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COMPUTATIONALLY EFFICIENT SUBSPACE SEPARATION ALGORITHM FOR HIGH RESOLUTION DYNAMIC IMAGE SEQUENCES

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Analysis and processing of dynamic image sequences (video feeds) is utilized in the widely developing areas of context aware networks and computer vision for event detection, interference removal, feature extraction, object recognition, etc. Principal Component Analysis (PCA) and Independent Component Analysis (ICA) are two of the most popular tools utilized for processing sensory data in such applications. PCA which is essentially a tool for dimension reduction and feature extraction has a wide array of applications in signal and image processing. PCA decomposes the sensor observation space and applies the Karhunen-Loeve (KL) transform for dimension reduction. Signal subspace is identified through the magnitude of the eigen value spread of the correlation matrix pertaining to the sensor observation space. Thereafter it utilizes the KL transform to form a subspace filter to reduce the dimensions of the observation space. It should be noted that as PCA uses eigen decomposition the subspace is formed through uncorrelated basis vectors. Thereafter ICA is applied to the resultant output to generate independent signals. Thus while PCA is used for feature extraction ICA is utilized for source signal generation.

In our application it is required to decompose a set of image frames for dimension reduction prior to its application to a temporal ICA (tICA) algorithm. For high resolution video feeds, due to the increase in the number of pixels per frame, eigen decomposition of the correlation matrix becomes computationally exhaustive. This is due to the fact that the sensor measurement correlation matrices' dimensions are equal to the product of the pixel count in an image frame. Thus, we have proposed a computationally efficient method for dimension reduction at the PCA implementation. While the normal procedure's complexity order is determined by the pixel size of a frame, the proposed method's complexity depends on the dimensions of the signal subspace and the frame count which are substantially smaller and can be controlled by the user. Thereafter, an eigen analysis is conducted on the observation space and subspace separation is conducted to demonstrate the use of the proposed method, in this case, for background detection of a dynamic image sequence.

It can be observed that the proposed method through the decomposition of the reduced matrix manages to identify the principle components and efficiently construct the background in a moving car sequence. It should be noted that the complete background was not visible in any of the original image frames.