Boxing Buddy

Initial Project Document and Group Identification
Divide and Conquer 2.0

Senior Design I
Department of Electrical Engineering and Computer Science
University of Central Florida
Dr. Lei Wei

Group 15 Members

Nicholas Ebert	Electrical Engineering	nicholas.ebert@knights.ucf.edu
Andy Gonzalez	Electrical Engineering	andy.g@knights.ucf.edu
Sabrina Mead	Electrical Engineering	sabrinamead1@knights.ucf.edu
Catherine Sailor	Mechanical Engineering	casailor@knights.ucf.edu

Overview

In this paper, we present a design for a device to assist in boxing training that is more advanced than the current options on the market. This project is intended to provide a boxing device that allows for training in various environments while returning qualitative feedback in order for users to improve their skills.

Motivation

Typically, in order for people to obtain boxing training with feedback they have to go to a gym with a coach. Gym memberships and coaching can often be expensive, and require availability in the schedule of the trainee to align with availability in the coach's training schedule. Additionally, coaches can provide feedback and the coach or trainee could record that feedback themselves, but humans make mistakes, so there may not consistently be recorded feedback from training sessions with a human coach. Although there are already some existing devices that allow for at-home training without a coach that provide automatic feedback to a user interface, the options are limited, they are expensive, and they often have poorly placed or developed user interfaces. Our device will be more affordable and will send rapid feedback directly to an application on the users' mobile devices providing a lower risk of damage compared to a user interface mounted onto the design itself, greater convenience for users, and an overall better experience.

Description

General Structure

The device will have a minimum of three strike pads. The strike pads will be attached to a base with adjustable height so it can be suitable for people of various heights or if the user just wants to adjust the angle at which they are striking. Each of the strike pads will have LED lights attached to the top of them that will turn on to assist in measuring reaction time.

The strike pads for the device will be the primary source of data collection. The two strike pads are intended to mimic striking different portions of the body. If there is additional time to modify and test the project after completing the initial design we will add more strike pads and allow them to move to allow for more striking zones and angles. Each of the strike pads will be padded so the users are not injured when they hit them. Within each strike pad, beneath the padding, will be a device to measure the force the user strikes the pad with. The force reading will be sent to an application on the user's mobile device and stored there. In addition to the force being measured, the user's reaction time can be measured based on the time between when they hit the strike pad and the LED lights illuminating on top of the strike pads signaling for the user to strike. An additional feature that may be added if the initial design is completed is the ability for the device to measure and record the user's heart rate. The heart rate data would be sent to the application as well.

In order for the data to be recorded and sent to the user interface, a microcontroller will be connected to the sensors. The microcontroller will also be connected to the lights to turn them on and off and to record the users' reaction time. There will be components on the microcontroller with wireless abilities to allow for the data to be sent to the application.

Mobile Application

One of the aspects of our device that separates it from regular striking pads often used for boxing training, is a user interface that allows for users to view feedback on their performance. The user interface will be an application accessible on the user's handheld mobile device. The data from users' training sessions will be sent to the application and recorded on it for them to review. In the application, users will be able to select a training mode and view the force with which they struck the strike pads as well as their reaction time depending on which training mode they select. If there is time

to further develop the application once the initial design has been accomplished, an option to select programmed workouts from the application will be added.

Training Modes

In order to offer various types of feedback and focus for training, there will be two different training modes for the user to choose from on the application. The training modes are described below.

Strike Force

The strike force training mode allows for the users to view how hard they can hit the strike pads. During this training mode the users will receive feedback in the application from the force sensors showing them a numeric measurement of the force with which they struck the pad.

Reaction Time

The reaction time training mode will utilize the LED lights to help measure the user's reaction time. Once the user selects this training mode, at a time unknown to the user, the LED light on top of one of the strike pads will come on indicating that they should hit that strike pad. This will happen multiple times within the session. Each time the light on a strike pad comes on, the time will be measured between when the light came on and when the user struck the pad to measure the user's reaction time.

Requirement Specifications:

The minimum technical requirements for our system are listed below in Table 1. The requirements highlighted in blue are those that are the most easily demonstrable.

Number	Purpose	Description/ Requirement
1	Performance	The system should measure the amount of force input into the striking pads with an accuracy of greater than 80%
2	Performance	Each strike pad should have LED indicators that flash when prompted by the linked interactive app in under 1 second after prompted
3	Performance	Startup time for application and device will be less than 25 seconds
4	Software	An interactive mobile app should be connected to the Boxing Buddy systems and will receive and display the input data in under 1 seconds
5	Sensor	Each strike pad should have the capability to measure the time between the LED light turning on and being hit with over an 80% accuracy
6	Software	The system should be able to operate autonomously for at least 1 pre-programmed training session(s) that can be selected through the app
7	Structure	The structure should have an adjustable height that will not exceed 7 ft
8	Structure	The system will have 2 basic strike pads and should have 1 optional strike pad
9	Sensor	Each strike pad will contain a force sensor, a way to measure reaction time, and an LED attachment
10	Structure	The strike pads should be able to withstand a force of 500 lbs

Table 1. System Requirements

Constraints:

The constraints section includes possible obstacles that may limit the scale or performance of our project. They are listed below in table 2.

Number	Purpose	Constraint
1	Supply Chain Issues	Limited availability of needed components, and long shipping times
2	Project Funding	Financially we want to create the system on as low of a budget as possible due to being self funded
3	Safety	User should wear protective equipment when using the system including wrist wraps and gloves when necessary
4	Maintainability	Downloading updates to the mobile app should be possible to allow for future improvements
5	Legal	Intellectual property investigation should be conducted to ensure no infringement on existing patents
6	Maintainability	The system structure should be able to operate without becoming unbalanced and be able to be accessed without destructive manipulation of the product

Table 2. System Constraints

Standards:

The industry established standards we plan to use the design of our system are listed below in Table 3.

Number	Purpose	Standard
1	Safety	UL Testing Certification
2	Functionality	Using ANSI 120 Vac wall outlet as a power source, must follow basic standards
3	Reliability	PCB(s) should use conformal coating to protect all electronic components
4	Safety	Proper labeling of the system for regulated components
5	Functionality	Wi-Fi 802.11xx

Table 3. System Standards

House of Quality:

This HOQ consists of the market and engineering requirements and how they correlate. The HOQ is shown in Figure 1 below.

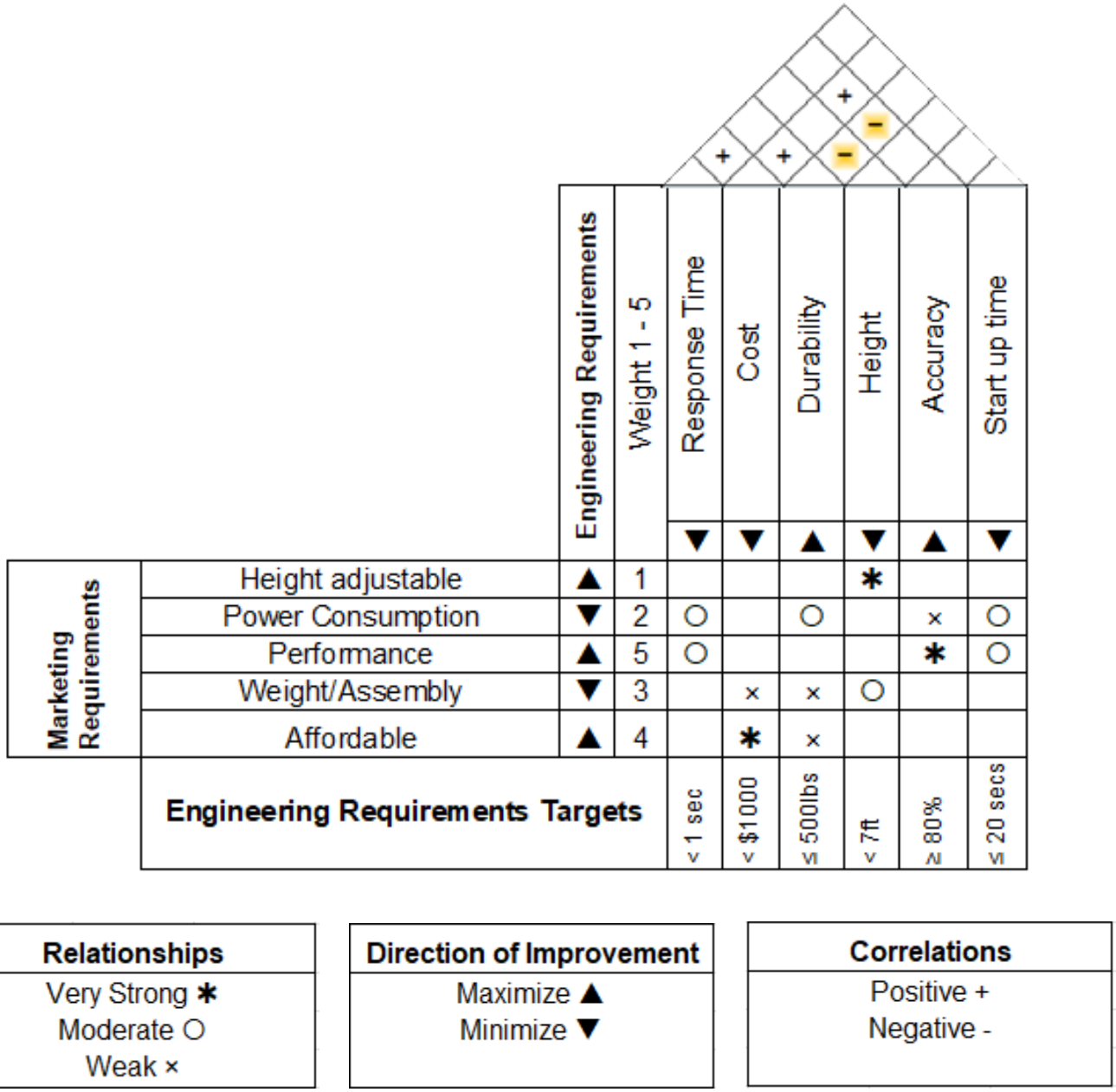

Figure 1. House of Quality

Block Diagram:

The block diagrams for our project are shown below. They include the status of each element along with the member responsible for each element. The hardware block diagram, in Figure 2 below, shows all the elements related to the electrical wiring and mechanical structure while the software block diagram on the next page, shown in Figure 3, includes elements relating to the mobile application and WiFi module in the main controller that will be sending data back and forth.

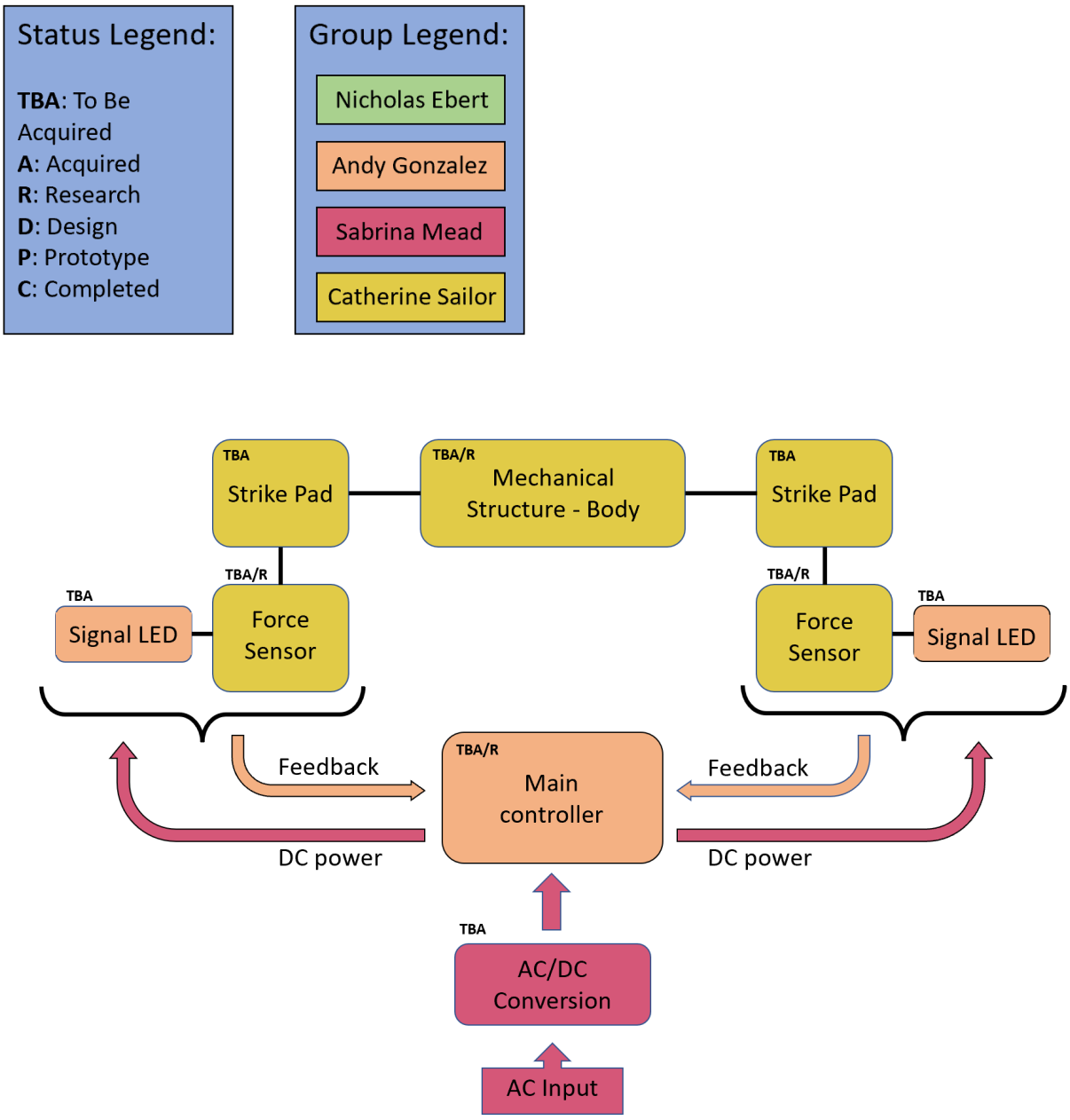

Figure 2. Hardware Block Diagram

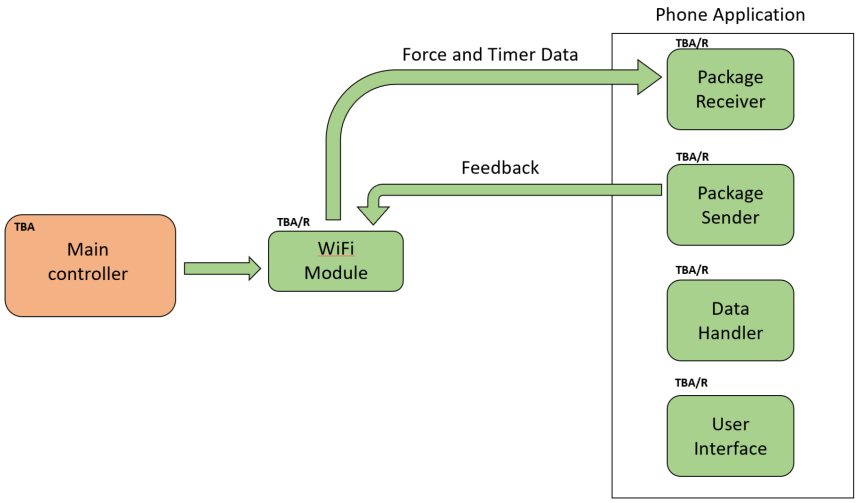

Figure 3. Software Block Diagram

Estimated Project Budget and Financing:

The estimated costs of the components of the project are listed below in Table 3.

Item	**Price**	**Quantity**	**Total**
Microcontroller	$25	1	$25
WiFi Module	$25	1	$25
Analog to Digital Converter	$10	1	$10
Force Sensors	$166.3	2	$332.6
LED lights	$1.3	2	$2.6
Metal/Material for the body of the object	$200	1	$200
Striking Pad	$12.5	2	$25
		Total Estimate:	~$620.2

Table 3. Project Budget Breakdown

Project Schematic:

A visual representation of the structural design of the device is depicted below in Figure 4.

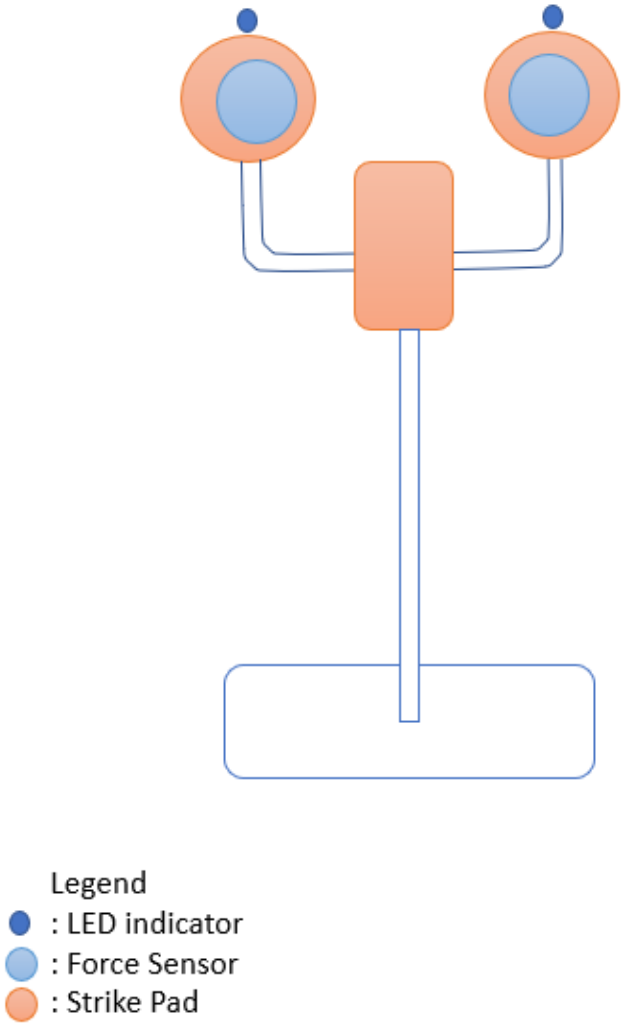

Figure 4. Device Structure Design

Initial Project Milestones:

The initial project milestones with brief descriptions of each milestone and completion dates are listed below in Table 5 and 6 for the fall and spring semesters respectively.

Fall 2022

Milestone	Assigned to	Task	Completion Date
Attend All ABET Lectures			
1	All	Form Group	08/25/2022
2	All	Initial Idea	09/09/2022
Divide and Conquer Phase			
3	All	Initial Project Document (Divide and Conquer)	09/16/2022
4	All	Divide and Conquer Meeting with Professor	09/20/2022
Divide and Conquer Phase 2.0			
5	All	Update Divide and Conquer Document	09/23/2022
6	All	Discuss what task everyone has	9/23/2022
60 Page Draft Phase			
7	All	Start writing Project Report	09/30/2022
8	All	Make a detail tasks list	09/30/2022
9	All	Order Test Components	10/14/2022
10	All	60 page Draft	11/04/2022
11	All	Start Testing Project	11/04/2022
12	Sabrina & Andy	Create PCB Design	11/08/2022
13	Nicholas Ebert	Create Software Prototype	11/08/2022

100 Page Draft Phase			
14	Nicholas Ebert	Write and Test Software Prototype	11/17/2022
15	Catherine Sailor	Test all Mechanical Aspects of the Project	11/17/2022
16	Sabrina & Andy	Build and Test Custom PCB	11/17/2022
17	All	100 page report	11/18/2022
18	All	Finalize and peer review the paper	11/30/2022
19	All	Final Report	12/06/2022

Table 5. Fall 2022 Schedule

Spring 2023

Milestone	Assigned to	Task	Completion Date
1	All	Finish Testing Project	February 2023
2	All	Get mobile website/app working	March 2023
3	All	Test Final Product	April 2023
4	All	Final Presentation	End of SD2
5	All	Final Report	End of SD2

Table 6. Spring 2023 Schedule