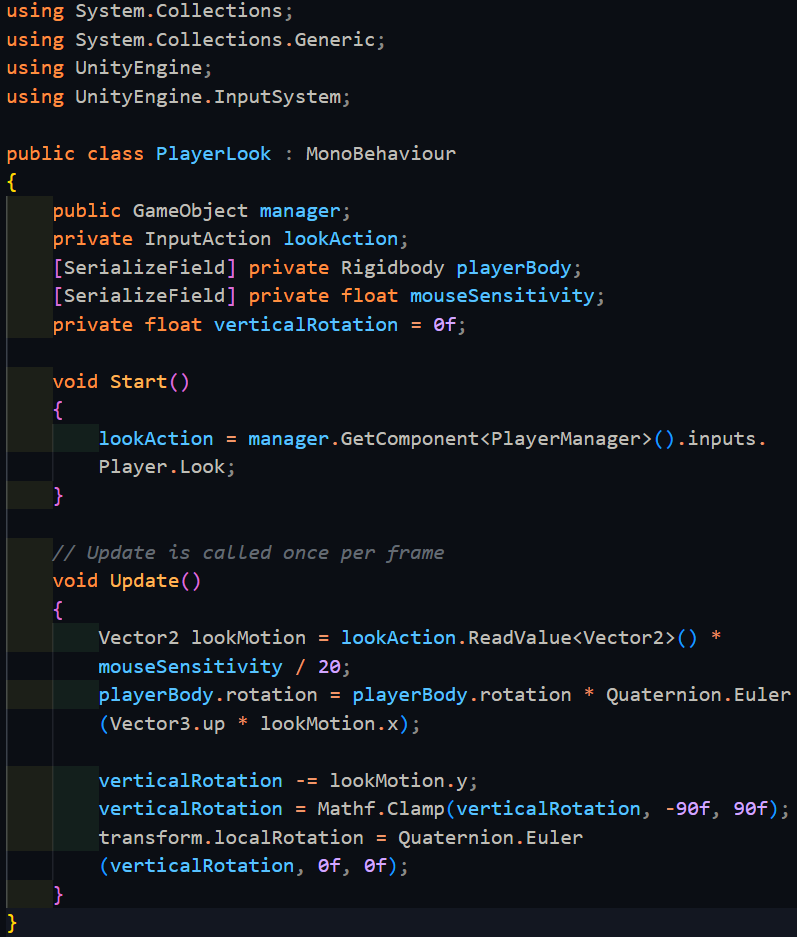
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A computer screen with text and symbols

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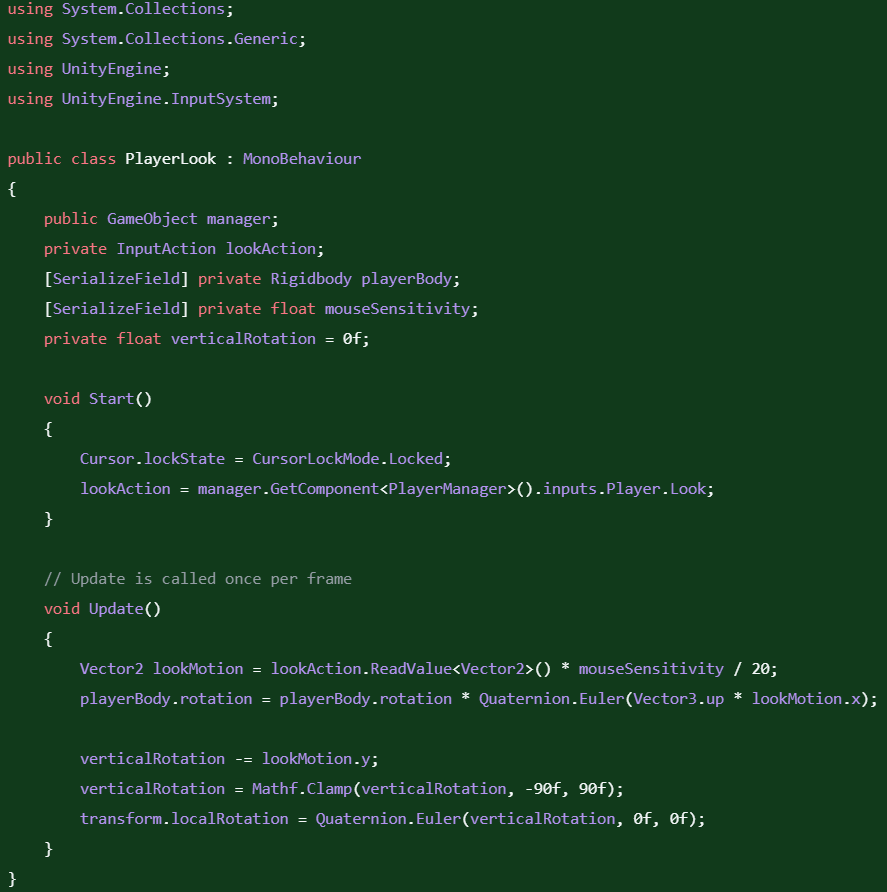
### Look

Handling the ability for the player to look by using their mouse movement was not complicated on its own. However, the movement scripts needed changing to account for the player's new ability to face any direction, instead of the cardinal directions, which was fixed as explained above. Looking can be split into 2 parts: looking side-to-side and looking up and down. Different parts of looking need to interact with different objects. Looking side-to-side can be done by rotating the player’s body on the y-axis (vertical axis) as one would do similarly in reality, however, looking up and down is done by moving your head which is separate from the body. Similarly, the whole body should not rotate when looking up and down, and only the camera should move up and down.



The only purpose of Start() is to retrieve the look action from the manager. The rest of the looking code exists within Update, since it needs to be updated every frame. The look action is a 2D Vector, containing the change horizontally and vertically. The horizontal direction is mapped directly to the vertical rotation of the body, while the vertical direction does not already have a value storing its rotation, so we need to add this in manually. This is then clamped between -90˚ and 90˚ to make sure that the player does not continue looking and end up backwards, theoretically breaking their neck. Since this script is placed onto the camera object, transform.localRotation is used instead of referencing the camera directly to save on memory.

This approach is missing 1 thing: the player’s mouse continues to move off the screen since it is not constrained within the window. This is a distraction and inconvenient when the player clicks, so Cursor.lockState is set to Locked.



### Entities (Damage)

### Interacting with weapons

From switch to array, changed to list

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### Dialogue

Implementing the dialogue system to fulfil all its requirements was incredibly difficult and arduous. To be able to easily add multiple languages, the best solution to this would be to have every single dialogue line in a database, where the different fields are the different languages. All one would need was the record ID and the related language, and the correct line of dialogue would be loaded.

The interactions will be stored in external files with the extension of .dlg, where the flow of lines will be marked with special syntax, of which will be stored in 2 locations: some within the line data in the database, and others within the .dlg file itself. Within the line itself, the syntax is:

* \_ which denotes the text surrounded by them to be in italics
* \* which denotes the text surrounded by them to be in bold
* - which denotes a pause
* < and > surround colour information about the text written in hexadecimal (#FFFFFF) like “<#FFFFFF example> where “example” will be in white.
* \ is the escape character, allowing any of the above characters to be displayed, so long as it is preceded by it

For the .dlg file, the syntax varies more, since rather than styling the text, it instead defines the flow of the lines:

* Dialog sections are marked with [], which is how the dialog will be able to jump and change based on variables. Dialog sections won’t naturally progress to each other unless a -> is used to go to the next section, allowing the last section to continue forever.
* Choices for the player are marked with | at the beginning, and the first choice is used as the title of the choice. These set a local ‘choice’ variable to the number of the choice, which can then by checked and jumped to after. After each choice, a comma is there to indicate another choice is there, except for the last one, signifying it is the last choice.
* Variables will be how the dialog will react to external events. To mark a variable-based line, it will be preceded by @. This will prompt the game to check for that relevant value being set in the save file. If the condition is fulfilled then the dialog will go to the dialog section that is labelled after the -> that succeeds the condition. Otherwise, it will go to the next line. Chaining together many of these will allow an if-else-like behaviour. If a variable is on a line by itself, it can be assigned to a value. Variables can also be assigned values similarly, instead using ’=’ to set the value, and no -> will be required after.
* To request each line of dialog, the line is prefaced with an actor ID, followed by :: then the line ID. The actor IDs are labelled with #Ax and the line IDs are labelled with #Lx, where the x in both is the record ID in the database for each of them.

As you might have noticed, this would require me to create a custom parser for all of this, along with managers for the subtitles and databases. To start with, I had to learn how to use SQL in C#. The database did not need to be hosted online, and as such SQLite was a perfectly usable solution of the SQL dialects. It was also an advantage to use this since I had some experience with using this in Python before, and was a somewhat well-used solution in Unity projects. However, the drawback is that SQLite was overall the least-used SQL dialect, as many flock to using MySQL instead. However, the many variations in syntax and its main use as a multi-user access database system is not a capability I require. In fact, SQLite is extremely useful in being lightweight, and its main use is for small applications such as this game.

Having decided on a dialect to use, I searched around for how this was implemented within Unity or C#. Unity contains a plugin within it called Mono.Data.Sqlite and combined with System.Data from C#, I could create database connections using the IDbConnection interface and send commands using the IDbCommand interface. I would need two databases, one for storing the entire list of actors, and another for storing the dialogue lines. Having all the actors in a database would make the parser easier to construct, since it would not need to be aware beforehand of which scene and interaction it was in – it could be easily generalised to handle all situations. A separate manager would be responsible for assigning the actors to the actual characters in the scene, but this would be included in the scene data making this a worthwhile option. I first started off by making a way to create the database and table connection, resulting in the below code:

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Description automatically generated

This code makes a reference to the StreamingAssets folder of Unity, which is how developers are able to include files unchanged with the build of their application. Usually when a file is included, it is serialized to make it easier and faster to load into memory. This also means that the format of the file changes, so it may no longer be possible to access it like you may have before. The way around this is StreamingAssets, which is where all the databases and .dlg files will exist. This version of the code does not take into account the different ways that different OS define paths to files, nor does it take into account that multiple different databases exist. To handle the different databases, and the different names for the columns, the function was changed to have two parameters: a string databaseName, and an array of strings that contained the columns. To handle the array, a string had to be made that combined the whole array into 1 string.

A screen shot of a computer code

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The for loop would iterate over each string in the array, and add it to the already combined total, along with a comma and a space to separate the different fields. The last field does not need a comma after it, so the last 2 characters will be cut off by taking a substring from the start of columnText, to 2 before the end of it.

To then fix the issue of the different OS, instead of concatenating strings together, I could use the Path class from System.IO which has a function that automatically stiches together a path with the appropriate connectors. I also discovered that C# had range slicing for substrings like Python did, and the code was far shorter to use, and as such I would be using the range operator going forward. To simplify the access of opening the actor or dialogue database to external classes, 2 public functions were made to fill in the required data into the OpenDb function.

A computer screen shot of text

Description automatically generated

Now that other scripts could easily setup a connection with the dialogue or actor database, it was time to start implementing the .dlg files. When the program had to go through the file, it first needed to preprocess it and find where the dialog sections were on the lines of the file. This also needed me to be able to read the text within the file.

Unity has a built in asset type called TextAsset, and the useful property of it was that the text could easily be extracted from within it with a single property. Writing code to sift through the lines and add it to a list of the line number and dialog section name was not terribly difficult.

A screen shot of a computer code

Description automatically generated

It consists of just a simple for loop, checking whether the end and start of a line had square brackets, the defining feature of dialog section headers. The code was extremely simple, but only if the .dlg file was to be recognised as a TextAsset. Unity unfortunately, was unable to do so, even with many attempts, including attempting to write a ScriptedImporter for the filetype.

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This was standard code to do the following, albeit without the icon (this was added as an easier check to see if the file was imported correctly), but unfortunately it would not work. Even after scouring for a solution to this problem, none were found, and as such I had to go for the less memory-efficient and slightly worse approach of using the C# method to opening and reading file contents – StreamReader. While the File class exists, it turns out to be far slower to StreamReader on its own, and as such I went with the below changed code to accommodate StreamReader.

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The new code is very similar to the previous, but has a custom counter instead, and reads off a new line using StreamReader.ReadLine(). It stops when the reader detects it has reached the end of the file.

### Saving and Loading System

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Use Formatting.Indented for readability - maintainability

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### Miscellaneous

#### Referencing the Game Manager

This is a minor change that was used to further optimise the code. Originally, the game manager was an object that could easily be referenced beforehand in each scene just by dragging the reference in the inspector. However, once multiple scenes were added, the manager was changed to an object that was only created once, then persisted between the scene changes. Because of this, the inspector reference no longer worked, since the object would not exist in most scenes before the scene was loaded. As such, GameObject.Find() was first used as such to find the Game Manager object.

A close up of words

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GameObject.Find() is useful, however not every single object required to use it, since some other objects would also be taken along in the scene change, such as the player or certain UI elements. Therefore, you must first check if the manager reference is null, and if it is, fetch the reference.

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GameObject.Find() is a very simple solution to the problem, but it comes with a few drawbacks, of which the main ones are that it is extremely slow (it uses a linear search to find the object) and it uses a string to reference the name of the object which is susceptible to typos. Therefore, the even better solution to reducing the time spent searching for the Game Manager is to not search for it at all, and make it a static reference. This works since only 1 Game Manager exists in memory at any time and therefore no problems will occur. This method is called a Singleton and is commonly used for manager objects.

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First the public reference is defined within the script, and then any script referencing the manager needs only to reference it like below.



This is the best solution since everything is baked into the code beforehand, which is the most efficient solution.

## Prototyping

## Modules

## Comments

## Naming

## Validation

## Reviews

# Development Testing

## Evidence

## Fails

# Evaluative Testing

## Evidence

## Usability Tests

# Evaluation

## Success Criteria

## Usability Features

## Limitations

Game Manager (PlayerManager) should be a static class so that GameObject.Find() does not need to be used and speeds up the runtime a lot.

Grappling

## Maintenance

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