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# Nonlinear Analysis and Synthesis of Video Images Using Deep Dynamic Bottleneck Neural Networks for Face Recognition

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## Abstract

Nonlinear components extracted from deep structures of bottleneck neural networks exhibit a great ability to express input space in a low-dimensional manifold. Sharing and combining the components boost the capability of the neural networks to synthesize and interpolate new and imaginary data. This synthesis is possibly a simple model of imaginations in human brain where the components are expressed in a nonlinear low dimensional manifold. The current paper introduces a novel *Dynamic Deep Bottleneck Neural Network* to analyze and extract three main features of videos regarding the expression of emotions on the face. These main features are identity, emotion and expression intensity that are laid in three different sub-manifolds of one nonlinear general manifold. The proposed model enjoying the advantages of recurrent networks was used to analyze the sequence and dynamics of information in videos. It is noteworthy to mention that this model also has also the potential to synthesize new videos showing variations of one specific emotion on the face of unknown subjects. Experiments on discrimination and recognition ability of extracted components showed that the proposed model has an average of 97.77% accuracy in recognition of six prominent emotions (Fear, Surprise, Sadness, Anger, Disgust, and Happiness), and 78.17% accuracy in the recognition of intensity. The produced videos revealed variations from neutral to the apex of an emotion on the face of the unfamiliar test subject which is on average 0.8 similar to reference videos in the scale of the

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<sup>1</sup>Conflicts of Interest: The authors declare that they have no conflict of interest.

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