Generating Terrain From Perlin Noise

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**Abstract:** Over the years, noise algorithms have been used for various 2D/3D modeling and image processing techniques. This paper covers the use of Perlin noise to generate a height map and ultimately a terrain. Afterwards, this paper will introduce the notion of using parametric functions to generate the terrain in a more desirable fashion.

CS Concepts: • **Applied** **Mathematics → 3D Mathematical Modeling**; • **Web Programming→** Three.js (HTML,CSS, Javascript)

KEYWORDS

Noise, Perlin noise, Three,js, functions, red-green-blue (RGB), gradient, height map, terrain-generation image

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1 INTRODUCTION

Creating terrains in CGI scenes or video game scenes are quite time consuming. Additionally, not everyone is skilled in environment modeling, such as game programmers, and as such will have difficulty doing so. However, this challenge can be done by using algorithms to procedurally create terrains during run time or in a pre-render. Although one may not get the terrain exactly as desired, much of the work can be done using one or several noise algorithms. In this project, Perlin noise is used. With this algorithm, I will show how we can achieve procedural generation of a mountainous landscape in application with other mathematics concepts.

**1**

2 METHOD

The project follows the structure:

1. Testing slight altercations to Perlin Noise algorithm to generate 2D images 🡪 Height Maps
2. Applying the proven mathematical model to generate the mesh for a plane 🡪 Terrain
3. Incorporating color schemes to the terrain based on height

3 PERLIN AND 2D IMAGES (HEIGHT MAP)

3.1 Simplex vs. Perlin

Before using noise, it is important to realize the two most popularly used algorithms, Simplex and Perlin noise. Simplex noise was presented by Ken Perlin in 2001 as a replacement for the original (classical) Perlin noise. Simplex proves to have fewer computations, can scale to 4 or higher dimensions and is easier to implement in hardware. Nonetheless, this project simply focuses on generating terrain, not being specifically target towards runt-time or pre-rendered scenery. With that said, Simplex noise should be considered if performance is a major goal. Another thing to consider is that Perlin uses interpolation of gradient vectors of its surround grid point, while Simplex uses summation instead. Hence, the output slightly differs between the two. Simplex also provides a more contrasting image, which is not necessarily needed for this purpose. For this reason, Perlin was chosen as the main algorithm to use.

3.2 Generating Height Map Images

Using a Perlin noise function, you can create a black and white image. This image (RGBA mode, 0-255 scale) will allow for a good visual of the terrain if the algorithm was applied. To start, a simple image was generated, then followed by slight modifications to the input of the function.



Fig. 1. Black and white image made with Perlin noise values for each pixel

(Perlin (x/2, y/2) \* 255)

The output of the function gives a value from [-1, +1] and so needs to be multiplied by 255 to be a valid value for coloring of pixels.

3.3 Zoom

Furthermore, we can create a “zoom” like effect by increasing the denominators for the input values.



Fig. 1. Images created with zoom levels of 2, 8, 16, and 64, respectively

(Perlin (x/zoom, y/zoom) \* 255)

3.4 Grayscale (Turbulence)

To get a smoother terrain, values of the height map cannot be either -1, 0, or +1. Instead, we need a grayscale image which serves to produce a smooth transition from high to low levels of land. Grayscale can be acquired by using the concept of “turbulence”. This is the concept of adding the percentage of multiple zoom level values from the function. Rather than getting either black or white, we will get an interpolation essentially. The image result followed by the pseudocode below explains this further.

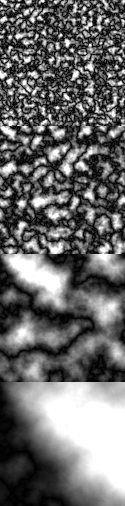


Fig. 2. Images created adding turbulence with Perlin noise with zoom levels 8, 16, 64, 256

**ALGORITHM 1:** Turbulence Algorithm

*// initialsize = zoom*

*Function turbulence(x, y, initialsize)*

*value = 0*

*size = initialsize*

***while*** *size ≥ 1*

*value += Perlin(x/size, y/size) \* size*

*size /= 2*

***end***

*Return* ***|*** *contrast \* value / initialsize* ***|***

The return statement of the algorithm is slightly modified to get values with 0-255 scale. Dividing the *contrast \* value*  by the *initialsize* decreases the brightness.

4 CONCLUSIONS

In summary, we have performed both an experimental and theoretical study of the spin eigenmodes in dipolarly coupled bi-component cobalt and permalloy elliptical nanodots. Several eigenmodes have been identified and their frequency evolution as a function of the intensity of the applied magnetic field has been measured by Brillouin light scattering technique, encompassing the ground states where the cobalt and permalloy dots magnetizations are parallel or anti-parallel, respectively. In correspondence to the transition between the two different ground states, the mode frequency undergoes an abrupt variation and more than that, in the anti-parallelstate, the frequency is insensitive to the applied field strength. The experimental results have been successfully interpreted by the dynamic matrix method which permits to calculate both the mode frequencies and the spatial profiles.

A detailed micromagnetic investigation of the properties of the eigenmodes as a function of the gap distance between cobalt and permalloy elliptical dots has been performed and the consequent variation of the internal field has been calculated. It has been shown that the inter-dot dynamic dipolar coupling plays a crucial by affecting the spin-wave mode frequencies as a function of the gap size and induces a modulation of the corresponding spatial profiles both in cobalt and permalloy dots. We believe that this work can stimulate conception, design and realization of reprogrammable magnonic crystals and microwave devices with improved performance basing on the magnetic contrast between different ferromagnetic materials.

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A HEADINGS IN APPENDICES

The rules about hierarchical headings discussed above for the body of the article are di.erent in the appendices. In the appendix environment, the command section is used to indicate the start of each Appendix, with alphabetic order designation (i.e., the first is A, the second B, etc.) and a title (if you include one). So, if you need hierarchical structure within an Appendix, start with subsection as the highest level. Here is an outline of the body of this document in Appendix-appropriate form:

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