Foveated Rendering

Team Fovea

Team Members

- Dietrich Kruse
- Mallikarjun Edara
- Scott McElfresh

Foveated rendering is a technique that reduces the rendering workload through a combination of sparse rendering and image generation through machine learning.

Foveated rendering mimics how the human eye works, as the eye only sees full resolution of what the center of the retina, or the fovea, is pointed at.

The peripheral vision is mostly generated by the brain. It can decrease the computational cost of rendering graphics by assigning a “fixation point” and decreasing the resolution of the image based on distance from the assigned fixation point.

This can either be done actively through eye-tracking or passively with a fixed fovea point.

While multiple applications exist for foveated render, primary research is being done to overcome the constraints of XR (Virtual, Augmented, and Mixed Reality) in the potential for high quality graphics and the current state of devices required to render the graphics. In XR, the device must render the same image twice per frame. High performance PC's have the capabilities to render these, but for XR to reach mass adoption standalone devices will need to be able to render the same level of graphics without high costs or connection to a computer.

Deep Learning
Image Generation

Team Fovea's plan is to take a full resolution image, train a generative adversarial network (GAN) on the fully rendered image, and then convert that image to a sparse pixel matrix. The matrix will be converted to an image with the same pixel mapping with the missing pixels filled in with an average value. This foveated image will serve as the basestate for a gan generating noise working to replicate the trained full resolution image.

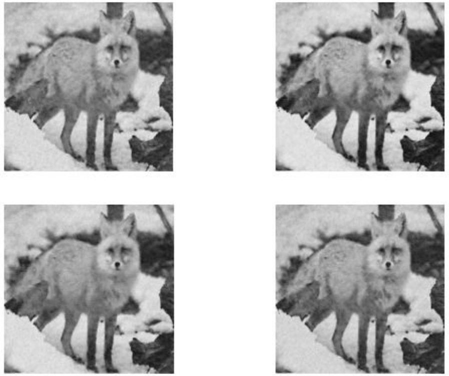
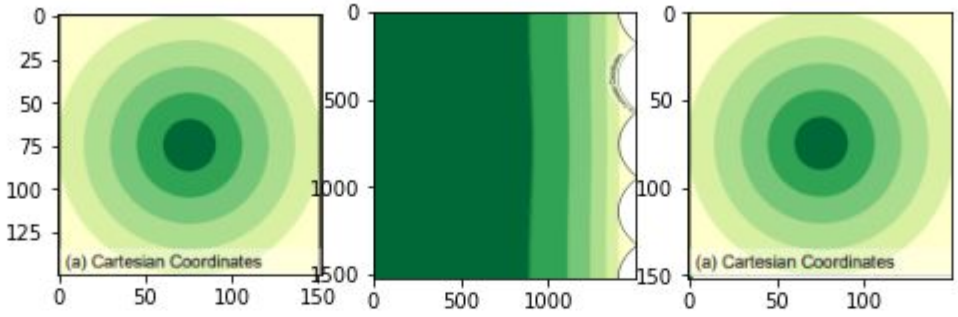
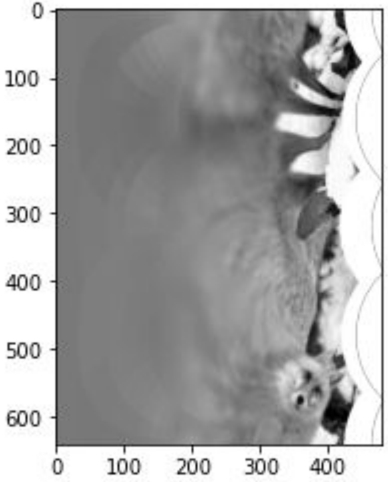


Image Conversion

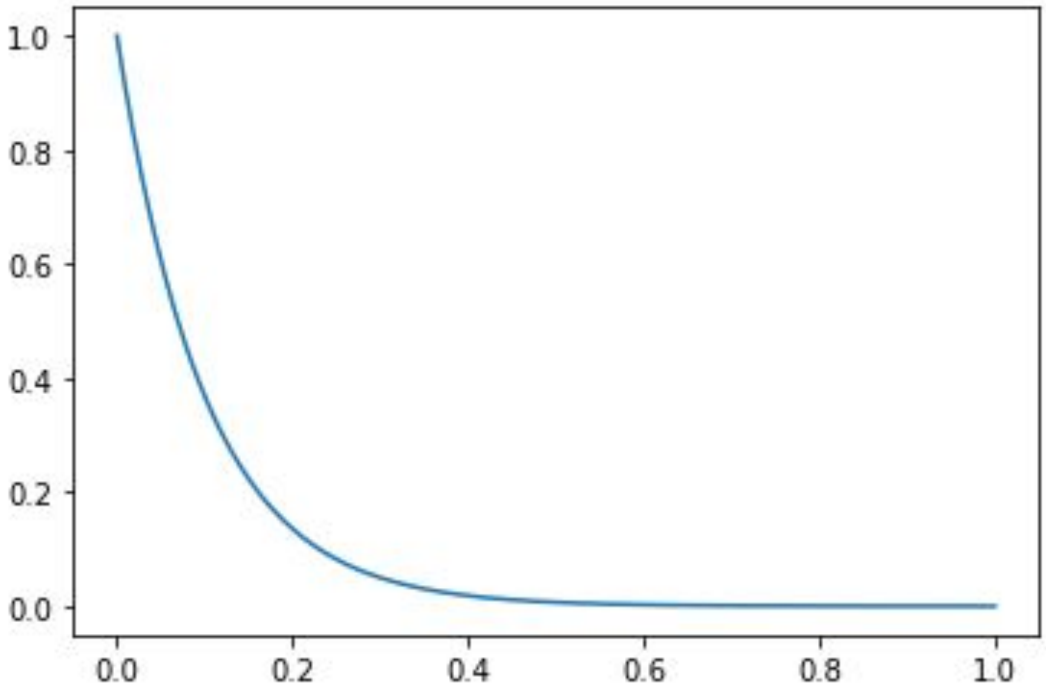
To generate our compressed image, we perform a Log-Polar conversion on our image from our image cartesian coordinates. This simulates a fovea at the center of our image.

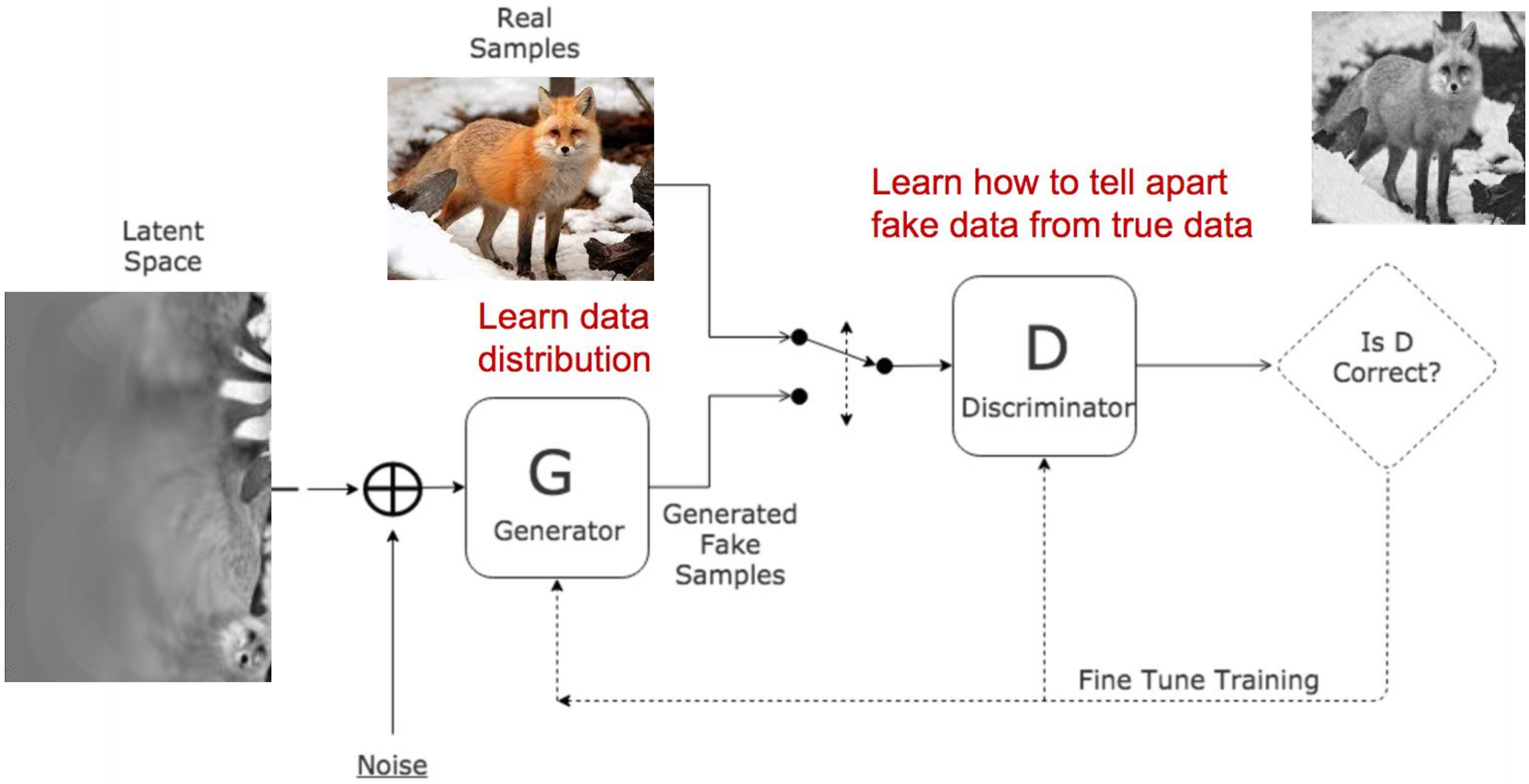




Pixel Sampling

After the Log-Polar conversion, pixel sampling will be done via inverse exponential distribution over the width of the image, which are the “weights” for each column of pixels.





GAN PROCESS FLOW

Generative Adversarial Networks (GANS) are modelled as a pair of competitive systems consisting of a Generator and a Discriminator.

Our generator inputs will be our pixel sampling and noise with its output being “fake” data.

The discriminator trains on a real data and learns through error in determining if an input is real or fake. When the discriminator makes mistakes, the generator in-turn learns.

Ultimately a generator can learn until the discriminator can no longer discern fake input from the real training set.

GITHUB

GITHUB: https://github.com/sme1d1/Foveated_Rendering

Current work distribution

ARJUN: Research and GitHub Maintenance

DIETRICH: Image transformation and sampling

SCOTT: GAN research and development

Work in Development

Currently our GAN structure is derived from published examples based on noise to image generation. We're working to finalize a method for our pixel sampling, improve our knowledge of GANs to refine & rewrite code. We need to develop a method for saving our trained model, and evaluate performance.

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Anton S. K, Anton S, Thomas L , Mikhail O, Todd G, and Gizem R.DeepFovea: Neural Reconstruction for Foveated Rendering and Video Compression using Learned Statistics of Natural Videos.Facebook Reality Labs

(Anton et al.2019)

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