Tactile Simulation Design Brief

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1 Problem Statement

Current Virtual Reality systems don't provide realistic tactile feedback. The majority of emergent haptic feedback technologies target force feedback, neglecting the tactile dimension. Simulating tactile sensation would be a huge improvement in immersion in Virtual Reality. Our project aims to deliver a peripheral nerve interface integrated into a wearable glove that can provide a realistic simulation of texture using trans-cutaneous electrical nerve stimulation.

2 Purpose and Background

The motivation of this project is to improve the experience of the virtual reality user. This is one of our key stakeholders and our target end user. The current state of tactile feedback is controller vibrations, which will be lost as the platform adopts hand tracking over physical controllers. There are lots of attempts at haptic feedback devices that simulate force, in the form of elaborate gloves or contraptions, but very few attempts to simulate tactile feedback.

3 Target End User

Our product will be applicable to those using virtual reality for gaming, as well as those using it as more of a tool such as for telecommunications and design. The device is primarily meant to be utilized alongside virtual and augmented reality headsets, but will be capable of operating independently. It will be easily customizable to fit any application an individual or company may envision for such a product. An example may include providing a user with touch feedback to aid in the experience of interfacing with a device such as a car or smartphone.

4 Client Objectives

End User Key Objectives:

- Novel user experience
- Recreation
- Entertainment
- Escapism
- Future technological improvements enabled by project

5 Client Profile

Our intended customer base consists of current and prospective virtual reality users. Our plan to obtain feedback consists primarily of frequent surveying and interviews of potential consumers. We will be testing prototypes with different users to spot any oversights we may have made as the developers.

6 Project Location

We will be working on this project, primarily in the labs of UCSC. We should be able to do a lot of design, background research, and some degree of prototyping remotely.

7 Team Composition

7.1 Professional Roles

Eli Harrison-Saeli

- Documentation Lead
- Financial Lead

Jacob Sickafoose

- Communications Lead
- Team Progress Lead

7.2 Technical Roles

Add brief descriptions of each position Eli Harrison-Saeli

- Engineering Systems Lead
- Quality Control Lead

Jacob Sickafoose

- Mechanical Lead
- Hardware Design Lead

Figure 1: Haptic Feedback Glove

8 Potential Solutions

Transcutaneous electrical nerve stimulation (TENS) is a technology that applies an electrical signal via an electrode to activate nerves in the body through the skin. Using a similar approach it is possible to activate the nerves in the skin connected to mechanoreceptors that are responsible for converting the mechanical deformation in the skin into the electrical signal our nervous system uses to perceive tactile sensation. By selectively stimulating different types of nerves, which reside in the skin at different depths, it should be possible to simulate a wide variety of textures. While theorization and research about this application of the technology is usually in the context of computer nerve interfaces i.e. creating prosthetics with tactile feedback, we intend to use the existing base of knowledge for our slightly different application: the replication of the texture of a material using artificial stimulation of nerves.

An alternative approach would be using a magnetic field rather than a direct current to activate the nerve. This would replace the electrodes with inductors. Current applications of magnetic nerve stimulation tend to focus on the brain, but there is research on peripheral (non brain) nerve stimulation as well. One advantage of this approach is that it could be used deeper than the skin nerves, perhaps providing other forms of haptic feedback in addition to texture. Another advantage is that it avoids applying a direct current to the skin, which may seem safer and more palatable to the user. Some disadvantages would be that it may be more difficult to source the materials required.

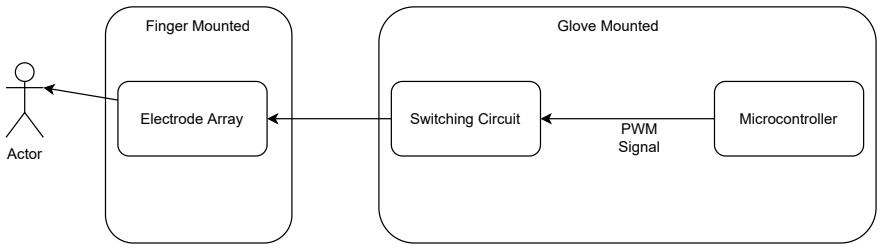

Figure 2: Preliminary System Block Diagram

9 Project Materials

9.1 Software

- PSpice
- SOLIDWORKS
- Unity
- EAGLE

9.2 Hardware

- Electrical components
- Microcontroller
- Electrode arrays (either build, order, or borrow)
- VR Headsets

10 Project Timeline and Major Milestones

- Complete materials list
- Complete budget document
- Enlist a mentor professor
- Conduct considerable initial feasibility research
- Begin prototype design