Introduction

Background: Histopathology is the microscopic examination of tissue in order to study the manifestations of disease. High resolution images are vital for accurate diagnosis and are a major obstacle to the use of digital imaging in histopathology. The inability to display these large images at interactive rates

Purpose: Create a tool for interactive visualization of biomedical image stacks using GPU-accelerated on-the-fly texture decompression [1]. The image stacks are compressed using a novel approach custom tailored for the data we are dealing with, i.e. data exhibiting exceptionally high coherence between the slices of each image stack.

Compression

The compression algorithm we employed is the Lloyd's method, which reduces the data size by encoding a cluster of similar pixels to a single element in the codebook.

The stack compression relies on the fact that every image is very similar to the images above and below it and is accomplished by:

1. Jointly encoding only the top and bottom images of the stack.
2. Using linear interpolation to predict the intermediate slices and only encoding the differences between the actual and predicted values.
3. Ensuring the number of bits used to store the differences is less than the number of bits that would be necessary to store the image itself.

Decompression

Reconstruction of the images is then accomplished by simply reversing the encoding process:

1. Fetch the 2x2 pixels for the top and bottom images and linearly interpolate the values to get the desired slice.
2. Expand the image to 32x32 pixels.
3. Fetch and incorporate the encoded differences into the predicted image.
4. Repeat step 3 once by expanding the image to 128x128 pixels and once more by expanding to 512x512 pixels.

Results

CPU vs. GPU: Decoding a single slice on the GPU was more than 36x faster than on an 8-core CPU. This is because the highly parallel architecture of the GPU enables decoding of blocks of pixels together, significantly reducing computation time.

Conclusion

Summary: We have created a tool for pathologists to visualize digital optical microscopy image stacks at interactive rates. This is accomplished by a novel variation on predictive hierarchical vector quantization that can be fully decoded on the GPU.

Future Work: Test and implement the compression algorithm and decoder for electron microscopy data to incorporate it into a framework for semi-automatic segmentation and visualization of neural processes.

References