Computational Investigation of Feature Extraction and Image Organization

DISSERTATION

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ABSTRACT

This dissertation investigates computational issues of feature extraction and image organization at different levels. Boundary detection and segmentation are studied extensively for range, intensity, and texture images. We developed a range image segmentation system using a LEGION network based on a similarity measure consisting of estimated surface properties. We propose a nonlinear smoothing algorithm through local coupling structures, which exhibits distinctive temporal properties such as quick convergence.

We propose spectral histograms, consisting of marginal distributions of a chosen bank of filters, as a generic feature vector based on that early steps of human visual processing can be modeled using local spatial/frequency representations. Spectral histograms are studied extensively in texture modeling, classification, and segmentation. Experiments in texture synthesis and classification demonstrate that spectral histograms provide a sufficient and unified feature in capturing perceptual appearance of textures. Spectral histograms improve significantly the classification performance for challenging texture images. We also propose a model for texture discrimination based on spectral histograms which matches existing psychophysical data. A new energy functional for image segmentation is proposed. With given regional features, an iterative and deterministic algorithm for segmentation is derived. Satisfactory results

are obtained for natural texture images using spectral histograms. We also developed a novel algorithm which automatically identifies homogeneous texture features from input images. By incorporating texture structures, we achieve accurate texture boundary localization through a new distance measure. With extensive experiments, we demonstrate that spectral histograms provide a generic feature which can be used effectively to solve fundamental vision problems.

Based on a novel and biologically plausible boundary-pair representation, perceptual organization is studied. A network is developed which can simulate many perceptual phenomena through temporal dynamics. Boundary-pair representation provides a unified explanation of edge- and surface-based representations.

A prototype system for automated feature extraction from remote sensing images is developed. By combining the advantages of the learning-by-example method and a locally coupled network, a generic feature extraction system is feasible. The system is tested by extracting hydrographic features from large images of natural scenes.

In memory of my parents, Fu-Lu Liu and She-Zi Liu, who taught me values and knowledge silently.

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FIELDS OF STUDY

Major Field: Computer and Information Science

Studies in:

Perception and Neurodynamics	Prof. DeLiang L. Wang
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Digital Photogrammetry	Prof. Anton F. Schenk
Geographic Information Systems	Prof. Alan J. Saalfeld

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