Ames Vision Group Research Overview

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Computational Models of Early Vision– A major goal of our research group is to develop mathematical and computational models of early human vision. These models are valuable in the prediction of human performance, in the design of visual coding schemes and displays, and in robotic vision. To date we have models of retinal sampling, spatial processing in visual cortex, contrast sensitivity, and motion processing.

Image Coding– Based on our models of early human vision, we have developed several schemes for efficient coding and compression of monochrome and color images. These are pyramid schemes that decompose the image into features that vary in location, size, orientation, and phase. To determine the perceptual fidelity of these codes, we have developed novel human testing methods that have received considerable attention in the research community.

Motion Processing– Visual motion processing is an important capability in both man and machine. In both cases, the challenge is to convert a time-sequence of images into descriptions of image motion, and ultimately into descriptions of object motions. We have constructed models of human visual motion processing based on physiological and psychophysical data, and have tested these models through simulation and human experiments. We have also explored the application of these biological algorithms to applications in automated guidance of rotorcraft and autonomous landing of spacecraft.

Neural Networks– The human visual system comprises layers of neural networks which sample, process, code, and recognize images. Understanding these networks is a valuable means of understanding human vision and of designing autonomous vision systems. We have developed networks for inhomogeneous image sampling, for pyramid coding of images, for automatic geometrical correction of disordered samples, and for removal of motion artifacts from unstable cameras. We are collaborating with the Research Institute for Advanced Computer Science (RIACS) on networks for automatic visual pattern recognition.

Human Psychophysics– To determine fundamental aspects of human visual performance and to validate our computational models we maintain a vigorous program of psychophysical experiments on human observers. Currently this work emphasizes perception of coding artifacts, motion perception, and spatial scale of visual functions. In collaboration with Stanford, we are testing fundamental color vision capacities.