Simulating human civilisation and the evolution of society based on factors such as culture, religion, and technology – December progress report

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1. Introduction

As outlined in the project plan, the weeks encompassing late October through early December were to be used to produce the preliminary materials needed for the simulation aspect of the project to commence – notably the literature review, design plan and pre-history world generation. The intention was that the analysis and literature review would be finalised as of November, during which the design phase would be completed, then followed by the development of the actual world generation methods. In summary, the original expectation was that at the date of writing the system requirements would be outlined in full and the terrain generation algorithm would be nearing completion.

As of December 6th, the project has met many of the milestones laid out but none to the degree that was originally anticipated, and the work schedule has largely deviated from the Gantt chart originally set out. Despite this, the results produced have been of the expected quality and have exceeded the original expectations in some respects. This document will discuss the products of development thus far and how, if applicable, they have deviated from the original plans.

1. Analysis and Literature Review

The analysis stage of development is nearing completion but still has some aspects lacking. As of now, four existing projects have been discussed – each with relevant aspects towards the artefact under development. Three of these are in the form of video games, a form of media that differs from that of the artefact, but nevertheless they have provided valuable information directly relevant to the project at hand. Regardless, it is important that review be completed on media with more direct links to the artefact – either in the form of software with similar objectives or with review of articles that discuss the factors the project is attempting to simulate.

As previously implied, a review into one such project has been completed, though very little information was found in this review. Going forward, additional study will be completed into these areas – particularly in reference to books and papers about what factors impacted humanity, a vital study that will highlight more of what needs to be developed in the world generation stage as well as how the simulation must react to certain stimuli. This endeavour will start with review into the 1997 Jared Diamond book “Guns, Germs, and Steel”, a non-fiction discussion into what factors, particularly geographical, have impacted history. The novel has been praised for its focus on countering outdated ideas like genetic superiority - the concept of which is an antithesis to the factor-based approach this artefact will represent. Study into materials like the aforementioned will provide significant advantages when attempting to refine the realism of the system – serving as a reference for what needs to be modelled and how it should affect the simulation.

The results of the literature review have been quite successful in identifying new avenues and algorithms that can and will be utilised by the system during development. As more study is done into this area it is certain that more relevant information will be uncovered and utilised effectively throughout development, and design plans will be amended with these new concepts and discoveries to create a better end product.

In summary, the following have been completed for this stage of development thus far:

* Literature review into some software with relevant data and concepts
  + Dwarf Fortress
  + Europa Universalis 4
  + Sid Miers Civilization 5
  + Iron Age
* Discussion and reference to various concepts included within these projects such as:
  + Diamond square algorithm
  + Provincial land system
  + Artificial intelligence “personalities”
  + Tile-based random generation
  + Various other terrain generation algorithms
  + Word generation

1. Design

The system design, specifically that of the world generation, has been mostly completed. Essential ideas like the basic functionality of world generation and what needs to be completed in this stage have been defined, as well as what constructs will need to exist to permit the simulation of the world in the future. The designed product takes a large amount of inspiration from that which was discovered during the literature review and highlights these inspirations where relevant. There are some aspects of the design document that need review, and proper outlining of the simulation aspects have yet to be conducted, but the designing stage of development has been almost entirely successful.

For this segment the following key features have been designed:

* What features need to be generated on terrain generation
  + Elevation
  + Temperature
  + Rainfall
  + Flora
* Any adjustments these make on one another (Such as temperature lowering with high elevations)
* Biomes and climates and what factors determine these designations
* Provincial system and the dividing of land into different population centres based on density

1. World Generation

Much of the focus of the last 8 weeks of development has been spent on developing the prototype for the terrain generation, which, while not yet completed, has routinely met the goals as described in the design document – while taking some variations to the original plan where appropriate. As of writing, the software is able to produce Map

Description automatically generateda 6000x4000 world map including height mapping and temperature mapping – the result of this being a basic world with oceans, continents, scattered islands, and climates that become more temperate as the equator is approached. While more is required to meet the terrain generation requirements, the progress achieved indicates that progress towards a complete system is underway and the terrain generation will most likely be developed on time. **Figure 1** shows an example world map generated with the program – as development progresses this map will become more detailed, showing areas such as deserts or forests.

Figure 1 An example world map

Additionally, some support tools have been developed to allow interaction with the result, including the ability to zoom in and out as well as move around the map, allowing for better debugging and review of materials. This led to further developments to improve the project as flaws with the result were identified, an example of which being the inclusion of octave-based terrain, allowing for a fractal coastline rather than the original smoothed product. This also led to the development of a function that permits the result to appear more map-like by reducing the intensity of aspects as they reach the borders of the map, which prevents terrain from wrapping around the world while maintaining the integrity of the world generation system.

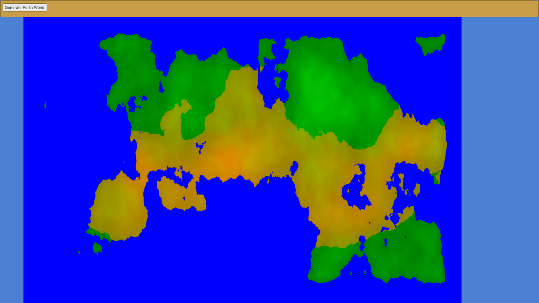
One interesting example of the success of the world generation system can be seen in a result which generated a map with similar geography to that of the real-world European continent. Shown in **Figure 2**, the Iberian Peninsula can be clearly seen, as well as a structure that resembles France and southern England (Connected by some land bridges). Additionally, despite the lack of any structure similar to Italy, the eastern Mediterranean can be seen, including two shapes that resemble Greece and turkey, even including the Bosphorus strait that connects the Mediterranean and Black seas. Finally, on the northern part of the map, an island similar to the Danish Sjaelland can be seen. Despite this generation pattern being coincidental, the fact that comparison can even be made to that of real-world geography demonstrates the success of the project in developing believable terrain.

Figure 2 A generated map that has some striking resemblances to that of the European continent

Of note is some variances that have been made from the original design plan. As outlined in the original design documents, the terrain was to make use of the diamond square algorithm, highlighted by the use of this system in the game “Dwarf Fortress”. This was attempted to little success – while the algorithm was implemented it did not produce results applicable to the system and had a requirement that the map must be a square of equal width and height. As such, the original Perlin noise algorithm was implemented, which produced the results as seen in the previous figures. Additionally, while the original temperature system called for purely an equator system, the final implementation made some additions to this concept. First and foremost, the temperature system now makes use of both Perlin and equator algorithms, producing a more varied temperature map more representative of real-world climates. Finally, the equator system itself was modified to include more random variance, with the “equator” line now consisting of a number of points with varying displacements from the equator linked by straight lines defined by linear interpolation algorithms, a simple change which provides vast improvements over earlier products.

While there is still a lot of work to be completed for the terrain generation, and even more when the pre-history mapping stage commences, the software has demonstrated it is able to meet the requirements as of the current stage of implementation. The next stage of this process will be to add the rainfall and flora generation methods, culminating in the production of a world map split into different climates and regions – a project that will be far quicker to implement than the previous systems due to the approach made allowing for new additions to make use of the algorithms used for temperature and terrain.

Overall, the following has been implemented as a part of the terrain generation:

* Perlin noise generation
  + Including both octave Perlin noise and regular smooth Perlin noise
* Gradient-from-line (Equator) generation
* Discarded but still potentially usable diamond square algorithm
* Elevation mapping using Perlin noise
  + Height/Sea mapping based on median of the elevation dataset
* Temperature mapping using both Perlin noise and equator gradient
* Implementation of an algorithm able to reduce noise values proportional to the distance to the sides of the map – preventing generated structures from appearing on the border of the map

1. Conclusion

In conclusion, process on the artefact has been steady and successful, but in some cases has not achieved the goals within the originally allotted timeframe Additionally, some deviations have been made from the design plan but only in aspects that benefitted the project as a whole, such as the use of Perlin noise in terrain mapping rather than the originally designed diamond square usage.

In terms of time management, the following Gantt chart, modified from the original diagram, represents the direction of development going forward. While there are very few modifications, additional time for designing and planning have been allocated to further refine the details of the system. The time slots specified for the objectives have largely remained the same, as systems like the terrain generation are nearing completion already. Aside from this, more time has been allocated to focus on the actions in the simulation segment, as the original two-week goal did not leave enough time for the functionality to be adequately refined.

Chart, timeline

Description automatically generated