Human Motion Perception: Higher-Order Organization

Mary K. Kaiser

NASA Ames Research Center

Dennis R. Proffitt

University of Virginia

This talk presents an overview of higher-order motion perception and organization. We argue that motion is sufficient to fully specify a number of environmental properties, including: depth order, three-dimensional form, object displacement, and dynamics. A grammar of motion perception is proposed; applications of this work for display design are discussed.

Goals of Research:

To define the competencies, limitations, and biases in human perception of motion events.

Application:

To design dynamic displays which exploit operators' competencies and compensate for limitations and biases.

What kinds of information can be specified via motion?

- Surface segregation
- Three-dimensional form
- Object displacement
- Dynamics

Surface Segregation (Depth Order Specification)

- Static depictions must rely on cues, conventions, or appeals to expectations: contrast, occlusion, familiarity, shading

- Motion, in and of itself, is sufficient to fully specify depth order (even if edge information is deleted)

Three-Dimensional Form

- An indefinite number of three-dimensional distal objects could produce a given two-dimensional pattern.
- Form specification through rotation resolves ambiguity (assuming rigid object): Kinetic Depth Effect.

- Perspective information (e.g., foreshortening of lines) not required; works with point-light display.

Object Displacement

- Motion of objects relative to observer virtually impossible to depict with static symbols and conventions.
- It is necessary to consider how the perceptual system parses object motion.

Dynamics

- Kinematics can specify underlying kinetics, at least to classes of solutions (e.g., relative masses of colliding objects).
- Observers demonstrate appreciations of dynamic properties even for events about which they hold erroneous beliefs.

Current Research

- Determine limits of perceptual competence (e.g., angular systems)
- Differentiate observers' ability to extract kinematic information vs. ability to perform dynamic analysis
- Develop taxonomy of event complexity (particle vs. extended body, dimensionality, dynamical feature analysis)

References

Cutting, J. E. and Proffitt, D. R. (1982). The minimum principle and the perception of absolute, common, and relative motions. Cognitive Psychology, 14, 211-246.

Kaiser, M. K. and Proffitt, D. R. (1987). Observers' sensitivity to dynamic anomalies in collisions. Perception and Psychophysics, 42, 275-280.

Proffitt, D. R. and Kaiser, M. K. (1989). Perceiving environmental properties from motion information: Minimal conditions. In S. R. Ellis and M. K. Kaiser (Eds.), Spatial displays and spatial instruments. NASA CP-10032.