**MULTIDIMENSIONAL CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION**

**ABSTRACT**

Contrast enhancement is an important preprocessing technique for improving the performance of downstream tasks in image processing and computer vision. Among the existing approaches based on nonlinear histogram transformations, contrast limited adaptive histogram equalization (CLAHE) is a popular choice for dealing with 2D images obtained in natural and scientific settings. The recent hardware upgrade in data acquisition systems results in significant increase in data complexity, including their sizes and dimensions. Measurements of densely sampled data higher than three dimensions, usually composed of 3D data as a function of external parameters, are becoming commonplace in various applications in the natural sciences and engineering. The initial understanding of these complex multidimensional datasets often requires human intervention through visual examination, which may be hampered by the varying levels of contrast permeating through the dimensions. We show both qualitatively and quantitatively that using our multidimensional extension of CLAHE (MCLAHE) simultaneously on all dimensions of the datasets allows better visualization and discernment of multidimensional image features, as demonstrated using cases from 4D photoemission spectroscopy and fluorescence microscopy. Our implementation of multidimensional CLAHE in Tensor flow is publicly accessible and supports parallelization with multiple CPUs and various other hardware accelerators, including GPUs.

**INDEX TERMS** Contrast enhancement, histogram equalization, multidimensional data analysis, photoemission spectroscopy, fluorescence microscopy.