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Motion Detection Using Dynamic Mode Decomposition

Dynamic Mode Decomposition (DMD) is a numerical method that seeks to fit timeseries data to a linear dynamical system. In doing so, DMD decomposes dynamic data into spatially coherent modes that evolve in time according to exponential growth/decay or with a fixed frequency of oscillation. A key example of timeseries data that DMD has been applied to are videos, where one interprets the high-dimensional pixel space evolving through time as the video plays. In this work, we propose a simple, interpretable motion detection security system for video firmly rooted in DMD. Our method leverages the idea that there exists a correspondence between the evolution of important video features (encoded in the coherent spatial modes) and the eigenvalues of the matrix resulting from DMD. Precisely, our method applies DMD to windowed subsets of the video, which allows one to localize disturbances in the frames by observing the dominant timescales present in the modes. The effectiveness of the algorithm in detecting motion in the video is measured through an analysis based on receiver operating characteristic (ROC) curves. Performance of the motion detection algorithm is optimized for a given dataset of training videos based on k-fold cross-validation.