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Atomic Decomposition Audio Data Compression and Denoising Using Sparse Dictionary Feature Learning

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Abstract : A method of data compression and denoising is introduced that is based on atomic decomposition of audio data using “basis vectors” that are learned from the audio data itself. The basis vectors are shown to have higher data compression and better signal-to-noise enhancement than the Gabor and gammatone “seed atoms” that were used to generate them. The basis vectors are the input weights of a Sparse AutoEncoder (SAE) that is trained using “envelope samples” of windowed segments of the audio data. The envelope samples are extracted from the audio data by performing atomic decomposition with Gabor or gammatone seed atoms. This process identifies segments of audio data that are locally coherent with the seed atoms. Envelope samples are extracted by identifying locally coherent audio data segments with Gabor or gammatone seed atoms, found by matching pursuit. The envelope samples are formed by taking the kronecker products of the atomic envelopes with the locally coherent data segments. Oracle signal-to-noise ratio (SNR) verses data compression curves are generated for the seed atoms as well as the basis vectors learned from Gabor and gammatone seed atoms. SNR data compression curves are generated for speech signals as well as early American music recordings. The basis vectors are shown to have higher denoising capability for data compression rates ranging from 90% to 99.84% for speech as well as music. Envelope samples are displayed as images by folding the time series into column vectors. This display method is used to compare of the output of the SAE with the envelope samples that produced them. The basis vectors are also displayed as images. Sparsity is shown to play an important role in producing the highest denoising basis vectors.

Keywords : sparse dictionary learning, autoencoder, sparse autoencoder, basis vectors, atomic decomposition, envelope sampling, envelope samples, Gabor, gammatone, matching pursuit
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