Compressing digital data with GMM

Background

Currently, in creative fields like digital art, animation, and film production, compressed images contribute to faster rendering and distribution of content without compromising visual quality. In addition, satellite imaging, security surveillance, and remote sensing applications depend on image compression to manage large volumes of data efficiently. Digital image compression is important because it helps strike a balance between conserving resources (storage, bandwidth, energy) and delivering acceptable image quality. This is especially crucial in today's data-intensive world, where the volume of digital images continues to grow exponentially. Although currently the MPEG type has been well developed for image compression, it is limited to the exploration of short-range spatial-temporal redundancies, which restricts future compression gains severely. It is well known that strong correlations between pixels in tens if not hundreds of successive images often exist. The challenge is how these long-range redundancies can be harvested for compression.

Problem Specification

The project will focus on the Gaussian Mixture Model (GMM) for coding digital images. Initial results with GMM for compression indicate that they promise great potential for the compression of digital data. The approach has conceptual similarities with segmentation-based coding. The fundamental mind shift proposed in our work, however, seeks to arrive at high-dimensional soft-gated regions with sharp or soft region transitions that jointly explore long-range spatial and temporal dimensions.

Suggested Method

Look into the GMM technique for compressing images (see useful tools & sources below). Performing GMM on one-dimensional data and obverse the correlation between Gaussian kernels. Understand how the parameters of kernels affect the GMM compression results. Extending the data to images and measuring the performances with different numbers of Gaussian kernels. Using different initialization methods to initial the parameter of kernels and measuring their results.

Relevant Articles

[1] Sung, Hsi Guang. “Gaussian Mixture Regression and Classification.” (2004).Y. Sulema and Samira Ebrahimi Kahou, "Image compression: Comparative analysis of basic algorithms," 2010 East-West Design & Test Symposium (EWDTS), St. Petersburg, Russia, 2010, pp. 534-537, doi: 10.1109/EWDTS.2010.5742106.

[2] Sun, Jianjun & Zhao, Yan & Wang, Shigang & Wei, Jian. (2021). Image Compression Based on Gaussian Mixture Model Constrained using Markov Random Field. Signal Processing. 183. 107990. 10.1016/j.sigpro.2021.107990.

[3] R. Jongebloed, E. Bochinski, L. Lange and T. Sikora, "Quantized and Regularized Optimization for Coding Images Using Steered Mixtures-of-Experts," 2019 Data Compression Conference (DCC), Snowbird, UT, USA, 2019, pp. 359-368, doi: 10.1109/DCC.2019.00044.