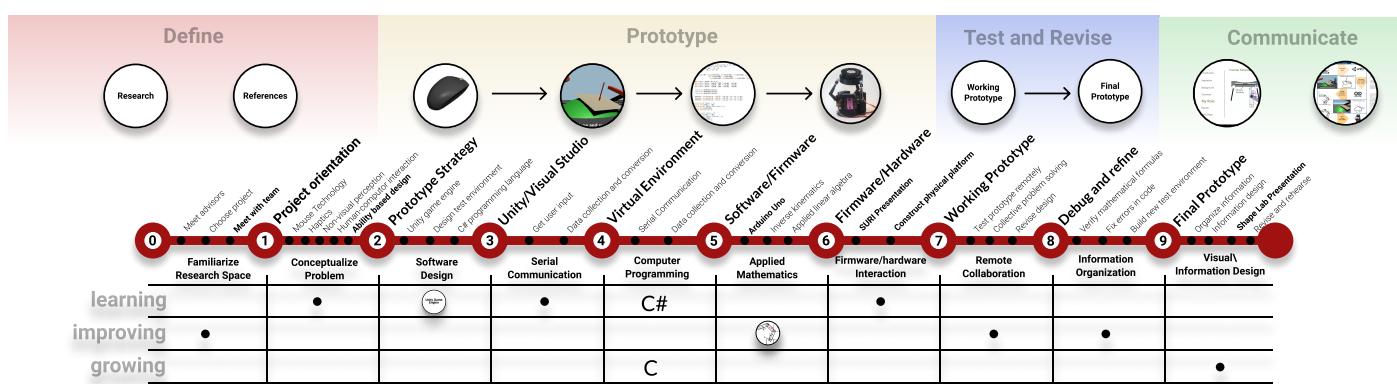


# Haptic Shape Display for Exploring Virtual Interfaces for Blind and Low Vision Users

with Stanford Undergraduate Research Institute and Shape Lab

with **Abena Boadi-Agyemang**  
lab advisor **Alexa Sui**  
and faculty advisor **Sean Follmer**



## Research Timeline

## Overview

For this project Abena and I developed a prototype of a **haptic mouse** designed to assist blind and low vision users (BLV) in navigating digital interfaces. The prototype is a two-handed kinesthetic device controlled by a standard computer mouse and provides kinesthetic feedback to the users via a 3DOF Stewart platform.

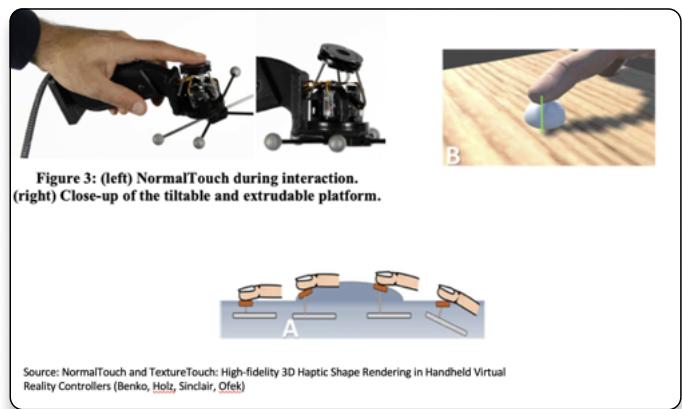


**Stewart Platform (3DOF)**

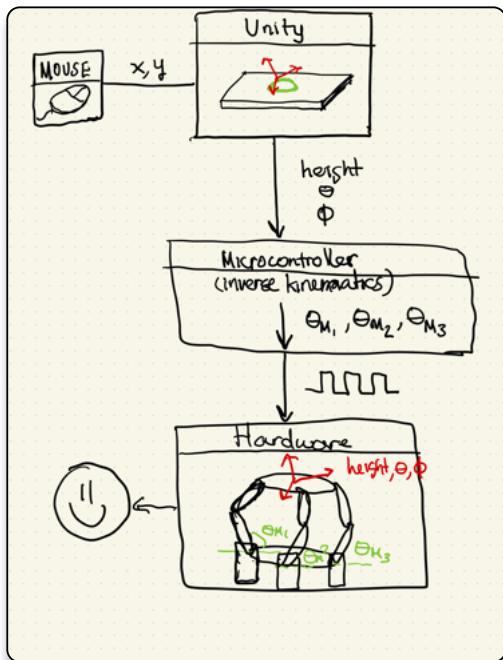
Designed, implemented, and photographed by **Abena**

# Design goals

Our goal was to develop a two handed device to be used with an off the shelf mouse for maximum inclusivity. The design was inspired by Microsoft's NormalTouch, a device used to provide haptic feedback in VR environments.



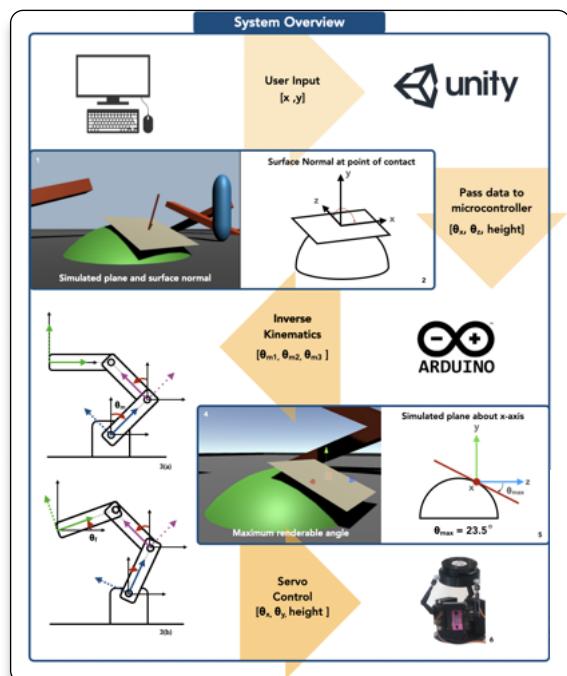
Inspired by  
Microsoft NormalTouch



Early sketch

# Strategy

Our strategy was to attack the problem from both ends. Abena's role was to work out the inverse kinematic equations and to design and construct the platform. My role was to develop the user-interface, firmware, and implement the inverse kinematics, all of which I learned as we went along.



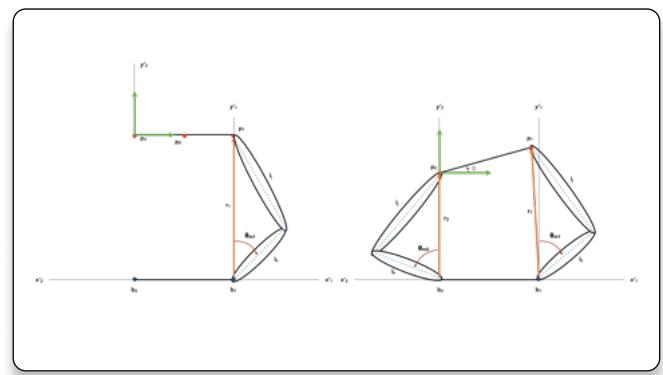
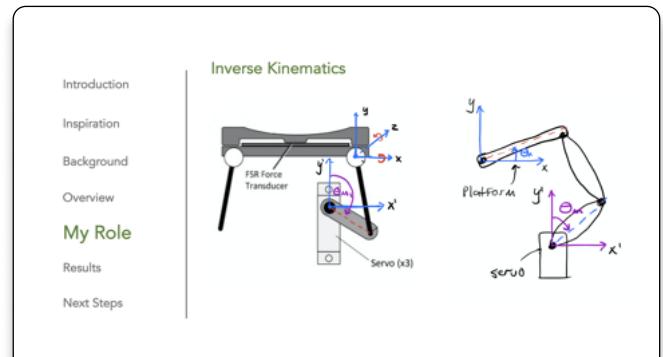
I/O Pipeline

# Implementation

Using Unity game engine, I created an environment meant to simulate a finger passing over a surface. The 2D mouse inputs are converted into 3D values representing plane angles and height, which are passed along to the Arduino, where are then converted to output angles using inverse kinematics.

# Communication

A key responsibility as a SURI researcher involved communicating results regularly, both to the larger SURI community, and the Shape Lab design group. My personal goal for the summer was to advance my development in science communication and visual design. I gave special thought and effort into how I presented my findings to the community.



## Haptic Shape Display for Exploring Virtual Interfaces

Alan Brantley

Research Partner; Abena Boadi-Agyemang, PhD Student Advisor; Alexa Sui, Program Advisor; Sean Follmer

### Results

#### Abstract

We present a prototype of a haptic mouse designed to assist blind and low vision users (BLV) in navigating digital interfaces through haptic perception. The prototype is a **passive kinesthetic device** that provides haptic feedback through a 3 DOF (pitch, yaw, height) Stewart platform. We discuss the system design and integration and conclude with preliminary results and future design considerations.

#### Background

- Inspired by Microsoft NormalTouch
- Kinesthetic receptors are responsible for detecting movement and force
- Cutaneous receptors are located in the skin and are responsible for skin sensations such as texture and friction
- Tactile perception refers to perception mediated by cutaneous receptors
- Haptic perception refers to perception mediated through kinesthetic and cutaneous receptors.

#### Design Considerations

Our final design goal is to build a **single handed haptic mouse** that would allow users to simultaneously explore and perceive digital environments.

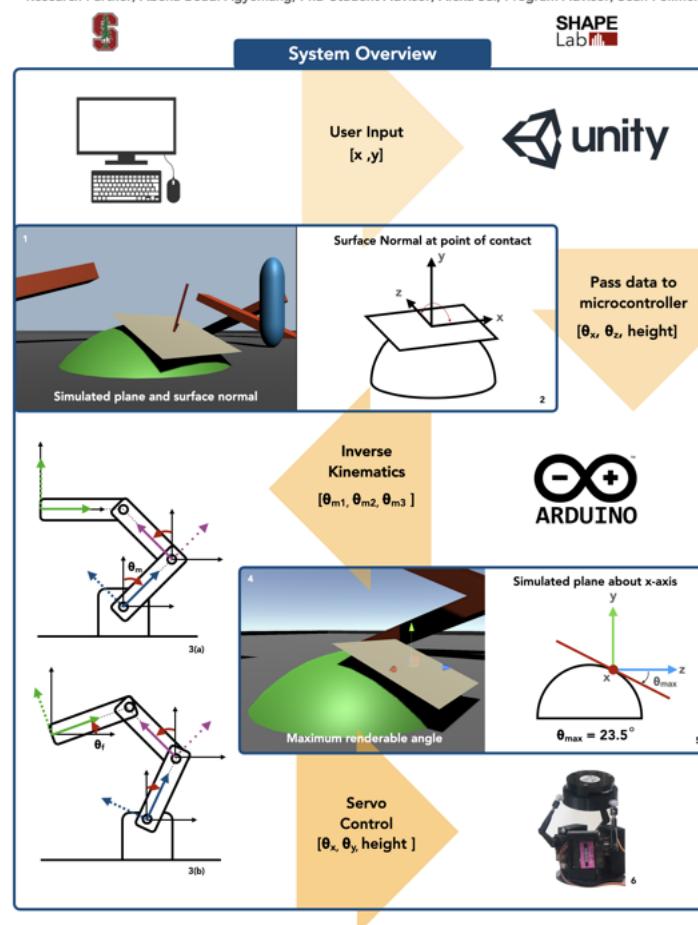
The 10 week SURI goal was to build a **two-handed prototype** using readily available material and software.

Accessibility and ability-based design principles were at the core of our process. In keeping with them, the prototype should

- Be compatible with any mouse
- Use open source development tools
- Be low cost and easy to replicate



### System Overview



### Results

- Developed functioning physical prototype as designed, including
  - Test and development applications
  - Firmware; Implement inverse kinematics and servo control
  - Max rendered angle = 23.5 degrees
  - Low resolution / low refresh rate

### Discussion

#### Future Work

- Voice coil for texture rendering
- Absolute positioning
- Servo control strategies
- User testing

#### Future Considerations

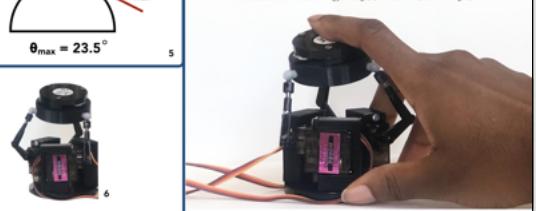
- Single handed versus two handed design
- Bimodal exploration

#### Limitations

- Size and scale
- Noise of servos
- Absolute versus relative positioning

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- Photo Credits: Abena Boadi-Agyemang (6, bottom left, bottom right)



## Poster Presentation