Balanced First Person Shooter Level-Generator

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# 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 there are certain FPS tiles, which have levels, that have not completely (or on rare occasions, at all), considered balanced level design. 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 context on this issue, there are various groups of Players who feel as though certain 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 three main phases (with two 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)
* Collision Bounds Phase: 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)
* Texture 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 One: 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 three phases of the project. 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 Two: 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 three phases of the project. 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 of the teams)

# Overall Aim(s)

Considering this, the overall aim of the project will be that of generating a level, for an FPS, that has an interior basis (such as a cave or an office building), with one main degree of level gradient (as this level will take place on 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). 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 presents the most up-to-date coverage of procedural content generation (PCG) for games, specifically the procedural generation of levels, landscapes, items, rules, quests, or other types of content. Each chapter explains an algorithm type or domain, including fractal methods, grammar-based methods, search-based and evolutionary methods, constraint-based methods, and narrative, terrain, and dungeon generation.

The authors are active academic researchers and game developers, and the book is appropriate for undergraduate and graduate students of courses on games and creativity; game developers who want to learn new methods for content generation; and researchers in related areas of artificial intelligence and computational intelligence.

(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.

In this book, veteran game developers, academics, journalists, and others provide their processes and experiences with level design. Each provides a unique perspective representing multiple steps of the process for interacting with and creating game levels – experiencing levels, designing levels, constructing levels, and testing levels. These diverse perspectives offer readers a window into the thought processes that result in memorable open game worlds, chilling horror environments, computer-generated levels, evocative soundscapes, and many other types of gamespaces. This collection invites readers into the minds of professional designers as they work and provides evergreen topics on level design and game criticism to inspire both new and veteran designers.

(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

ABSTRACT

Kenneth Hullett

The Science of Level Design: Design Patterns and Analysis of Player Behavior in

First-Person Shooter Levels

Level designers create gameplay through geometry, AI scripting, and item placement.

There is little formal understanding of this process, but rather a large body of design

lore and rules of thumb. As a result, there is no accepted common language for

describing the building blocks of level design and the gameplay they create. This

dissertation presents a set of level design patterns for first-person shooter (FPS)

games, providing cause-effect relationships between level design patterns and

gameplay. These relationships are explored through analysis of data gathered in an

extensive user study.

This work is the first scientific study of level design, laying the foundation for further

work in this area. Data driven approaches to understand gameplay have been

attempted in the past, but this work takes it to a new level by showing specific cause

effect relationships between the design of the level and player behavior.

The result of this dissertation is a resource for designers to help them understand how

they are creating gameplay through their art. The pattern collection allows them to

explore design space more fully and create richer and more varied experiences.

(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 receive management by following a notable portion of sensible 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

(Sean Maserang, 2002).

The techniques used to manage the project, are most notably that of the Program Evaluation Review Technique (PERT) Charts and Gantt Charts, for suitable time management of the project, to keep on track with the project, not finishing tasks too late or too early (Sean Masterang, 2002).

The Software Development Methodology that will receive utilisation in the project, is that of the Spiral Methodology. This was chosen as it is an iterative development cycle; getting a concrete baseline of the system’s requirements, before creating the initial and subsequent prototypes of the system, of which, the final prototype becomes the final version, which is then thoroughly evaluated and tested (IT Knowledge portal, 2017).

A high-level overview is shown below (IT Knowledge portal, 2017):

The project management tools that I will use, are that of Microsoft Project, to construct PERT and Gantt Charts, along with Microsoft Visio, for creating Flow Diagrams/UML Activity Diagrams, UML Class Diagrams etc. Such as the diagram shown to the left.

A Trello board, will also receive construction for the project, to make sure that certain important tasks, receive the necessary priority required to conduct the necessary sub-tasks for the project.

Along with using a Trello board, source control for the project’s source files will receive utilisation as well, specifically, the GIT source control system. This will receive usage in of itself, with an appropriate client. The client chosen for the use of the GIT source control system is that of GitHub. (© 2017 GitHub, inc.)

# 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 |
| 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 plugin, 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 plugin, 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 plugin, taking into account 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). |

(Cast Software, 2016).

# References

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