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# Vijayan K Asari

*University of Dayton, USA*

## A nonlinear manifold learning strategy for robust face recognition

The human brain processes enormous volumes of high-dimensional data for everyday perception. To humans, a picture is worth a thousand words, but to a machine, it is just a seemingly random array of numbers. Although machines are very fast and efficient, they are vastly inferior to humans for everyday information processing. Algorithms that mimic the way the human brain computes and learns may be the solution. In this paper we present a theoretical model based on the observation that images of similar visual perceptions reside in a complex manifold in a low-dimensional image space. The perceived features are often highly structured and hidden in a complex set of relationships or high-dimensional abstractions. To model the pattern manifold, we present a novel learning algorithm using a recurrent neural network. The brain memorizes information using a dynamical system made of interconnected neurons. Retrieval of information is accomplished in an associative sense. It starts from an arbitrary state that might be an encoded representation of a visual image and converges to another state that is stable. The stable state is what the brain remembers. In designing a recurrent neural network, it is usually of prime importance to guarantee the convergence in the dynamics of the network. We propose to modify this picture: if the brain remembers by converging to the state representing familiar patterns, it should also diverge from such states when presented with an unknown encoded representation of a visual image belonging to a different category. That is, the identification of an instability mode is an indication that a presented pattern is far away from any stored pattern and therefore cannot be associated with current memories. These properties can be used to circumvent the plasticity-stability dilemma by using the fluctuating mode as an indicator to create new states. We capture this behavior using a novel neural architecture and learning algorithm, in which the system performs self-organization utilizing a stability mode and an instability mode for the dynamical system. Based on this observation we developed a self-organizing line attractor, which is capable of generating new lines in the feature space to learn unrecognized patterns. Experiments performed on various face lighting variant, pose variant and expression variant databases for face recognition have shown that the proposed nonlinear line attractor is able to successfully identify the individuals and it provided better recognition rate when compared to the state of the art face recognition techniques. These results show that the proposed model is able to create nonlinear manifolds in a multidimensional feature space to distinguish complex patterns.

## Biography

Vijayan K Asari is a Professor in Electrical and Computer Engineering and Ohio Research Scholars Endowed Chair in Wide Area Surveillance at the University of Dayton, Dayton, Ohio, USA. He is the Director of the Center of Excellence for Computer Vision and Wide Area Surveillance Research (Vision Lab) at UD. He received his BS in Electronics and Communication Engineering from the University of Kerala, India, and MTech and PhD degrees in Electrical Engineering from the Indian Institute of Technology, Madras. He holds three patents and has published more than 500 research papers, including 85 peer-reviewed journal papers in the areas of image processing, pattern recognition, machine learning and high performance embedded systems. He has supervised 22 PhD dissertations and 35 MS theses during the last 15 years. Currently 18 graduate students are working with him in different sponsored research projects.

vasari1@udayton.edu

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