Executive Summary

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

Keana Kief - kiefk@oregonstate.edu

Everett Brandt - brandte@oregonstate.edu

Lilian Chan - chanlil@oregonstate.edu

Hunter Cato - catoh@oregonstate.edu

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.

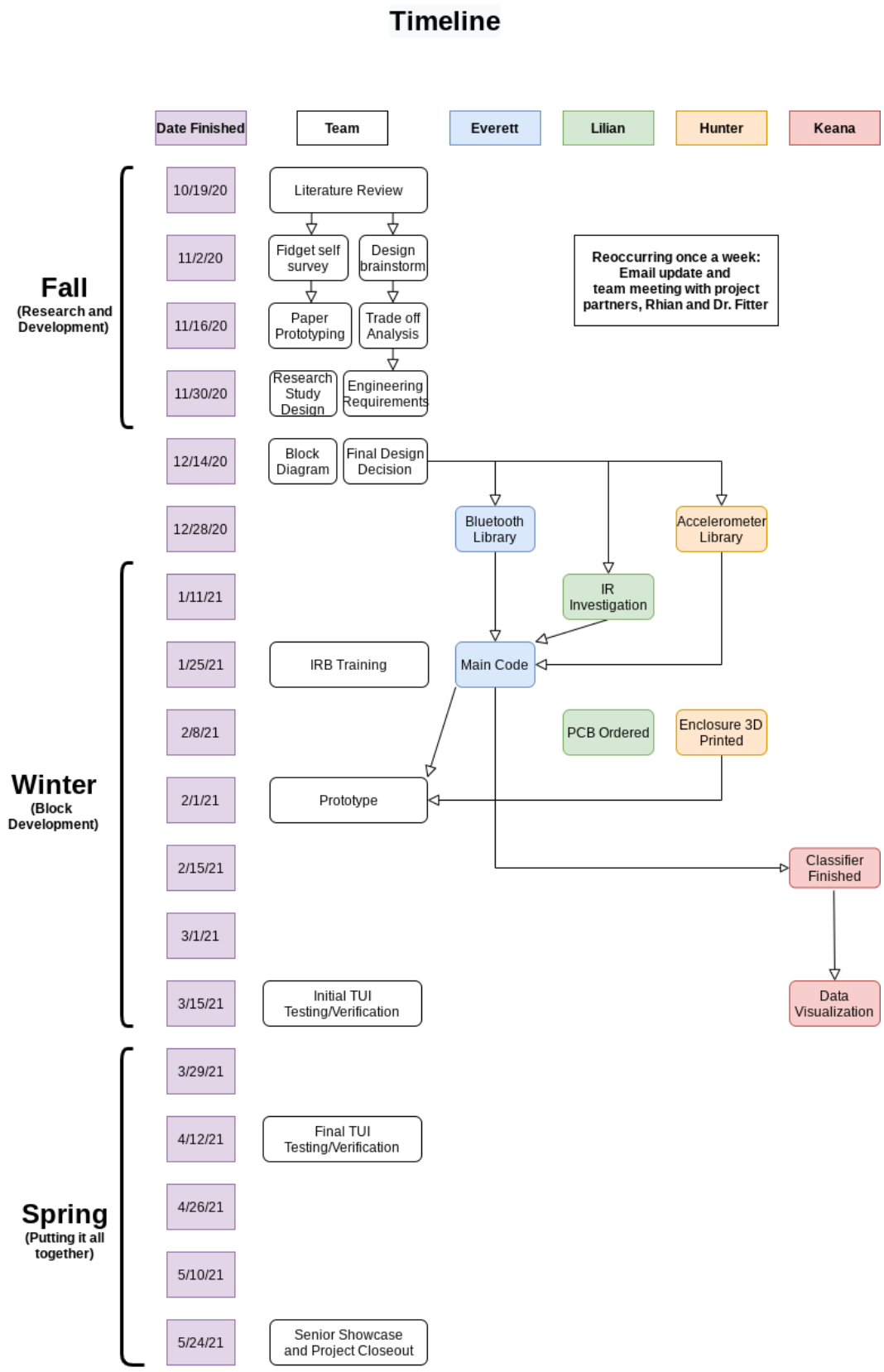
Project Development

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


Timeline
Date Finished
Team
Everett
Lilian
Hunter
Keana
Fall
(Research and Development)
10/19/20
Literature Review
11/2/20
Fidget self survey
Design brainstorm
11/16/20
Paper Prototyping
Trade off Analysis
11/30/20
Research Study Design
Engineering Requirements
Reoccurring once a week: Email update and team meeting with project partners, Rhian and Dr. Fitter
12/14/20
Block Diagram
Final Design Decision
12/28/20
Bluetooth Library
Accelerometer Library
Winter
(Block Development)
1/11/21
IR Investigation
1/25/21
IRB Training
Main Code
2/8/21
PCB Ordered
Enclosure 3D Printed
2/1/21
Prototype
2/15/21
Classifier Finished
3/1/21
3/15/21
Initial TUI Testing/Verification
Data Visualization
Spring
(Putting it all together)
3/29/21
4/12/21
Final TUI Testing/Verification
4/26/21
5/10/21
5/24/21
Senior Showcase and Project Closeout

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.