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Vision Science and Technology for Supervised Intelligent Space Robots

Jon D. Erickson

NASA Johnson Space Center

We believe that robotic vision is required to provide the rich, real-time descriptions of the dynamic space environment necessary to enable the intelligent connection between machine perception and action needed for free-flying robots that do real work in space. We also believe that space in low Earth orbit offers simplicities of only a few objects with these being man-made, known, and of cooperative design.

The focus of our recent work in robotic vision for application in intelligent space robots such as EVA Retriever is in visual function, that is, how information about the space world is derived and then conveyed to cognition. The goal of this work in visual function is first to understand how the relevant structure of the surrounding world is evidenced by regularities among the pixels of images, then to understand how these regularities are mapped on the premises that form the primitive elements of cognition, and then to apply these understandings with the elements of visual processing (algorithms) and visual mechanism (machine organization) to intelligent space robot simulations and test beds. Since visual perception is the process of recognizing regularities in images that are known on the basis of a model of the world to be reliably related to causal structure in the environment (because perception attaches meaning to the link between a conception of the environment and the objective environment), our work involves understanding generic, generally applicable models of world structure (not merely objects) and how that structure evidences itself in images. Causal structure is of interest so as to be able to predict consequences, anticipate events, and plan actions so as to achieve goals.

Despite a focus on visual function, the majority of the resources expended to date have gone into implementation of visual processing and visual mechanism to meet test bed requirements for determining object holdsite grasping with dexterous hands and for free-flying navigation with obstacle avoidance. Our test bed includes laser range imagers as well as multiple visible and infrared video cameras.