Executive Summary

Team 25: Designing and Evaluating Tangible User Interfaces for Assistive Robots

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Original Design Problem

The purpose of this project was to design a tangible user interface (TUI) device that can provide feedback on when and how a user interacts with the device to determine when users are feeling nervous, anxious, or bored. The TUI can be thought of as a “fidget sensor” that tracks the length and frequency of fidget tasks. The project will serve Professor Naomi Fitter, PhD student Rhian Preston, and Oregon State University’s SHARE Lab. The TUI developed will be used for future research in the SHARE Lab that will focus on determining and responding to the emotional state of a user.

Project Development

The first phase of development was performing a literature review and a self-study of fidgeting habits. Following the literature review and self-study, the team conceptualized a number of devices that could monitor different fidgeting habits and created paper prototypes to evaluate the effectiveness of each design. A final design was selected after a cost benefit analysis was performed on the top seven designs favored by the team. Some of the factors considered in the cost benefit analysis were usability, maintainability, and feasibility. The final design chosen by the team consisted of an infrared emitter worn by the user, a chair module that contains sensors to track movement of the infrared emitter and of the user’s chair, and software that logs the movement data and classifies it as one of two fidgets or as non-fidgeting movement.

In the second phase of development, the design and ordering of parts for the TUI took place. Two custom PCBs were designed, one for the IR emitter, and a second for the chair module. Custom enclosures for the physical devices were modeled in Fusion 360 and then 3D printed. The team evaluated the power requirements and battery life for each module, and selected batteries that would satisfy those needs. Data logging and Bluetooth applications were developed in order to collect data from the TUI. Foundational work was done on the classifier to determine feasibility and model selection. Phase two was completed with the assembly of the two modules.

The third phase of the development was to evaluate the design, collect training data, and develop the classifier for the TUI. Revisions to the enclosures were made to simplify assembly and make the emitter more comfortable for the user to wear. Two users generated a total of 48 minutes of training data. The training data was converted into a format that could be processed by a classifier and assigned class labels. This data was then used to train a K-Nearest Neighbor classifier.
Timeline

Fall
(Research and Development)

Date Finished | Team | Everett | Lilian | Hunter | Keana
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10/19/20 | Literature Review | | | | |
11/2/20 | Fidget self survey | | | | |
11/16/20 | Design brainstorm | | | | |
11/20/20 | Paper Prototyping | Trade off Analysis | | | |
12/14/20 | Research Study Design | Engineering Requirements | | | |
12/28/20 | Block Diagram | Final Design Decision | | | |
1/11/21 | | | | | |
1/25/21 | IRB Training | | | | |
2/9/21 | | | | | |
2/1/21 | | | | | |
2/15/21 | | | | | |
2/21/21 | | | | | |
3/1/21 | | | | | |
3/15/21 | Initial TUI Testing/Verification | | | | |
3/29/21 | | | | | |
4/12/21 | Final TUI Testing/Verification | | | | |
4/29/21 | | | | | |
5/10/21 | | | | | |
5/24/21 | Senior Showcase and Project Closeout | | | | |

Reoccurring once a week: Email update and team meeting with project partners, Rhian and Dr. Fitz

Winter
(Prototype)

Main Code

Bluetooth Library

Accelerometer Library

IR Investigation

Prototype

PCB Ordered

Enclosure 3D Printed

Classifier Finished

Data Visualization
Lessons Learned

It is important to build in extra time in a project for when things take longer than initially expected. Documentation is important, and should be done extensively from the beginning of the project. Documentation can help with solving communication problems that may not be immediately apparent. For example, at one point a verbal description of the concept of the final design was misinterpreted by some of the project members, while this was caught before there were any negative repercussions, this could have been prevented entirely with better documentation, figures, and robust communication.