Algorithms and Architectures for Robot Vision

Paul S. Schenker

Jet Propulsion Laboratory

The author has previously conducted research in vision devices, algorithms, and architectures. Most of this work has addressed problems in scene perception and object recognition in support of autonomous robotics. A number of novel algorithms have resulted, including pyramid image analysis using contrast-normalized feature extraction [1], scale-rotation-aspect invariant image analysis using polar-exponential-grid representation [2,3], and high-speed image segmentation using multi-resolution stochastic search techniques [4]. Other efforts have included development of a multi-sensor fusion approach to scene analysis, and the development of a real-time VLSI machine vision architecture [5,6].

The scope of our current work is to develop practical sensing implementations for robots operating in complex, partially unstructured environments [7,8]. A focus in this work is to develop object models and estimation techniques which are specific to requirements of robot locomotion, approach and avoidance, and grasp and manipulation. Such problems have to date received limited attention in either computer or human vision—in essence, asking not only how perception is in general modeled, but also what is the functional purpose of its underlying representations [9]. As in the past [1,2], we are drawing on ideas from both the psychological and machine vision literature. Of particular interest to us is developing 3-D shape and motion estimates for complex objects when given only partial and uncertain information and when such information is incrementally accrued over time. Our current studies consider the use of surface motion, contour, and texture information, with the longer range goal of developing a fused sensing strategy based on these sources and others.

References

1) Schenker, P. S., Unangst, D. R., Knaak, T. F., Huntley, D. T., and Patterson, W. (1982). Pyramidal normalization filter: visual model with applications to image understanding, Proc. SPIE Conf. Real Time Signal Processing (V) (J. Trimble, Ed.), Vol. 341, Arlington, VA.

2) Schenker, P. S. (1981). Toward the robot eye: (in search of) an isomorphic image transform for machine vision, Proc. SPIE Conf. on 3-D Machine Perception (B. R. Atschuler, Ed.), Vol. 283, Washington, D.C.

3) Schenker, P. S., Wong, K. M., and Cande, E. G. (1982). East adaptive algorithms for low-level scene analysis: applications of polar-exponential-grid (PEG) representation to high-speed, scale-and-rotation invariant target segmentation, Proc. SPIE Conf. Techniques and Applications of Image Understanding (J. J. Pearson, Ed.), Vol. 281, Washington, D. C.

4) Schenker, P. S., Cooper, D. B., and Wong, K. M. (1980). "A parallel-window estimator for simple-object boundary finding in noisy images," Proc. 5th Intl. Conf. Pattern Recognition, IEEE 80CH1499-3, Miami Beach, FL.

5) D. P. Panda, P. S. Schenker, et. al. (1983) "Hierarchical multisensor image understanding," Honeywell Systems and Research Center, Minneapolis, MN, AFOSR contract study.

6) "Electro-optical signal processor (EOSP) brassboard," Honeywell Corp., Minneapolis, MN, VHSIC Phase I development under DARPA/WPAFB contract.

7) Schenker, P. S. (1989), NASA research and development for space robotics, IEEE Trans. Aerospace Electr. Sys. Vol. 24, 5, pp. 523-534 (September).

8) Schenker, P. S. (1989), Intelligent robots for space applications, to appear in Intelligent Robotic Systems: Analysis, Design, and Programming (S. Tzafestas, E.), Marcel Dekker, New York City, NY.

9) Schenker, P. S. (1988), Sensor fusion: task frames, spatial reasoning, and intelligent control; presented at SPIE Conference on Sensor Fusion: Spatial Reasoning and Scene Interpretation (P. S. Schenker, Ed.), Vol. 1003, Cambridge, MA, Extended manuscript on request.