Balanced First Person Shooter Level-Generator

James Moran

# Overview

Having played various First-Person Shooters (FPS), since my early teenage years, as well as having seen the competitive play of more recent FPS titles (such as Counter Strike: Global Offensive (CS: GO)), it has become apparent to me, that creating balanced levels for FPS titles, could be considered a project in of itself. That is in a nutshell, levels that would not favour one side or the other, on an overall basis (with advantages and disadvantages for each team, given where they start in a level, that the Players must overcome). For the creation of balanced levels, having a team dedicated to such a purpose seems necessary, with them using a substantial quantity of the overall project’s resources (the game’s), to create balanced levels.

For context on this issue, there are Players who feel as though specific levels of certain FPS titles, favour one side far more greatly than the other. This leads to Players having feelings of unfairness, in relation to how they are at a disadvantage from the start of a game (irrespective of Player skill-level). This is in respects to the paths Players can take through the level, along with where they would have to look to find enemies at certain points in a path, or from entrances/exits to/from a path, as well as entrances to other paths. (LevelCapGaming, 2014)

The scope of the project, will be broken down into one main phase (with four Bonus Phases):

* Greybox Phase: In this phase, the initial framework for the level generator will be implemented, so that it can produce the geometry for the level (such as the walls, entry and exit points, as well as obstacles to provide cover). Not only this though, as the generator will also have to consider where the chokepoints in the level will be, along with the light/dark areas of the level, as well as how props will affect lines of sight within the level. It will also have to consider the vantage points on the level and all of the routes that the Player can take to navigate through the level
* Bonus Phase One: Collision Bounds Phase: This is a bonus phase (a stretch goal), as it is not critical to the purpose of the project and will only receive implementation, if there is suitable time for such, after completing the first phase of the project. After the geometry for the level has been generated, one could import this level, as a mesh into a game project. The problem with that is, the project handling system (e.g. a game-engine), would consider the level asset as one asset, applying a collision box or sphere, that envelops the whole level. For this phase then, the Level-Generator would have to create collision bounds for each piece of geometry it has generated in the first phase (for walls, obstacles, doorways and other entry/exit points to name a few)
* Bonus Phase Two: Texture Phase: This is a bonus phase (a stretch goal), as it is not critical to the purpose of the project and will only receive implementation, if there is suitable time for such, after completing the first phase of the project, as well as the first Bonus Phase. After a level with suitable geometry and collision bounds has been generated, comes that of applying appropriate textures to the geometry, as per the setting of the game’s level (such as clinical, office related textures, for the corridors/cubicles and walls, of an office building)
* Bonus Phase Three: Prop Phase: This is a bonus phase (a stretch goal), as it is not critical to the purpose of the project and will only receive implementation, if there is suitable time for such, after completing the first phase of the project, along with the first two Bonus Phases. In this phase, props (either dynamic or static) will be added to the level accordingly (such as chairs, desks, stationary equipment, water-coolers, given an office setting). These can either be destroyed, moved or broken through, to remove them as additional obstacles in the level.
* Bonus Phase Four: Lighting Phase: This is a bonus phase (a stretch goal), as it is not critical to the purpose of the project and will only receive implementation, if there is suitable time for such, after completing the first phase of the project, along with the first three bonus phases. If this phase is not undertaken in the project’s development timeline, an ambient (global) light source, will be applied evenly to the whole level, but if this phase is undertaken, then appropriate lighting for each section of the level, will be generated by the Level-Generator (coming from ceiling lights, lamps, torches, external sources (such as from windows), as well as from certain other props in the level (such as a mobile-light source, provided to one or both teams)

To clarify, the focus of this project is on the first phase, with the bonus phases, although unnecessary for the project, the aspects of such phases, are to be considered in the first phase, for balance purposes.

Looking closer at the first phase then, it is important for the generator to consider the following aspects, to generate a balanced level:

* Positional Advantage: Spaces where one Player has an advantage over another
  + Sniper Location: A Protected, elevated location that overlooks a segment of the level (re-envision this for a closed indoor area)
  + Gallery: An elevated area parallel and adjacent to a narrow passageway
  + Choke Point: A narrow area with no alternative routes, causing Players to be exposed to engagement as they move through
* Large-Scale Combat: Areas designed to facilitate combat involving large numbers of Players.
  + Arena: An open area of wide corridor
  + Stronghold: A Confined area with dense cover and limited access points
* Alternative Gameplay: Introduce new elements that break from the established mechanics of the game
  + Turret: An area with a fixed high-powered weapon, where one side has a clear advantage
  + Vehicle Section: Sections of alternative gameplay, where the Player drives or rides in a vehicle (re-envision this for a closed indoor area)
* Alternate Routes: Create alternatives for the Players, in how they approach the level
  + Split Level: A corridor with an upper and lower section, where those on the upper section can attack those on the lower section
  + Hidden Area: A small area off the main route that contains secrets (such as special items), that Players can obtain
  + Flanking Route: An alternate path that allows Players to gain a positional advantage

(Kenneth M. Hullett, 2012)

## Target Platform

This balanced level-generator, will be developed as a tool, for the Unreal Engine 4 (UE4) game engine. This is due to the how the Unreal game engines (with such functionality still included in UE4), favour first person shooters, along with the modularity available, via a vast class hierarchy. (© 2004-2017, Epic Games, Inc.)

# Overall Aim(s)

Considering this, the overall aim of the project will be that of creating a tool, that generates a level, for an FPS, that has an interior context (such as a cave or an office building), with one main degree of level gradient (as this level will take place on, for example, one level of a building, with minor ascent possible via obstacles that the Player can get on top of, if accommodated for in the level-generator). In addition, the generator will produce a ‘balanced’ level, that takes account of various properties for a balanced level, such as movement paths through the level (to objectives or otherwise), choke-points in the level, as well as where Players will want to check for enemies, given the route they have taken through the level.

# Initial Objectives

When thinking of some initial objectives for the project, the following come to mind:

* Consider relevant literature, for algorithms that one could utilise for (procedural) level-generation (literature considered for review and initial lines of research, will be listed in the next section)
* Using the chosen level-generation methodology, implement this method to the extent that it will generate the level’s ‘floor’ (to be used as a basis for all other parts of the level)
* Following on from the previous point, implement functionality to allow the system to generate bounds, surrounding the base floor of the level (such as a wall on each of the four sides, to represent a level of a building)
* After this, then move onto to implementing functionality to allow the system to generate the main geometrical features of the level, contained within the bounds of the level (such as rooms with their subdivisions for a building)

# Relevant Literature

I intend to use the following sources to guide me in the implementation of the project (This is subject to change):

Procedural Content Generation in Games (Computational Synthesis and Creative Systems) – Noor Shaker, Julian Togelius and Mark J Nelson.

This book covers procedural content generation for games, specifically that of levels (as well as items, quests and other types of content). This book is noted as suitable for undergraduate students, as ‘The authors are active academic researchers and game developers’.

(Springer International Publishing AG, © 2017)

This source will provide me with the relevant theories on procedural level generation, which I can then use as a basis for level generation in this project.

Level design: Processes and experiences – Christopher W. Totten.

This book details the experience of game developers, academics, journalists (as well as others), for their take on level design. Each of these sets of people, provide their perspective on the steps for level design, to create the gamespace for the Player (whether that is a horror environment or a computer-generated level).

(CRC Press, ©2017)

This source will offer me the prerequisite knowledge, for developing an engaging level, that I can then use as a basis, for the properties of a level, that this level-generator must adhere to.

The Science of Level Design: Design Patterns and Analysis of Player Behaviour in First-person Shooter levels – Kenneth Hullett

This dissertation provides a series of guide lines, for developers to use in the design of First-Person Shooter Levels. This was put together, as the author feels as though there is no common design pattern, that level design could fit into or be described by effectively. This piece of work also lays the foundation to allow further research into this area of gameplay.

(Kenneth M. Hullett, 2012)

This source will provide me with an in-depth level of detail, into specific design patterns for the levels of an FPS, given extensive detail on the many components to consider in the level of an FPS.

# Project Management Approach

The Project will use standard project-management techniques. This process is initiated by identifying certain characteristics of the Project, these are:

* The Project’s objective
* When the Project is to have been completed by (scheduling)
* Project Complexity
* Tasks of the Project, the time required to complete these tasks and how one should complete a project task
* Available Resources
* Organisational Structure
* Information and Control Systems

(James Moran, 2017).

# Initial Plan

## Risk Assessment and Evaluation

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Risk Description | Probability of Occurrence (%) | Severity (1-10, 1 = negligible, 10 = catastrophic) | Loss Size (Days) | Risk Exposure (Probability x Loss Size) | Priority (Probability x Severity) | Contingency Plan |
| The Software Development Methodology that was chosen, is found out to be unsuitable for the project. |  |  |  |  |  |  |
| Following (sample) end-user testing additional features are requested (that were not foreseen). | 70 | 2 | 6 | 4.2 | 1.4 | Put in place a modular system, composed during the initial planning phases, that allows for addition of features to the generator, on an ad-hoc basis (fluidly). |
| Requirements are found to have not received full definition. | 55 | 4 | 10 | 5.5 | 2.2 | Make sure to follow the requirements gathering process thoroughly, so as to reduce the imprecision of any requirement definitions, if any imprecision is identified. |
| The project’s deliverables are not finished in the time that was calculated, for how long it should take to finish them. | 50 | 5 | 10 (overtime) | 5 | 2.5 | Making sure to utilise any spare time as effectively as possible (if completing other parts of the project before they are due), as well as allotting suitable leeway, to the time it should take to finish a component of this project, accounting for any delays. |
| Following (sample) end-user testing, more effort on the user guide is required. | 40 | 3 | 4 | 1.6 | 1.2 | Make sure the user guide thoroughly details all aspects of the generator, as well as the implementation of it in one’s project. |
| Software Development Methodology (SDM) deemed insufficient. | 35 | 4 | 20 | 7.0 | 1.4 | Ensure that the SDM utilised meets the expected development practices, for the generator, considering as many conditions as possible. |
| The project enters an ‘over-budget’ state. | 25 | 6 | 18 | 4.5 | 1.5 | Making sure to accurately identify costs during the planning phases, as well as having an emergency company capital funds account. |
| A power cut occurs during compilation time. | 0.1 | 9 | 40 | 0.04 | 0.009 | Making sure to compile and save as often as possible, as well as backing up the files in multiple locations. |
| A hacker is able to hack into the development system as well as any backup locations (accessible online) and corrupt/delete the project files. | 10^-9 | 7 | 7 | 0.00000000007 | 0.00000000007 | Keep an up-to-date copy of the project on a storage medium that is not connected to the internet. |
| Thieves are able to break into the location where a development platform and any physical backup storage devices are kept and steal them. | 10^-5 | 5 | 14 | 0.0000014 | 0.0000005 | Keep an up-to-date copy of the project on a cloud storage system (which is hence, not possible to ‘steal’ physically). |

(James Moran, 2017).

# References

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