Project Deliverable D: Detailed Design and Prototype 1

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1. Summarize the client feedback that you received during your second meeting for your conceptual design and clearly state what needs to be changed or improved in your design.

The client meeting can be best summarized by these bullet points:

- The client has shown interest in the idea presented by our team.
- The client wishes to know what areas on a human body would be impacted the most if a fall occurs
- The client stated that he had previous experience with similar technology
- His previous experience was quite pour due to the sensors being too weak to detect an impact
- Then the idea of using amplifiers was brought up by one of the members of the team
- The client wants a high level of accuracy in fall detection
- He wishes for a working prototype be finished on time
- One sensor in a specific location that detects a fall with enough sensitivity is required of us to build
- The client suggested that we look into Red Dot Alert: “Safe Sole” or other projects that might help us in prototyping or coming up with new solutions
- The client once again stated that he would like to see a working hardware and software prototype by the deadline.

Based on client’s feedback we know what our next steps should be. We now can go ahead and test out possible improvements for this idea. Once we get a working sensor pad prototype done; we can focus more on multiplying the quantity of those sensors and the analytics based on the recordings done by them.

2. Develop an updated and detailed design of your concept, based on your client meeting, which includes:

The overall system has not changed drastically since the client meeting. Rather, the approach and specifics of implementation have been determined further. In this section, a detailed overview of both the hardware and software of the product are presented.

Based on topics for the client meet, an update (for detailing) was made to the system. This update can be seen in the system level block diagram here.

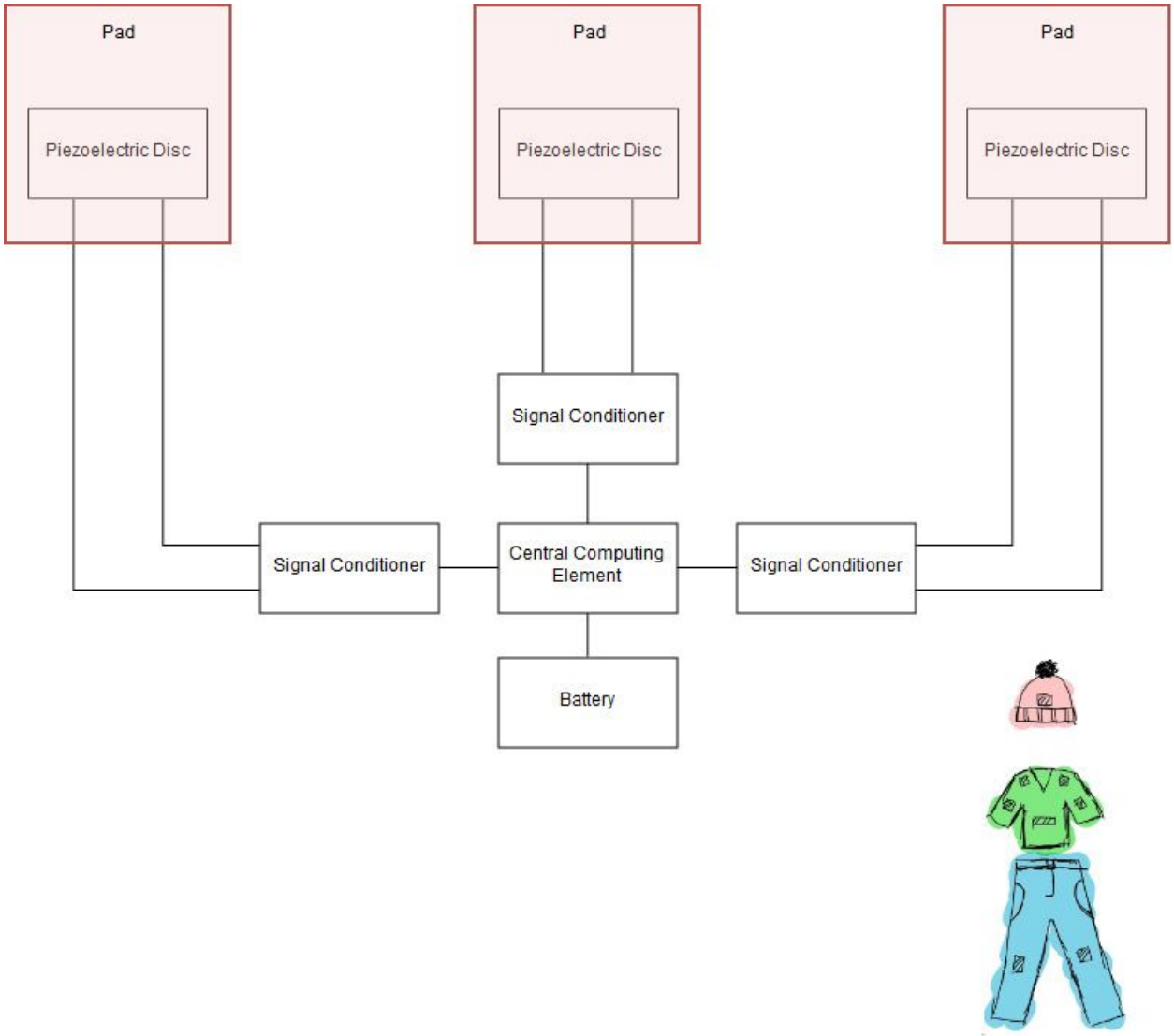

Figure 1: Updated System Diagram

With this updated system diagram, a detailed design study of the final product was conducted. Before considering the final results of this study, a re-evaluation of the assumptions and progress plan were conducted.

The major changes included the following:

- Development of the 2nd prototype has a heavier precedence due to client expectations. Ie. the client desires to see a functioning sensor pad more than the clothing the pad integrates onto.
- The BOM has been modified to include the signal conditioning elements that help better detect the voltage from piezoelectric discs

- The BOM has been modified to include a battery that will act as main power

With these modifications and updates in mind, the electrical schematic of the sensor pad was developed. As this is the major criteria for success from the client, this is presented as the detailed design of the system. The team will focus development efforts on getting this sensor pad to be as functional adaptable as possible to allow for future development of clever software for more accurate detection of falls.

The results of the detailed design study is best presented in the form of the following electrical schematic.

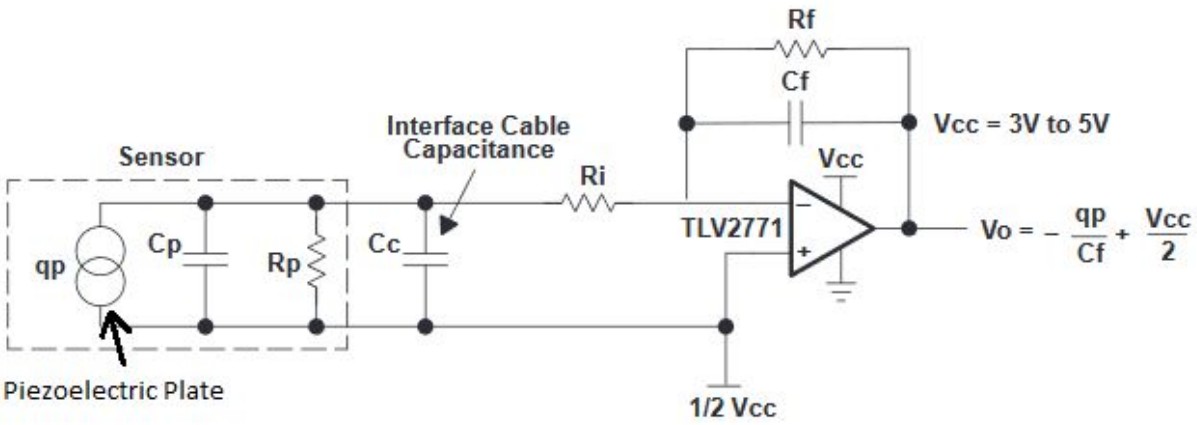

Figure 2: Electrical Schematic of Sensor Pad and Signal Conditioner

As the signal conditioner will exist close to the central computing unit (as opposed to close to the sensor pad), a capacitance enabled signal conditioner is designed using the high slew rate, rail-to-rail operation amplifier, TLV2771. In essence, the signal from the piezoelectric plate will be amplified to match the full range of the analog to digital converter (ADC) on board the main computing element. As such, the output from the signal conditioner, Vo, will connect directly to the ADC of the main computing element.

Furthermore, a simple software state machine was developed to further clarify the routines and procedures any computation element must perform to fully implement the desired product. The state machine diagram is given below:

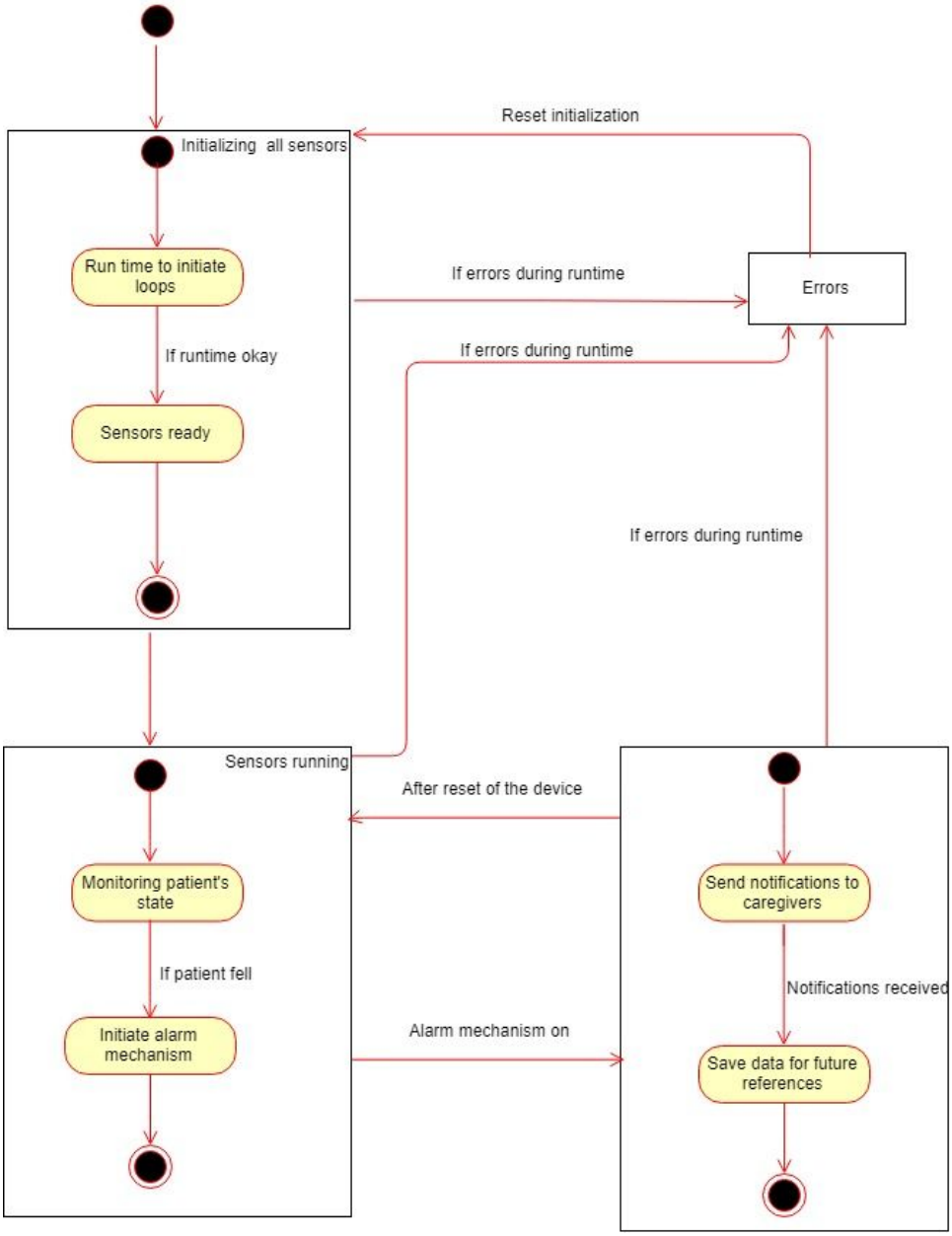

Figure 3: State Machine Diagram for Central Computing Element

3. Define your most critical product assumptions and create your first product prototype, which will be used to test those assumptions.

The first prototype is non-functional and its primary purpose is to measure comfort level as well as test wire management strategies to avoid restriction of movement. The following sections show sketches that depict the prototype and its development as well as actual images of this first prototype.

4. Document your prototype using as many sketches/diagrams/pictures as required and explain the purpose and function of your prototype.

First a set of sketches were created to fully define the prototype. They are provided below.

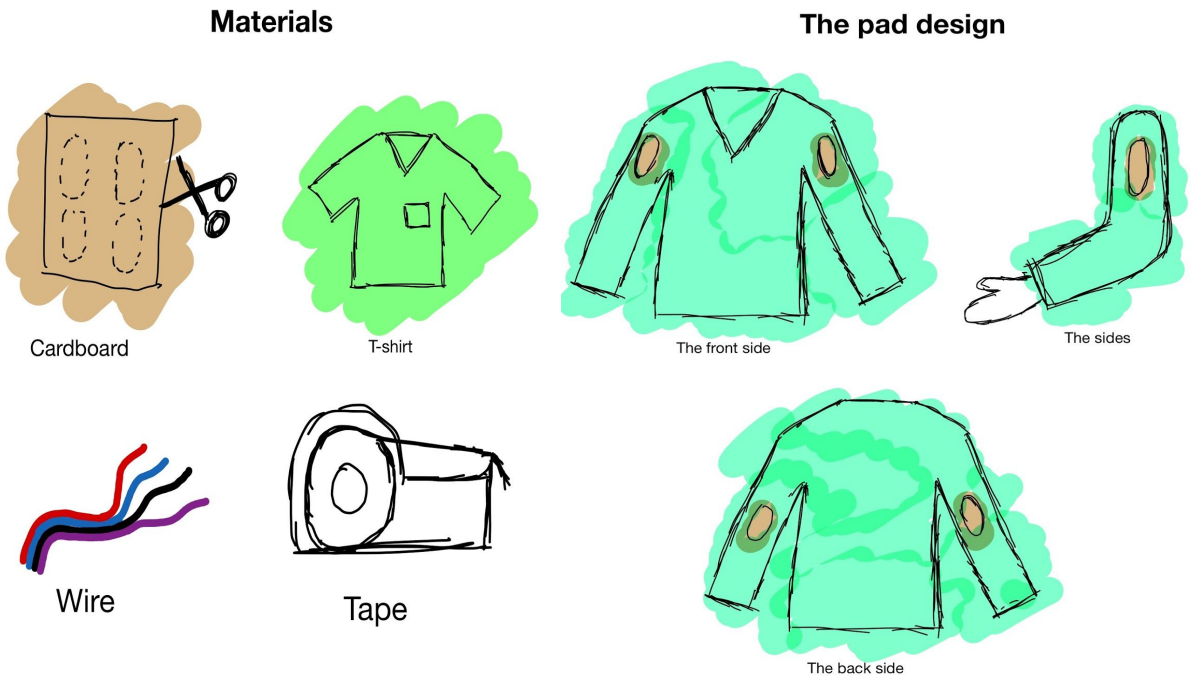

Figure 4: Sketches that Kickstarted the First Prototype

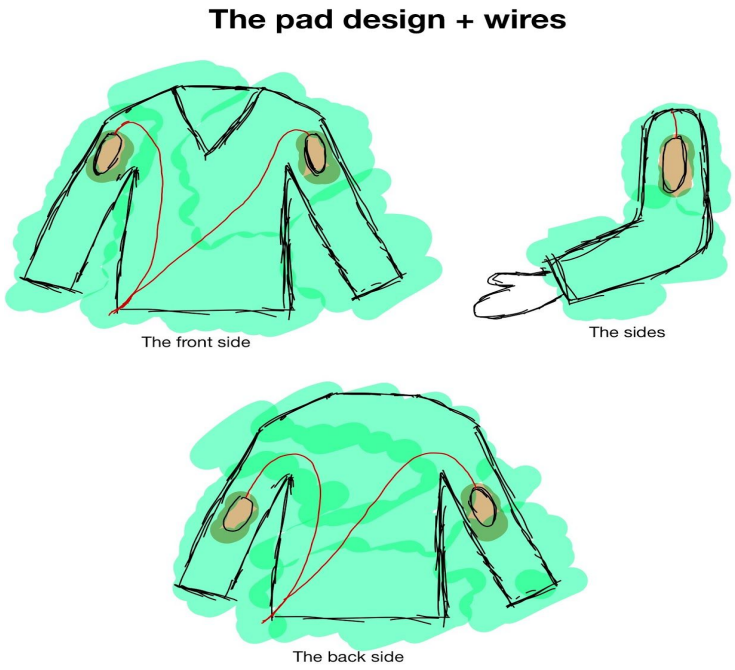

Figure 5: Prototype Sketch Amended with Wiring Concept

Using these sketches as a template, the prototype was implemented with limited resources. Photos of the physical prototype are provided here:

Figure 5: Visual of Implementation of Non-Functional Prototype

The testing and validation of this prototype was mostly subjective. However, it provided some fairly useful information.

5. Carry out prototype testing, analyze and evaluate performance compared to the target specifications developed in Project Deliverable B and document all your testing results. Present your testing in an organized, tabular format that shows expected versus actual results.

Even with this simple non-functional prototype, much was discovered. These discoveries are given in the table below.

Level of comfort	
Expected results	Actual results
The device doesn't restrain movements and is comfortable.	The first prototype is comfortable, however movements are still limited due to the wires therefore, arrangement of the wires is needed in order to achieve that freedom of movements while keeping comfort to the highest level.

Table 1: Results of Testing Non-Functional Prototype

In further prototyping we must consider trying and using different materials to ensure the comfort and durability.

6. Outline what your team intends to present to your client(s) and what information you would like to gather at your next client meeting.

For our next client meeting we intend to present him the first non-functioning prototype as well as, ideally, the first functioning prototype; the functioning prototype being a single sensor pad that has a high level of accuracy. Also show the client a detailed design concept as well as the analysis of the prototypes, how, what, why, when, who and where of the functions. Then we can receive a proper feedback to continue on improving prototypes, adjusting to the client's needs and adding extra features upon request.