Title:	Sparsity Constrained Dictionary: Design and Applications
Author(s):	Ranjan, Raju
Supervisor(s):	Gupta, Sumana Venkatesh, K S
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Abstract: Dictionary based signal processing has gained considerable importance in the recent past. Analytic dictionaries such as Discrete Fourier Transform, Discrete Cosine Transform, and Wavelet are often not expressive enough to capture the complex behavior of the signal. With the advent of cheap computational resources, use of expressive over-complete dictionaries has gained popularity. Use of over-completeness and sparsity criterion for dictionary have resulted in state of the art results in many signal processing applications. In this thesis, we investigate the inherent drawbacks of some existing dictionary learning algorithms such as high computational complexity, lack of closed form solution as well as mathematical tractability and propose an efficient regularized sparsity constrained dictionary learning algorithm. We have mathematically formulated and derived atom update expression for different priors. Dictionary learning algorithm that considers a smoothing regularizer on dictionary atom has been proposed for image de-noising. It has the advantage of having closed form expression for atom update. A set of schemes have been investigated for image pixel labeling using dictionaries learned with sparsity constraints in supervised framework. As the process of dictionary learning and sparse coding are computation intensive, different schemes are proposed to speed up the labeling process. We have studied the effect of model parameters such as patch size, dictionary size, sparsity constraint, and number of training vectors on the labeling accuracy. A signature based algorithm is proposed to detect the frontal human face, left eye, right eye, nose, lips, and respective corners. A dictionary similarity measure has been proposed to estimate distance between two sets of subspaces generated by the dictionaries. We propose schemes for image retrieval in an unsupervised framework using dictionary similarity measure.


Fig. 3: Facial part detection.


Fig. 3.13: Sample images of McGill Calibrated database.

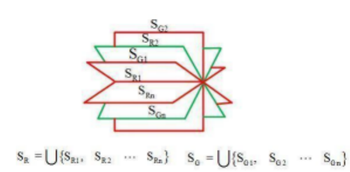
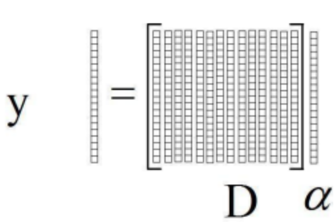
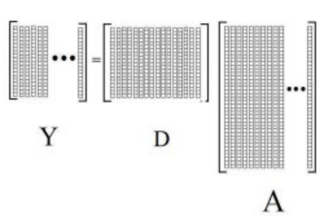


Fig. 4.9: Union of subspaces for two classes.


Fig. 3.14: Lena: (1). Original and (2). Noisy.





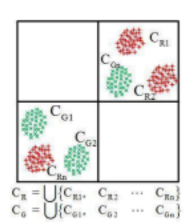


Fig. 2.2: K-Means.

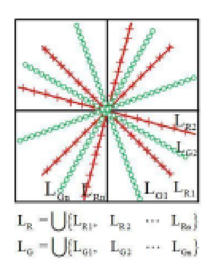


Fig. 2.3: KLine.

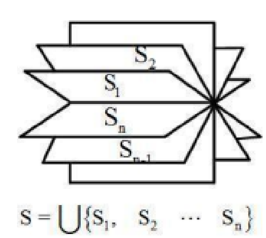


Fig. 2.4: Union of subspaces.