Planar Manipulator Display

Dan Rosenfeld
NYU Media Research Lab
danr@cat.nyu.edu

Ken Perlin
NYU Media Research Lab
perlin@cat.nyu.edu

Michael Zawadzki
NYU Media Research Lab
mike176780@aol.com

The Planar Manipulator Display (PMD) is a novel input/output device which enables simultaneous planar movement and sensing of multiple physical objects. It was built to test the hypothesis that interaction mediated by computer-controlled objects will improve understanding and collaboration in many types of simulations for which screen-based interaction is not optimal.

Our brains are particularly good at solving problems when we are able to make use of our physical and propriocentric intuition, yet current computer interfaces make little use of these abilities. Several research systems (e.g. [FITZ 1995]) have been developed which incorporate passive (non-actuated) physical objects in a user interface in the hope of leveraging such faculties. Our device closes the input-output loop by enabling software control of position and orientation for physical objects.

We believe the PMD will be especially suited to collaborative applications. Since any number objects can be grabbed and moved simultaneously, multiple people can participate in a computer-mediated interaction. Additionally, the PMD takes the form of a table, which most people find natural and familiar as a context for interaction.

In some applications, use of the PMD is enhanced by the use of a video projector to present additional information on the table surface. The properties of the device also complement applications in which users' directives are recognized via vision-based gesture recognition.

Design of the PMD was driven by the following criteria: (i) Each of many physical objects can be moved quickly, accurately and independently upon a surface, (ii) the mechanism scales gracefully to surfaces of large area, and (iii) the cost of commercial production per movable object would not exceed several dollars, thereby making possible eventual widespread adoption of the device.

The architecture devised includes four major components: small motorized platforms onto which objects are placed, a shared central processor, position sensing opto-electronics, and a standard PC on which PMD applications run. The current system controls and senses the planar motion of fifteen platforms at roughly 160Hz. This relatively high update rate enables control system computation to be localized in a shared central processor, while still allowing vehicles to move rapidly. Because such computation is not performed on the platforms, very inexpensive processors can be used, thus significantly reducing per platform costs and making the use of large numbers of objects practical.

For SIGGRAPH 2003 Emerging Technologies we will present two example PMD applications. The first is a design support system for interior architecture. It allows participants to design an interior space by moving model furniture, while the system continuously moves the remaining furniture into new configurations to satisfy selected layout constraints. The second application is a behavioral simulation inspired by the machines described in Braitenberg's *Vehicles* [Braitenberg 1984].

Figure 1: PMD in use

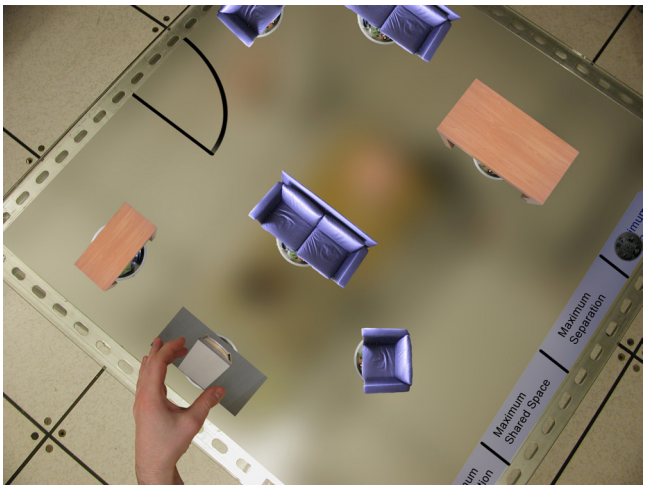

Figure 2: Interior architecture application

References

BRAITENBERG, V. 1984. Vehicles: Experiments in Synthetic Psychology. The MIT Press.

FITZMAURICE, G., ISHII, H., AND BUXTON, W., 1995 Bricks: Laying the Foundations for Graspable User Interfaces, *Proceedings of CHI '95*, 442-449.