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 (IR) light. Its filters were modified to block visible-light and let IR light pass.

The user wears two gloves, each containing three 950nm IR LEDs on the fingertips. The gloves are wireless and are powered by three 1.5V AAA batteries. (Fig. 1)

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 must perform gestural commands within a set of LED configuration parameters in order for the application to recognize the LED configuration. (Fig. 2)

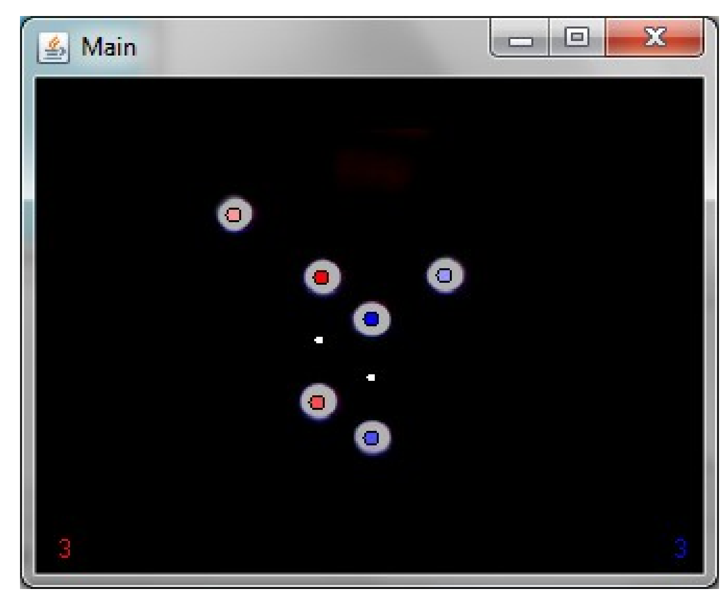

Fig 2. (Left) Classified LEDs, Fig 3. (Right) Photo manipulation application

PHOTO MANIPULATION APPLICATION

A photo manipulation application was created for testing and demonstrations (Fig. 3), in which the user can drag, rescale, and rotate photos as well as pan and zoom the application viewpoint using both the mouse and glove interfaces. Photo and viewpoint position/orientation data is collected into a CSV file during the performance of a task, in which the user must manipulate photos and/or the viewpoint to achieve a final orientation.

GESTURE RECOGNITION AND COMMAND EXECUTION

A two-finger pinch drags a photo, while a double two-finger pinch rescales and rotates a photo. A three-finger grab pans horizontally and vertically, while a double three-finger grab zooms in and out.

EXPERIMENT

Ten controlled tasks were performed using both the mouse and glove interfaces. The tasks involved dragging, rescaling, rotating, panning, and zooming. Eleven trials were performed, and the median five were analyzed.

RESULTS AND ANALYSIS

Single-handed two-finger pinch gestures performed slower than the mouse because they matched the complexity of the mouse. Two-handed gestures reduced the time difference and even performed faster than the mouse. Panning both horizontally and vertically had the best performance as it turned the multi-step command into a single-step command.

CONCLUSION

This glove interface overcomes its disadvantages as a camera-based interface when multi-step commands are reduced into single steps, or when commands naturally match the resulting actions on-screen. To effectively use a glove interface, an application must take advantage of the greater levels of input in the interface's gestural commands.

[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.