The Implementation of a Glove-Based User Interface
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ABSTRACT

Multi-touch interfaces are rising in usage because they can simplify complex tasks. However, they require the user to physically touch the screen. This project explores the glove-based interface, which provides the utility of multi-touch without the need to touch the screen. Though it is not a replacement for a mouse interface, its multiple levels of input allow for even greater task simplification and for a more natural human-computer interaction experience.

CURRENT DEVELOPMENTS

As technologies for building alternative user interfaces have become more readily available, alternatives to button and mouse interfaces have emerged. Multi-touch interfaces have been implemented as early as the mid 1980s [1], and have grown in usage recently. And though the idea of a glove-based user interface dates back to the beginnings of virtual reality [2], the glove-based interface can reach wider usage through IR LED sensing.

OBJECTIVES

The goal of this project is to implement a glove-based user interface in order to determine where its advantages and disadvantages lie. A focus on task completion is necessary to evaluate the effectiveness of such an interface [3], and it must be allow for the evaluation of gestures relevant to controlling various applications such as software for geo-spatial imaging, 3D modeling, information visualization, and presentations.

IMPLEMENTATION

This research project is written in Java using the Java Media Framework.

A modified Logitech USB webcam is used to provide a live video feed of infrared light. Its filters were modified to block visible-light and let infrared light pass.

Each glove contains three 950nm infrared LEDs. The LEDs are located on tips of the thumb, pointer finger, and middle finger. The gloves are wireless and are powered by three 1.5V AAA batteries.

Fig 1. IR LED Glove Final Version

PROCEDURE

LED DETECTION AND TRACKING

Each captured video frame is evaluated through binary rasterization – grouping pixels on if their brightness values are above/below an optimal threshold value past the peak brightness level automatically determined using a histogram of pixel brightness values [4].

The user is required to place all LEDs on-screen in order to classify them as left/right and pointer/clicker/aux prior to gesture execution.

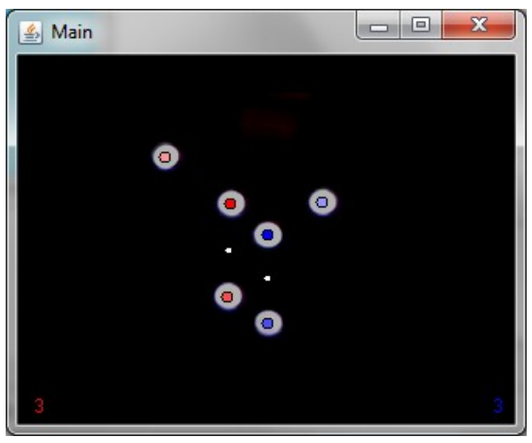

Fig 2. (Left) Classified LEDs, Fig 3. (Right) Photo manipulation application

PHOTO MANIPULATION APPLICATION

A simple photo manipulation application was created for testing and demonstration purposes, in which the user can drag, rescale, and rotate photos using both the mouse and glove interfaces. Cursor and photo position/orientation data is collected and exported into a CSV file during the performance of a task, in which the user must manipulate photos to achieve a final pre-determined orientation.

GESTURE RECOGNITION AND COMMAND EXECUTION

The cursor moves proportionally to the LEDs' locations in the frame. The cursor press/release gesture is performed by pinching these two LEDs together. Combining these results in the drag and drop gesture.

EXPERIMENT

Three tasks were performed in the photo application using both the mouse and glove interfaces. The separate tasks were dragging, rescaling, and rotating a single photo to reach a specified final state. Only one-handed drag gestures were used in the glove interface.

RESULTS AND ANALYSIS

The glove interface consistently required more time than the mouse interface to complete each task, and required more correction time while placing the photo into its final position. This indicates that a glove interface is not an efficient alternative to the mouse interface if the gestures being performed are identical in complexity.

CONCLUSION

This glove interface is not more efficient than the mouse interface if its gestures merely match those of a mouse interface. Instead, the glove interface can only prove to be superior in the execution of commands that are complex for a mouse interface, but are greatly simplified with a glove interface due to its multiple degrees of input.

[1] Lee, SK, William Buxton, and K. C. Smith. "A Multi-Touch Three Dimensional Touch-Sensitive Tablet." *Conference on Human Factors in Computing Systems*. San Francisco, pp. 21-25, 1985.

[2] Sturman, David J., and David Zeltzer. “A Survey of Glove-based Input.” *Computer Graphics and Applications IEEE.,* pp. 30-39, 1994.

[3] Molina, Jose P., et al. “The Development of Glove-Based Interfaces with the TRES-D Methodology.” *Virtual Reality Software and Technology* pp. 216-219, 2006.

[4] Baek, SeongHo, et al. “IRED Gun: Infrared LED Tracking System for Game Interface.” *Lecture Notes in Computer Science 3768/2005 . pp* 688-699, 2005.