Dots & Pixels: a C++ library for the display of random dot patterns

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Abstract—A C++ library is described for generating random-dot and random-pixel displays on Apple Macintosh (68K or PowerPC) computers.

1. INTRODUCTION

‘Dots & Pixels’ is a package for generating random-dot and random-pixel displays (Julesz, 1971). We distinguish between random pixel arrays, where the dot positions form a fixed rectangular grid and the number of actual dot positions is fixed (as is common on current microcomputers), and random-dot patterns (Fig. 1). In the latter, dots can be placed at any position and the number of possible dot positions is theoretically infinite (as is common on oscilloscopes). Also, in pixel arrays a dot is generally placed at about 50% of all possible dot positions, whereas random-dot patterns are more sparse, covering at most a few per cent of the display with dots. Lastly, the velocities of random pixels are generally identical, whereas they can vary between dots in random-dot displays. This difference is blurred somewhat since random-dot patterns are often displayed using the pixel arrays of modern video hardware. Figure 1 gives an example of each of the two stimulus types.

2. HARDWARE REQUIREMENTS

The code runs on Macintosh (68K or PowerPC) computers. For the display of random dot patterns, a monitor which can be switched to 8-bit indexed mode (standard 256-colour mode) must be available. Pixel arrays can be displayed on a monitor at any bit depth (but are fastest when the monitor is in 1-bit mode). On 2-bit-deep devices, red-green stereo pairs can be generated fairly easily.

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3. INTENDED USE

The library can be used in psychophysical or physiological studies of motion processing. It is not a complete experimentation package, but must be augmented by code to drive the experiment.

Pixel arrays have been used extensively with custom hardware by the Utrecht vision groups to study human motion detection and movement aftereffects (for a description of this hardware see Fredericksen et al., 1993). The Dots & Pixels library makes it possible to display similar stimuli on standard hardware. This may be advantageous both for experimentalists and in the classroom. Also, adapting the software to generate a new stimulus is easier than building new hardware.

The random-dot display part of the software focuses on the generation of optic flow stimuli up to the first order (i.e. arbitrary mixtures of translation, expansion, rotation, and shear). The library allows the flow ‘carried by’ a set of dots to be dynamically changed. This may be useful in physiology, where testing with the entire set of first-order optic flows is not practicable, and a limited set of flows (e.g. only rotations, expansions, contractions, and spiral motions) is used instead. The library can be used to easily implement hill-climbing in ‘optic flow space’ in order to search for the first-order flow to which a cell reacts best.

4. SPEED

This software solution is more flexible but also somewhat slower than a custom hardware solution. However, the routines are fast enough for many applications.

The random-dot pattern stimuli are limited to first-order optic flow (Koenderink, 1986) patterns. We have used the stimuli for research in the motion after-effect (Verstraten et al., 1994) and to test models for optic flow processing (Verlinde, 1996).