A Novel Multimedia Input Device: The Electro-Sphere

Students: Peter Foon-Wang Pong, Yen-Wen Liu

Advisor: Anind K. Dey

Problem Definitions/ Goals:

Motivated by a frustration with the limitations of conventional electronic input devices (such as the ubiquitous mouse and keyboard), we proposed a novel input device that would allow user to input and control data in a more intuitive manner. We wanted to develop an input device/method that will extend the workspace environment to three dimensions and will allow more intuitive data manipulation.

Methods/Processes

Throughout the project, we were faced with many design choices and numerous dead ends. During the past year, we made several major revisions to our original design before settling on our final one.

Design 1 - Electro-Sphere

Our original design was an "electro-sphere", a ball like device that is capable of detecting finger touches via an array of touch sensors on the surface of the sphere. The device would also be equipped with accelerometer and gyroscope to sense movement and angular rotation and thus allowing us to interpolate orientation. All sensors would communicate to a microcontroller inside the sphere, which would relay the signal to the computer via Bluetooth. However, we realized that constructing the hardware would be quite difficult. We would need to place at least 50-100 touch sensors on the surface of the sphere to achieve an acceptable resolution. Our microcontroller only had 10 analog input ports, so we would need to deploy a multiplexer to accommodate for all the sensors. The complexity of the solution could be problematic. Eventually we moved onto a more feasible solution.

Design 2 - Multi-touch LED Matrix Display

Motivated by Jeff Han's Multi-touch LED Matrix Display, we were interested in exploring LED matrix as a possible solution for our project. The intuition for using LED display bidirectionally to detect finger touches is quite intriguing. LEDs are also photodiodes, so they are capable of sensing in addition to emitting light. By using a LED matrix instead of an array of sensor, we can reduce the amount of input ports needed. We decided to build a prototype to explore this technology. During the prototyping process, we found that isolating the activation of the LEDs from each other is quite difficult. When a LED in the matrix is touched, nearby LEDs are also activated. This is the direct result of the interconnectivity of the LEDs in a matrix form. After making no further progress with the LED display for a month, we considered our next solution.

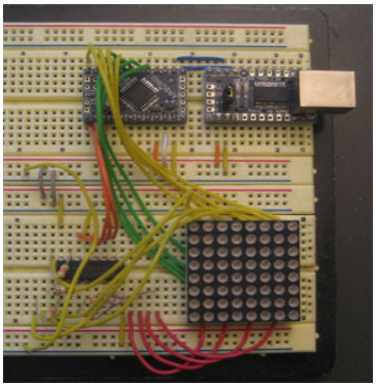

Figure 1. Picture of our prototype of the Multi-touch LED Matrix Display

Design 3 - Camera Based Input

For this design, we used a webcam to track the wraps on the user's hand (see picture) to interpolate the position of the finger. We were able to interpolate the distance of the finger from the camera based on the size of the wraps perceived by the camera. The camera captures image of the user's hand and we perform statistical segmentation on the objects in the image to locate the wraps on the finger.

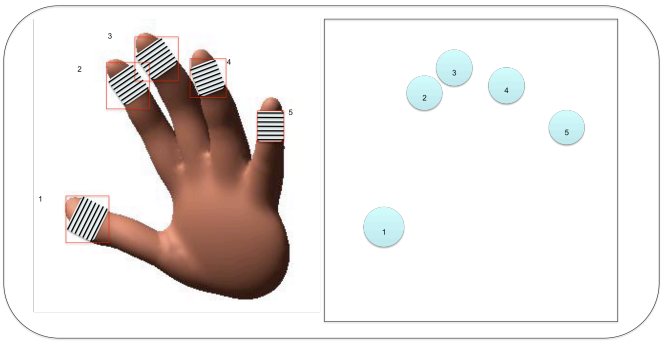

Figure 2. Picture showing the finger wraps and our original design. Initially we planned to use barcode like strips on the wrap to allow identification of individual finger, but we did not have the time to implement that yet.

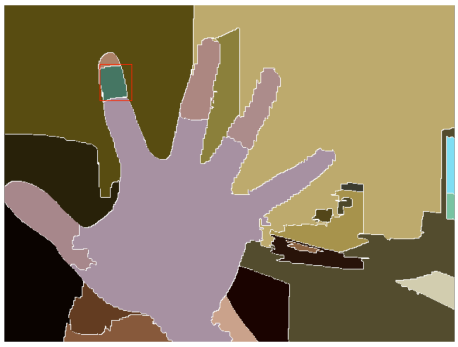

Figure 3. Picture showing the segmented image and the finger tracked by our program

Conclusions

Our most consistent consensus is that CREU was a valuable experience for us to learn about research in computing. During the past year, we were able to explore different technologies and experience the joy and the pain of computing research. This project enables us to experiment with microcontrollers and ICs, something that we, computer science majors don't usually have the opportunity to learn about. It also allows us to explore technologies in computing, such as image segmentations and blob tracking. Overall, the goal of the project was accomplished. We devised an input method that extend the workspace environment to three dimensions and will allow more intuitive data manipulation.

Literatures Produced:

The poster we made for Meetings of the Minds, an undergraduate research symposium hosted by Carnegie Mellon University's Undergraduate Research Organization (URO). The link for the poster is at: http://ppong.files.wordpress.com/2008/05/poster.pdf