Senior Design I

Initial Project and Group Identification Document

“Divide and Conquer”

Preventing, Anticipating and Mitigating Off-Task Behavior in Special Needs Students

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Purpose

Students with Autism Spectrum Disorder (ASD) or Emotional Behavior Disorders (EBD) face more problems than just keeping up with the curriculum (on-task behavior). Frustrations arise that result in off-task behaviors which negatively affect the learning process for themselves and others. One example that may lead to such frustrations is difficulty with transitioning between events or activities (e.g. going from Math to Reading, or from Centers to lunch, or even dismissal). In many cases this can be attributed to the concept of closure; the student is not mentally prepared to proceed to the next activity/lesson until completely finished with the current one. Of course, frustrations can occur during any activity/lesson whereby the student becomes upset and the result is the same.

This project attempts to reduce off-task behavior through prevention, anticipation and mitigation. It will use a system comprised of two devices. One is a set of sensors worn by the student that will detect anxiety, or the onset of a behavioral problem. The second device is interactive (touch screen) and will try to diffuse the problem.

The system will prevent off-task behavior by providing the student with a visual indication of how much time remains on a specific activity/lesson. The idea is to help the student transition because they can prepare for it. This "timer" can either be on the sensor (like a watch face), or the second device.

The system will anticipate conditions of off-task behavior by being programmed to the student's schedule (indicating transition events) or by responding to physical markers such as heart rate, temperature, movement, blood pressure, or sweat. These will be used to indicate the onset of a potential behavioral issue.

The system will mitigate off-task behavior through methods corresponding to the cause. When a problem is imminent the system will direct the student's attention away from the cause to the interactive device. The purpose of this is two-fold. If the student is experiencing a behavior issue that does not require immediate attention and is not related to transitioning, then the system can calm student down – de-escalate. This is analogous to "taking five". If, however, it is related to transitioning, then it will distract the student from the activity from which they are transitioning to some activity on the interactive device. This will then keep their attention until the activity is completed, thus providing that needed sense of closure, and allowing the student to successfully transition to the next activity/lesson.

The system is not intended to complement their academic lessons. Rather, it provides a kind of automatic response that identifies and handles the problem in a manner that would be quicker than direct intervention by a teacher or guardian. Any interference from the "timer" or touch screen activity would be justified since less time is taken away from the academic day than if the teacher had to completely interrupt the lesson to get the student back on track.

For the system to be unobtrusive, then, it must meet certain criteria. One of which would be portable; the monitor itself must be small and light enough to not be an added burden, and the

touchscreen should be small and light enough that its mere presence does not negatively affect the class. It also must not be loud enough to disrupt class, while being loud enough for a person of normal hearing.

It must also be easy to use; teachers/parents/guardians will need to tailor the “timer” feature such that is corresponds to the daily schedule. This will need to be done initially, and then any time the day’s schedule is altered. In addition, the interactive feature of the system is used by a special needs student; simplicity is inherent.

As this is primarily conveyed by a special needs student, it must also be durable and water resistant. These requirements are obvious for any child during normal school activities.

The two devices work together to provide the desired output. They must then communicate with each other. To satisfy the requirements that it be unobtrusive, then, they should communicate wirelessly.

While the system could possibly work in any condition where transitions or other frustrations are possibly present, it is intended mainly for those during scheduled class time. The system must then last throughout a school day, at least. This hints at a power supply that does not require dependency on access to an outlet such as a rechargeable battery. Also, this rechargeable battery should allow for the system to function long enough to complete the school day.

The system relies on interpreting physiological markers to anticipate behavior problems. This is done through sensors on the child. These sensors must then be accurate to prevent unnecessary initiations of the mitigation portion of the system.

Finally, as with nearly every endeavor, cost is a considerable factor. End users will only pay what they consider is fair value. Producers should then minimize the cost of development to achieve that fair value, along with a profit if possible.

Requirements Specifications

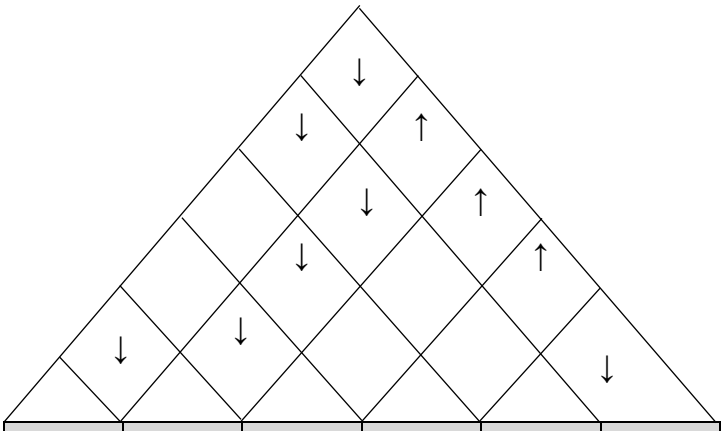
The engineering requirements for the project are listed in Table 1 below along with their associated marketing requirements mentioned in the previous section and their justifications.

Marketing Requirements	Engineering Requirements	Justification
1, 3, 4	1. Dimensions of both components. (a) Wearable rubber sensor: 2" × 2" × 0.75", less than 8 oz. (b) Touch screen: 8" × 4" × 1", less than 3 lbs.	These are comparable to current GPS locator devices worn on a wrist strap, and handheld devices. Rubber is proven durable and water resistant.
5	2. Batteries for both components should operate for 12 hours at maximum power consumption of less than 50 watts.	This ensures that the system can be used for at least an entire school day without having to recharge at a power consumption that is comparable to current devices (iPad, Kindle).
6	3. Sensor accuracies should all be within ±20%.	This takes into account the accuracies of the sensors with changes to ambient conditions.
2	4. System use will follow three (3) prompts from the touchscreen: "ENTER", "NEXT", and number input.	Programming the timer and interactive features should be simple for all users.
8	5. Speaker sound will be between 20 and 60 decibels.	This ensures a child of normal hearing can hear it, and it will not interrupt class (between a whisper and normal conversation)
7	6. Production cost should be less than $500.	This is comparable to current monitors (GPS, anxiety sensors).
Marketing Requirements 1. Portability (small, light-weight) 2. Easy to use 3. Durable/Water resistant 4. Wireless 5. Low power consumption 6. Accurate sensors 7. Low cost 8. Mild sound		

Table 1: Requirements specifications

Engineering-Marketing Tradeoff Matrix and House of Quality

The following figure correlates the effects of the marketing requirements to the engineering requirements. The positive "+" and negative "-" symbols next to each requirement refer to its polarity; increasing or decreasing that requirement increases the desirability of the system. The up and down arrows indicate if the requirements correlate as positive (↑), strongly positive (↑↑), negative (↑), or strongly negative (↑↑).



		Dimensions	Battery Life	Accuracy	Ease of Use	Sound	Cost
		-	+	+	+	-	-
Portability	+	↓	↓		↑		↑↑
Ease of Use	+		↓		↑↑		↑↑
Durability	+						↑↑
Wireless	+				↑		↑↑
Power consumption	-	↑	↓↓				↑↑
Accuracy	+			↑↑			↑↑
Cost	-	↓	↑↑	↑↑	↑↑	↑	↑↑
Sound Intensity	-		↓			↑↑	↑
Targets for Engineering Requirements		2 × 2 × ¾ in., < 8 oz. 8 × 4 × 1 in., < 3lbs	≥ 12 hours @ < 50 watts	±20%.	Three (3) entry prompts	20 - 60 dB	< $500

Figure 1: House of Quality

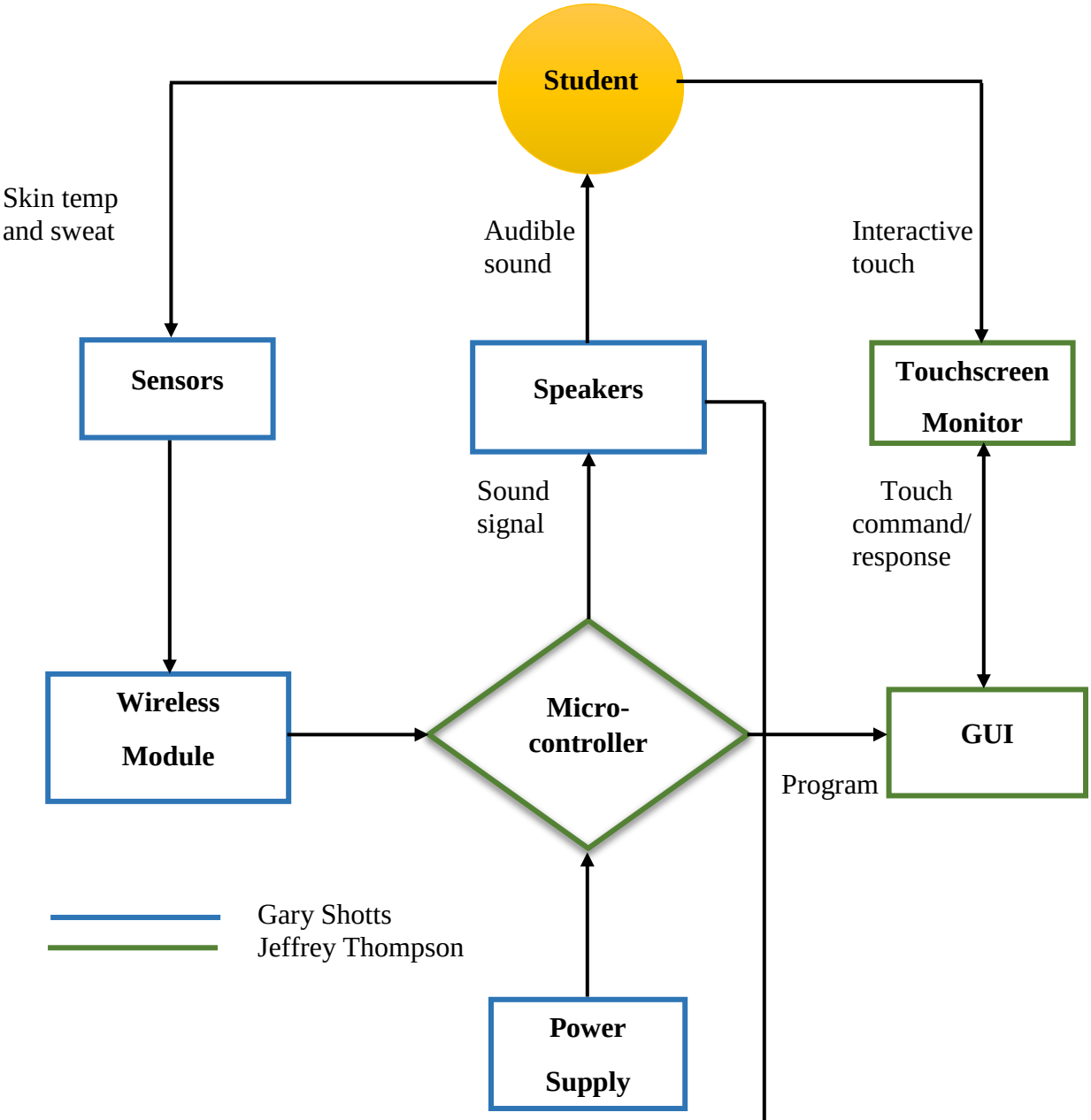
Project Budget

The prices listed below are estimates from online research and are subject to change prior to completion of the final project. There is no sponsor, and so all costs will be incurred by the group members.

Description	Vendor	Price per Item	Amount of Items	Total Cost
Bluetooth Module	Adafruit.com	$19.95	3	$59.85
Touchscreen	Adafruit.com	$39.95	1	$39.95
Microcontroller	Mouser.com	$2.14	10	$21.40
Heart Rate Monitor	Sparkfun.com	$19.95	2	$39.90
Microprocessor	Sparkfun.com	$39.95	1	$39.95
Wristband for Heart Monitor	Adafruit.com	$65.00	1	$65.00
Speaker/Audio	Sparkfun.com	14.95	3	$44.85
Resistors, Capacitors, Inductors, Transistors	UCF			
PCB		$100	1	$100.00
Power Management	Sparkfun.com	$19.95	2	$39.90
Galvanic Skin Response	Robotshop.com	$9.90	2	$19.80
Total		$351.74	27	$470.60

Table 2: Project budget

Block Diagram



The Status of each block as of 02/03/2017

- Every block is being researched
- No items have been purchased
- All blocks are being designed
- No item has been modeled
- All blocks need to be completed

Figure 2: Block diagram, status and responsibility

Milestones

Number	Task	Start Date	End Date	Status
Senior Design I				
1	Ideas	1-10-17	1-13-17	Completed
2	Project Selection and Role Assignments	1-10-17	2-3-17	Completed
	Project Report			
3	Initial Document – Divide and Conquer	2-3-17	2-17-17	In Progress
4	Table of Contents	2-17-17	3-24-17	In Progress
5	First Draft	2-17-17	3-31-17	In Progress
6	Final Document	3-31-17	4-27-17	In Progress
Research, Documentation, and Design				
7	Microprocessor	1-31-17	2-17-17	Researching
8	Audio/touchscreen	2-7-17	2-28-17	Researching
9	Wireless Technology	2-7-17	2-28-17	Researching
10	Heart Rate/Skin Conductance	2-7-17	2-28-17	Researching
11	Microcontroller	2-7-17	3-31-17	Researching
12	Test Components	2-17-17	3-31-17	Researching
13	Schematics	2-17-17	3-31-17	Researching
14	PCB Layout	2-22-17	3-31-17	Researching
15	Soldering	3-15-17	4-30-17	Researching
16	Power Supply	3-28-17	4-30-17	Researching
17	Program Board	TBA	TBA	Researching
18	Packaging	TBA	TBA	Researching
19	Order and Test Parts	TBA	TBA	Researching
Senior Design II				
20	Build Prototype	TBA	TBA	TBA
21	Testing and Redesign	TBA	TBA	TBA
22	Finalize Prototype	TBA	TBA	TBA
23	Peer Presentation	TBA	TBA	TBA
24	Final Report	TBA	TBA	TBA
25	Final Presentation	TBA	TBA	TBA

Table 3: Timeline of milestones

NOTE: Dates are subject to change in the research document and design area as these are just placeholder dates because we do not yet have a potentially full group and the parts may change due to change in design.