EARTH GEN

PLANETARY TERRAIN GENERATION USING
DIFFUSION MODELS AND TEXTURE SYNTHESIS

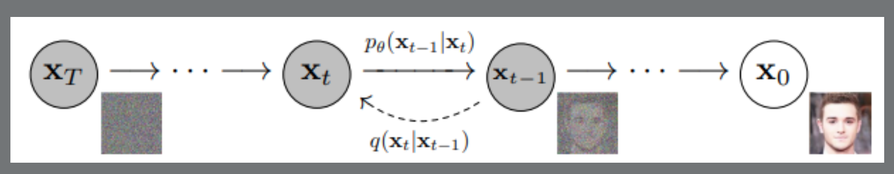
OVERVIEW

Generating digital planets is vital for creating virtual environments in media such as movies and games. It is difficult to achieve the trifecta of realistic, efficient, and adaptable terrain generation due to algorithmic and computational constraints. We aim to address these issues using the example-based approaches of Diffusion Models and Texture Synthesis.

BACKGROUND

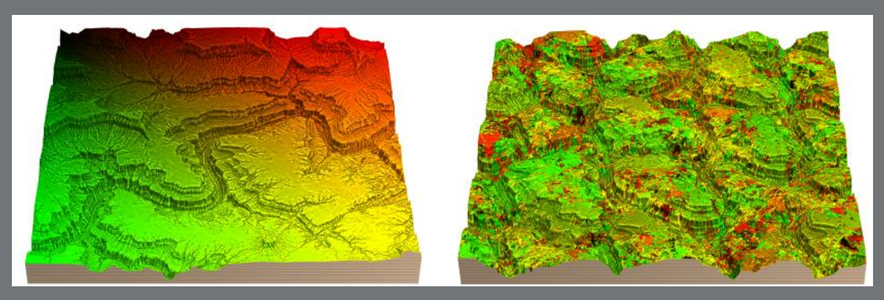
Diffusion Models

Diffusion models generate new images by progressively adding noise to an input image and then learning to reverse this process to produce a refined output.



Texture Synthesis

Texture synthesis methods reassemble regions of an input image to create an output image with similar characteristics.



DATA

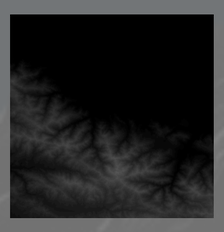
Elevation and Satellite:

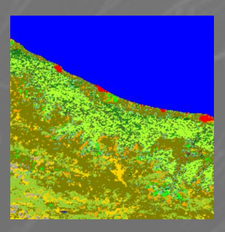
- NASA's Blue Marble Next Generation (BMNG) archive.

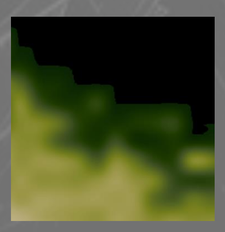
Classification:

- Global Land Cover by National Mapping Organizations (GLCNMO)
- Normalized Difference vegetation index (NDVI) was acquired from NASA Earth Observations (NEO).


Satellite


Elevation

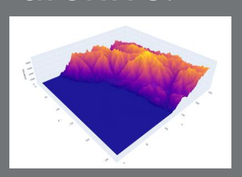
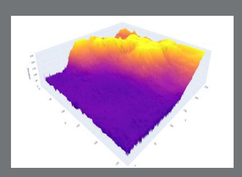
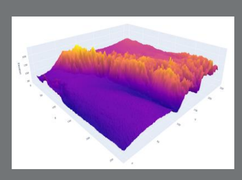

GLCNMO


NDVI

DESIGN AND IMPLEMENTATION

Diffusion Models

We generate terrain using GLCNMO and NDVI classification as guidance while training on the BMNG archive.

Input  Output →  

Texture Synthesis

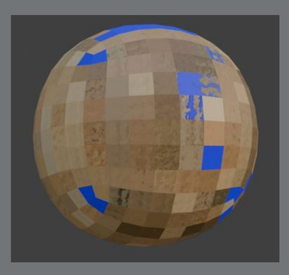
We traverse through the coarse-to-fine levels of the synthesised terrain and the exemplar in the Gaussian stack, and we:

1. Upsample the parent coordinates
2. Randomise the synthesis coordinates using jitter
3. Correct pixel values through several passes.

Globe Interface

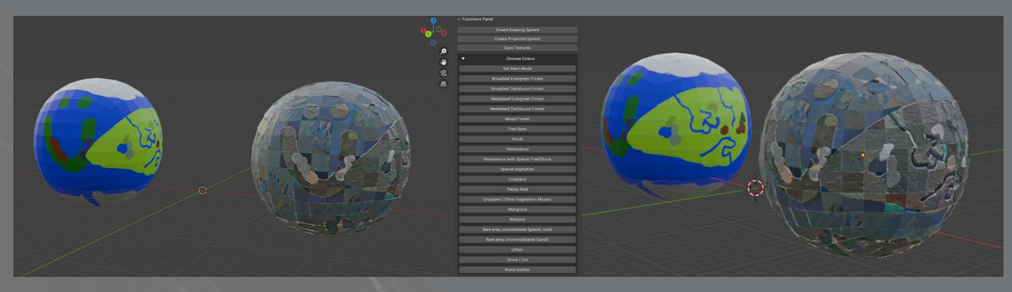
We use a globe interface to illustrate generated terrain accurately on a globe. The globe interface also allows for creating different types of planets and adding user controls. The globe interface minimises distortions and artefacts by using a subdivided mesh cube. Users can choose between 20 categories of landscape types, allowing them to draw on the globe on the left and the terrain is generated on the right.

RESULTS



We generated various planets with varying terrain types. E.g. Desert Planet.

We generated planets guided by user sketches with the 20 scape types E.g., mixed forest, wetland, and snow



We compared our generated results using the Learned Perceptual Image Patch Similarity metric (LPIPS) (0 = Similar, 1 = Different)

Example Images	DDPM big VIE	LPIPS	DDPM big LC	
		0.91		0,77
		0.79		0,72
		0.83		0,75
		0.81		0,77
		0.92		0,70
		0.71		0,69

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