
UFCFS4-30-3 Creative Technologies Project Proposal Document

Luke Tolchard | 17024063

Procedural city generation on a pre-existing height map

Introduction

The consumer appetite for more detail, realism, and scale within the modern media industry is ever growing. Game developers are amongst many in this field that are struggling to meet the expectations set by the largest projects and everyday production costs are spiralling out of control. (George Kelly et al., 2006)

My Creative Technical Project (CTP) will investigate ways to overcome the obstacles that studios encounter. Furthermore, I aim to develop a Unity program that will allow the user to create a city using an imported terrain as a world map, with the program automatically detecting impassable geographical features such as rivers and mountains and adapting the creation around them. The user would then be able to export their scene for their own use, whether it's a video game, simulation, or for military training. This is an adaptation on the city generator produced by Introversion Software for their now cancelled title of 'Subversion' (2011).

Research & Background

One way of producing a unique and stimulating experience for users is to create a level procedurally with user-defined constraints, keeping both the scale and feel relevant for the desired project. Research from George Kelly et al (2006) go into great detail about procedural generation but also backup my theory that the majority of existing technology seems to only deal with just 2 axes, with landscape verticality often overlooked. Taking this into consideration, the thesis for my proposal is thus,

“What is the best way to create a procedurally generated city on a pre-existing height map?”

This central research question allows me to relate different strands of procedural generation research, such as Wave Function Collapse (Arunpreet Sandhu et al, 2019), Perlin Noise (Andrei Tatarinov, 2019) and Lindenmayer Systems (L-Systems), the latter of which is described by Yoav I H Parish et al (2001) as a mathematical theory for biological development, which has been evolved and adapted by the games industry as a means of fractal generation and of procedural generation of plants.

The right choice of a method of generation is heavily dependent on the geometry of the city the user wishes to create. For example, cities often have different road layouts and geographical features that have been adapted over centuries of architectural evolution. Creating a procedural city as a mimic of Paris, with a radial-to-centre style, will be completely different to creating a rectangular raster city like New York (Yoav I H Parish et al, 2001).

Researching each individual generation method along with the outputs of existing programs will allow me to discuss the different blend of techniques that I will need to employ in order to create a product that pushes the boundaries of current existing tools.

Project Objectives

1. Allow a user to import raw terrain data into the generator to generate a height map with which to build the city on
2. Allow a user to change settings at runtime to constrain the generator to create a city in the size and design that the user is happy with
3. Have the generator create the city around impassable terrain, such as bridges over water or tunnels under steep inclines
4. Allow the user to play as a simple character in the city at runtime to test their creation
5. Allow the user to export their new scene for use in their own projects

Research Objectives

1. Research Wave Function Collapse, Perlin Noise, L- Systems, Fractals, Voroni Textures, and other methods of procedural generation to evaluate their roles in the creation of my project
2. Research the architecture and design of modern day cities and how they differ in terms of planning and structure
3. Research into the optimisation of the generation of content in Unity to speed up simulation times

Learning Objectives

1. Develop knowledge of Unity Engines in built terrain and landscape creation tools to explore the functionality of importing and exporting raw terrain data
2. Learn more about user experience and how to produce a simple yet detailed interface

Dissertation Methodology

I will undertake extensive qualitative and quantitative research to gain a better understanding of this field. I will design questionnaires to distribute amongst my peers that determine what aspects of the level design workflow they feel could be improved by the use of external tools. The feedback generated will allow me to develop an efficient end product for developers, whilst ensuring I don't spend unnecessary resources adding functionality for areas that are not considered as troublesome.

Throughout development, I will also show small focus groups of developers my prototypes in order to obtain qualitative feedback on the feel of the product. The recorded responses will

help me to analyse personal progress and highlight areas for improvement. The use of focus groups made up of developers with varying skill sets will avoid skewed responses in favour of familiar aspects. I will also be creating a development log on my Itch.io page to ensure I maintain focus throughout my project and create opportunities to evaluate the progress of my project.

Techniques, tools, and processes

I will create this project using Unity 2019.2.0f1 to match the version in the labs, and Microsoft Visual Studio 2019 for the same reason. Important variables will be publically available in the inspector or in a panel menu at run time. Therefore, the user does not need to dive into lengthy scripts in order to edit the desired variable.

During my time at University I have become familiar with my own skillset both as a game developer and, a programmer. I have enjoyed and engaged with level design the most. I plan on utilising this passion as I feel the finished project would benefit individuals such as myself.

In contrast, AI has been one of my weaker areas. Consequently, I may encounter challenges when researching and creating the generator. However, this is an exciting opportunity to develop a weaker area of my skillset and become a more well-rounded game developer and programmer.

Risks

<u>Risks</u>	<u>Mitigation</u>	<u>Contingency</u>
Poor feedback during qualitative sessions	Have a clear focus going in about the topics that need covering	Use similar research as a template
Exporting live scene data may not be possible	Research ways around this obstacle such as grouping generated city as an object	Generator would have to be the base file in other projects
Scope may be too big, potential angles of research are very broad	Stay focused on the project aims first, don't get distracted by other stretch features until the end if there's time	Reduce hours at part time work to allow more time for research and prototyping

Sources of initial research

Good examples of city generation, but only dealing with flat planes

Stock, K. (2019). YouTube. Available at: <https://www.youtube.com/watch?v=zBDrH3lg4YY> [Accessed 5 Oct. 2019].

Entertainment, W. (2018). Procedural Road Network Generation In Unity! YouTube. Available at: <https://www.youtube.com/watch?v=WolqPlbOTE0> [Accessed 5 Oct. 2019].

reddit. (2009). r/Unity3D - I have been working on a procedural city generator tool for the last couple of weeks. [online] Available at: [https://www.reddit.com/r/Unity3D/comments/ahxzc1/i have been working on a proced_ural_city/](https://www.reddit.com/r/Unity3D/comments/ahxzc1/i_have_been_working_on_a_proced_ural_city/) [Accessed 5 Oct. 2019].

General research

BUCKLAND, M.
Programming Game AI by Example
In-text: (Buckland, 2010)

Unite 2015 - A coder's guide to spline-based procedural geometry. (2015). YouTube. Available at: <https://www.youtube.com/watch?v=o9RK6O2kOKo> [Accessed 1 Oct. 2019].

Parish, Y. and Müller, Procedural Modelling of Cities. [online] Available at: https://cgl.ethz.ch/Downloads/Publications/Papers/2001/p_Par01.pdf [Accessed 5 Oct. 2019].

Citygen. 2019. Citygen. [ONLINE] Available at: <http://www.citygen.net/>. [Accessed 09 October 2019].

Ken Perlin, "Improved Noise", International Conference on Computer Graphics and Interactive Techniques, Proceedings, Pages: 681-682, 2002

Perlin noise in Real-time Computer Graphics - Semantic Scholar. [ONLINE] Available at: <https://www.semanticscholar.org/paper/Perlin-noise-in-Real-time-Computer-Graphics-Tatarinov/b49da45b19f6ad6c28b3748223b715810711d15f>. [Accessed 09 October 2019].

Enhancing wave function collapse with design-level constraints. 2019. Enhancing wave function collapse with design-level constraints. [ONLINE] Available at: <https://dl.acm.org/citation.cfm?id=3337722.3337752>. [Accessed 09 October 2019].

Monthly Project Plan

*Gather qualitative feedback on implementation after every major development marked **

October	Final proposal to be submitted by 10/10/2019	4 days
	<i>Survey distribution</i>	2 days
	Set up importing terrain raw data from file into projects	7 days
	Procedural object placement into scene at run time	End of every week
	<i>Update log for the week</i>	
November	Create simple road network *	5 days

	Add settings to restrict generation	2 days
December	Generate different sized roads for motorways, A roads and suburb roads and generate buildings close to A and suburb roads *	12 days
January	Evolve road network to be more interesting and dynamic, make it look more like a city with curved roads, more diverse routes *	8 days
	Research road generation following a height map	14 days
February	Make road generation follow a height map *	14 days
	Vary Building height and size depending on how close they are to the centre of the city *	3 days
	Generate roads to bridge rivers and create tunnels under mountains (Potentially use a cost-per-segment analysis to determine whether it's more cost effective for a city planner to bypass the obstacle	4 days
March	Explore possibility for stretch goals such as generation of lampposts, benches, bins, parks, foot and vehicle traffic	14 days
	Create a basic player for the user to test drive their level *	1 day
	Begin full write up	7 days
April	Continue full write up	
	Hand-in 23/04/2020	



Ethical Review Checklist for Undergraduate and Postgraduate Modules

Please provide project details and complete the checklist below.

Project Details:

Module name	Creative Technologies Project
Module code	UFCFS4-30-3
Module leader	Michaela Palmer
Project Supervisor	Sean Butler
Proposed project title	Procedural city generation on a pre-existing height map

Applicant Details:

Name of Student	Luke Tolchard
Student Number	17024063
Student's email address	Luke2.tolchard@live.uwe.ac.uk

CHECKLIST QUESTIONS		Yes/No	Explanation
1.	Does the proposed project involve human tissue, human participants, animals, environmental damage, or the NHS.	No	<i>If the answer to this is 'No' then no further checks in the list need to be considered.</i>
2.	Will participants be clearly asked to give consent to take part in the research and informed about how data collected in the research will be used?		
3.	If they choose, can a participant withdraw at any time (prior to a point of "no return" in the use of their data)? Are they told this?		
4.	Are measures in place to provide confidentiality for participants and ensure secure management and disposal of data collected from them?		

CHECKLIST QUESTIONS		Yes/No	Explanation
5.	Does the study involve people who are particularly vulnerable or unable to give informed consent (eg, children or people with learning difficulties)?		
6.	Could your research cause stress, physical or psychological harm to humans or animals, or environmental damage?		
7.	Could any aspects of the research lead to unethical behaviour by participants or researchers (eg, invasion of privacy, deceit, coercion, fraud, abuse)?		
8.	Does the research involve the NHS or collection or storage of human tissue (includes anything containing human cells, such as saliva and urine)?		