Background and Purpose

Stereo vision is an important component of human vision for depth estimation. In most sports a more precise and faster depth estimation results in higher athletic performance. The purpose of our work is to develop a system to automatically evaluate the performance of human stereo vision.

Methods: System

Our developed stereo vision test software framework provides functionality to control the current projection system:
- Two LCD projectors with resolution of 1024×768
- Back projection
- Semi-transparent screen (2.50m×1.86m)
- Linearly polarized light for eye separation

Figure 1: An observer performing a stereo vision test using the current projection system.

Figure 2: Example for two disks as target objects without (top) and with disparity (bottom, color coded; red: left eye, cyan: right eye) as they appear in the stereo vision test.

Figure 3: Decision time differences for each subject for specific disk sizes in arc seconds (°). The times are subtracted from the decision time for the largest disk size.

Methods: Preliminary study

The stereo vision test framework was configured to evaluate the disparity resolving times while the object sizes in arc seconds (°) decrease.
- Disk diameters: 2394°, 1799°, 4711°, 2943°, 1137°
- Disparity differences: 975°, 812°, 650°, 325°, 162°
- 5 healthy male subjects (25-28 years)

Results

- The decision times increase with decreasing disk sizes.
- The decision times show a variation from 1266 ms to 4438 ms.
- Figure 3 displays decision time differences compared to the decision time for the largest disk size.
- The decision time differences of subject 5 differ significantly compared to the other subjects.
- All subjects achieved more than 50% correct decisions.

Methods: Stereo vision test framework

The system provides a fully configurable and interactive stereo vision framework. Basic test procedure:
- Two objects showing same size if no stereo vision is applied (Figure 2)
- One object with larger disparity (front object)
- Random front object in each iteration
- User decision by button press to identify perceived front object
- Output of test results graphically and as text file

A setup program allows the configuration of the stereo vision test. Configurable parameters:
- Target object type (disk, rectangle, sphere)
- Target object size
- Number and extent of disparity differences
- Number and extent of disparity bases
- Number of test iterations
- Disparity of one pixel in arc seconds
- Required distance for observer will be displayed

Two performance parameters are measured

1. Decision time until user input is detected. It describes the resolving time.
2. Number of correct decisions for certain object sizes or disparity differences. It describes the minimum disparity.

Conclusion

We developed a comprehensive stereo vision test framework embedded in a polarized dual-projection system. It is able to reliably measure the performance of human stereo vision with arbitrary user defined tests. The integration of 3D capable devices and traditional 2D displays (red-cyan color coded) is already supported by the framework.

Outlook

The framework is currently extended to include more target objects to reduce the probability of a lucky guess. An intuitive gesture control that enables pointing onto targets is in progress to emphasize the sports character. The projection system is currently upgraded to higher resolution of full HD (1920x1080) to enable lower disparities. Future studies will present stereo vision performance as a function of the visual acuity.

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Commercial Relationship

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