HAPTIC GLOVES for VR

AM5011

VIRTUAL REALITY ENGINEERING

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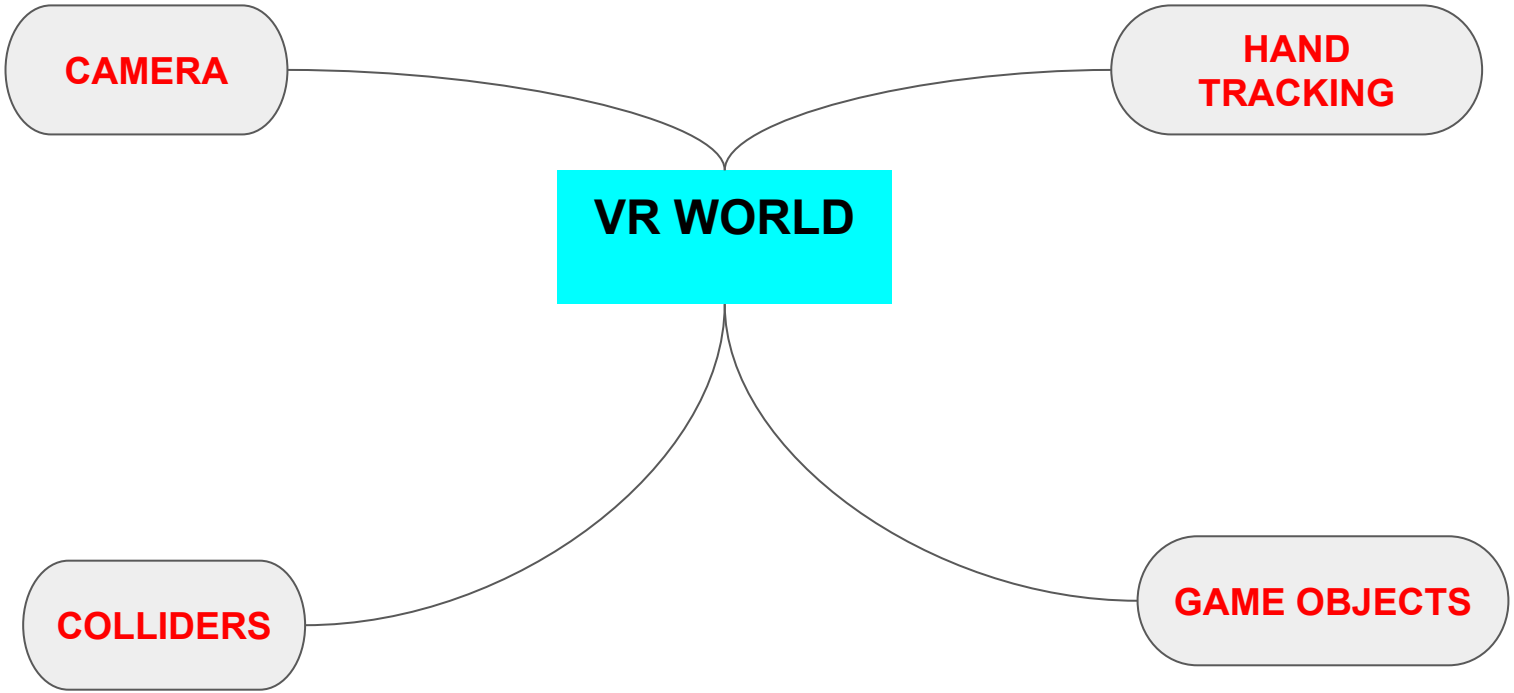
OVERVIEW

VR world

Arduino

Glove Module


CAMERA
HAND TRACKING
VR WORLD
COLLIDERS
GAME OBJECTS

Camera

Motion capture using camera integrated with Unity

A single Leap Motion camera integrated with the VR environment in Unity 3D

Device placed at location in vicinity of hand's range of motion

Workspace: 120 deg conical frustum

Frame Rate: 45-50 FPS

Hand Tracking

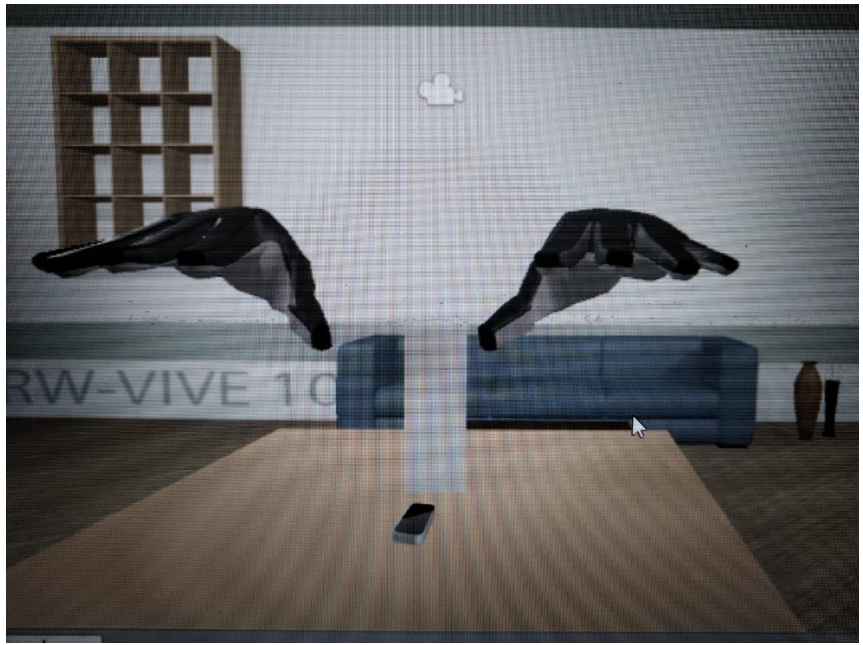
Movements modeled based on hand movement in the real world.

Hand Model rendered by calibrating with respect to the Leap Motion device

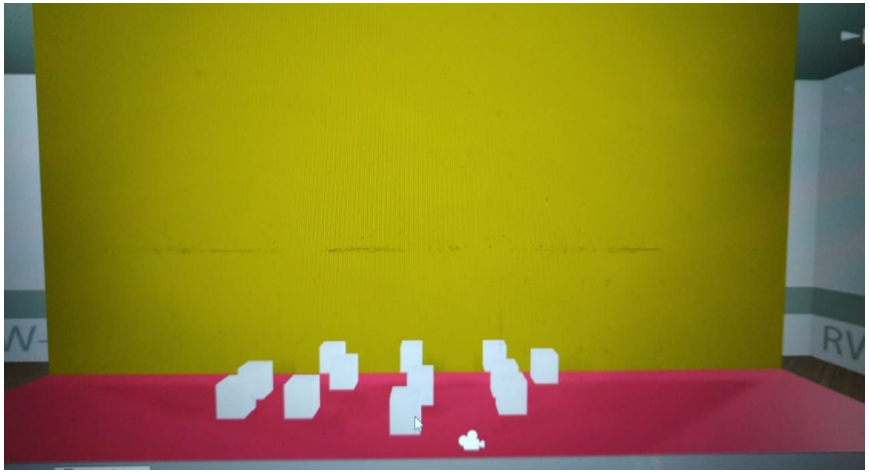
Camera placed on “ table ”,
same as in real and virtual worlds

Virtual world calibrated with centre of camera as location of world frame

Tracks both right and left hand in real time



Game Objects



Randomly placed Cubes (rigid body) on a “ Table” for interaction.

The hand represented as a “ Glove module” in the VR world.

The hand models in VR world are Game Objects

Has 27 children components

Detecting Collisions

Initial Approach:

Coordinates are extracted from the hand model across the temporal dimension

Distances between solid blocks and hand are calculated

If the distance approached close to side length of the object -Trigger!

Colliders

Instead, all Game objects equipped with collider, with mesh, larger than its size

When both physical spaces of Hand and Object come in contact, they produce a trigger

Implemented with C# script

In this way, model can be simplified

Very less computational cost

TRIGGER

unity

RELAY

INPUT

Collision Trigger

When player interacts with cubes, a trigger signal is generated

C# Script for communicating between Unity and Arduino via PC serial ports

Testing a Toy Example:

LED output for collision

Trigger sent to Arduino which activates respective sensors in glove module

Input

Collision Trigger

Serial port of the computer is tethered to the arduino through the port.

The arduino receives 2 kinds of inputs from the port.

The arduino is programmed prior to act certainly based on the input received.

The arduino output is derived from a designated pin as - 0 or 1

Relay Control

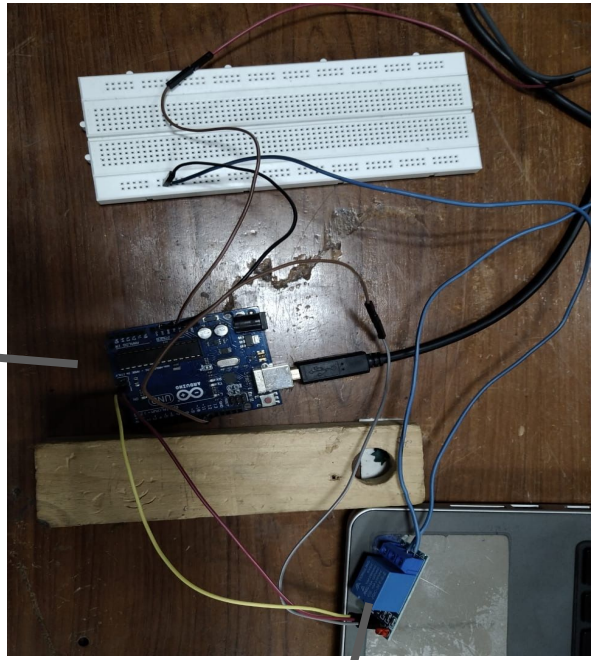
The output from arduino is fed into Normally Closed

Common is grounded

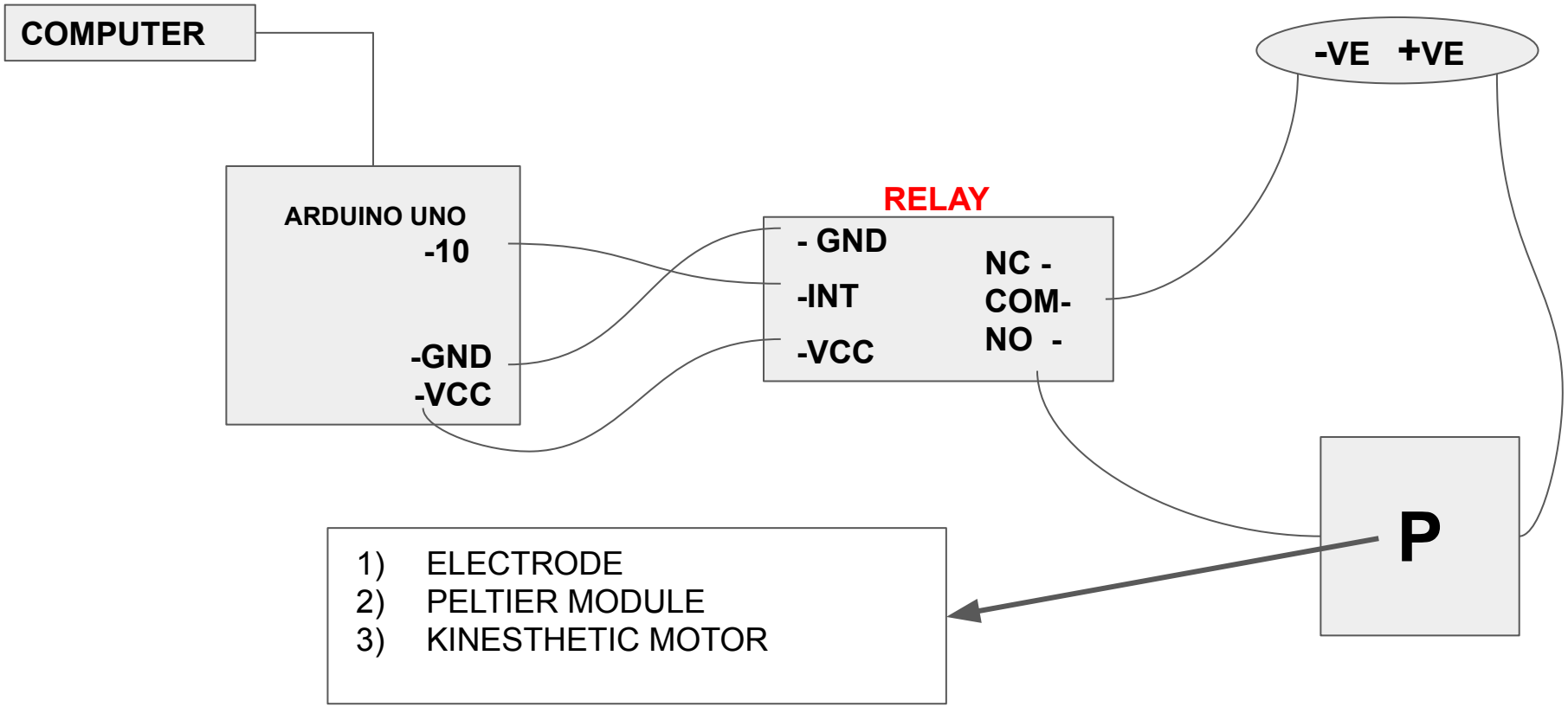
If arduino output is

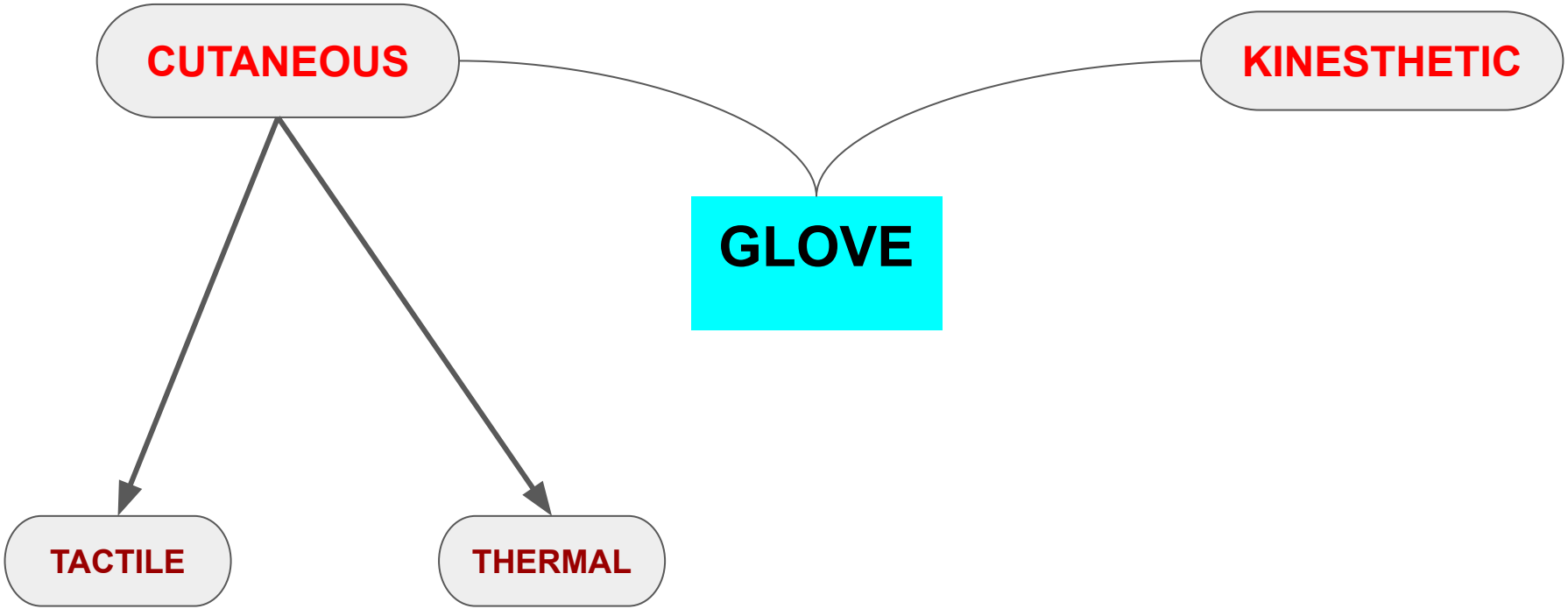
- 0 - the relay receives no input, the system is shorted, switch ON
- 1 - this input directly, and the switch OFF

Relay placed in the *middle of circuit* containing the haptic sensors



CIRCUIT


COMPUTER
ARDUINO UNO
-10
-GND
-VCC
RELAY
- GND
-INT
-VCC
NC -
COM-
NO -
-VE +VE
P
1) ELECTRODE
2) PELTIER MODULE
3) KINESTHETIC MOTOR


CUTANEOUS
KINESTHETIC
GLOVE
TACTILE
THERMAL

Cutaneous Feedback

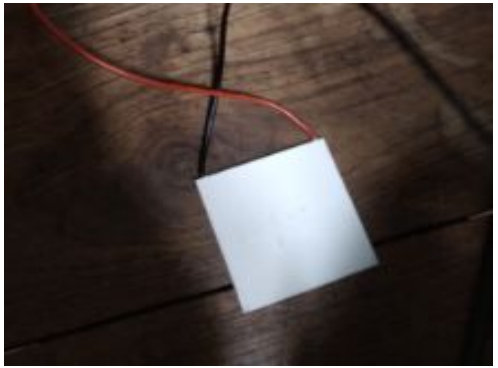
We provide two types of cutaneous feedback

1) Electro Tactile:

   ECG electrodes - available as discrete units can be embedded in a modular setup.

2) Thermal:

   Peltier Thermo-electric cooler



Electro-Tactile feedback

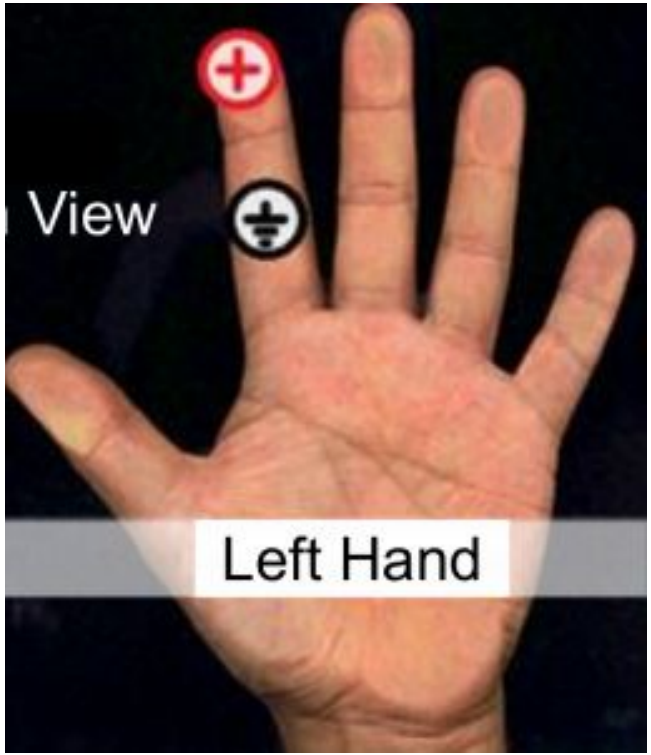
ECG electrodes are stuck at 2 points on a finger

Second electrode completes the circuit.

Input Voltage Required: 9-10 V

Electrode properties:

- Comprises Ag-AgCl Mixture
- Stainless Steel tip for conduction



Thermal Feedback

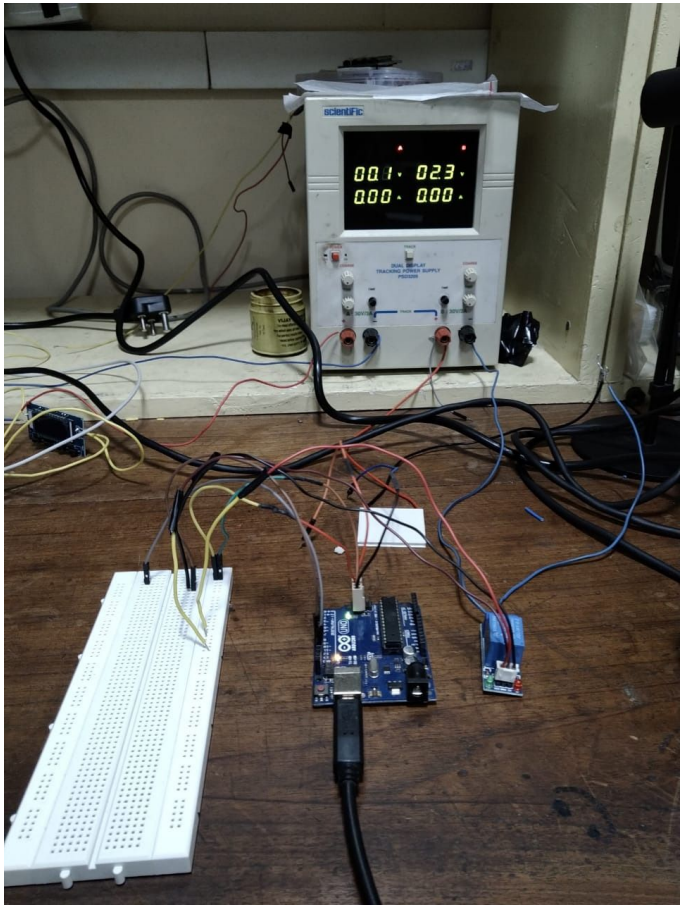
Peltier Effect:

Temperature Difference when current passes via junction between two materials

Input Voltage required = 2-3 V

We use 2 Peltier sensors - for **HOT** and **COLD** objects

Positioning: One Peltier is inverted with respect to the other



Kinesthetic Feedback

Use of physical systems to constrain the hand movement.

Electrostatic / Magnetic brakes are efficient, but require very high voltages - not feasible in an educational setting

Mechanisms such as ones using skeletal linkages increases load and complexity of the system

Simple mechanical systems are used to constrain fingers: **string and motor**

Kinesthetic Feedback

Goal: To restrict the “fist-closing” action when obstructed by a rigid object in VR

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Immersive nature of the mechanism is the important factor to consider.

Need a mechanism to restrict individual finger movement

Challenges:

Actuator has to be light-weight while providing the required counter-torque to restrict individual finger movement

We use a micro-servo motor to achieve the same

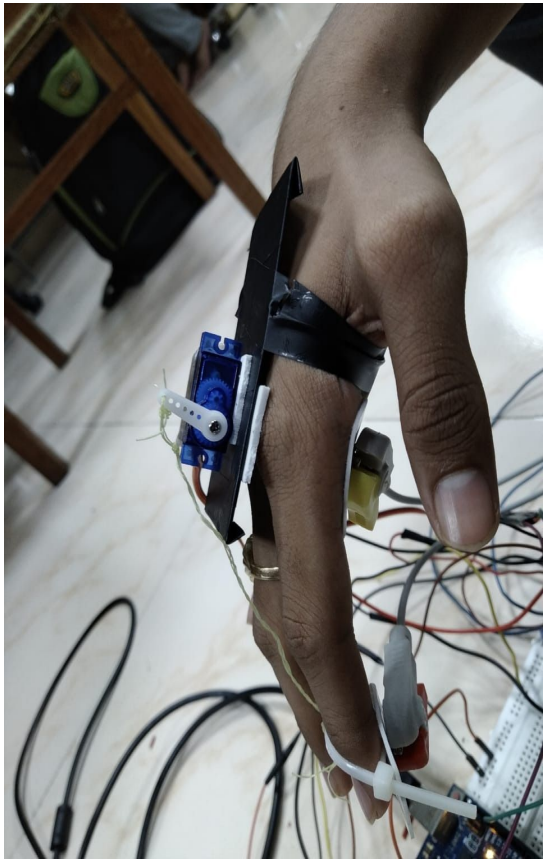
Servo Motor

Specifications:

Weight: 9g
Torque: 1.8kg-cm
Allowed Rotation: 0-180 deg

We mount the micro-servo motor on outer palm

We attach an **inelastic** Nylon string and tether it between motor and finger tip



Design Decisions

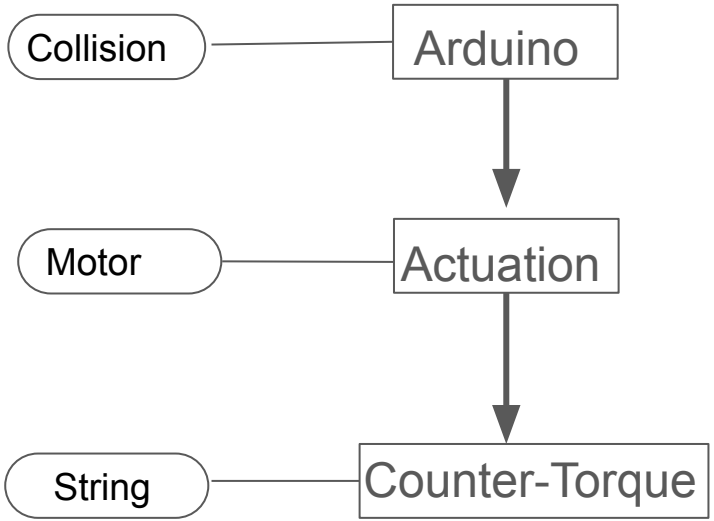
If mounted on the naked hand, user experiences a reaction force at the corresponding point.

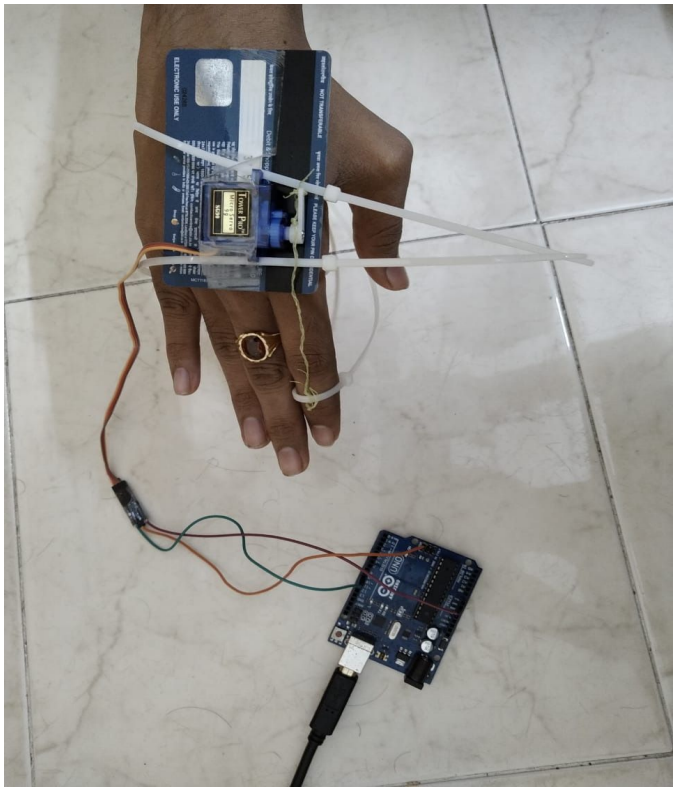
To mitigate this problem, we mount the motor on a planar body which is fastened to the hand

This allows the reaction to be distributed uniformly across the plane body.

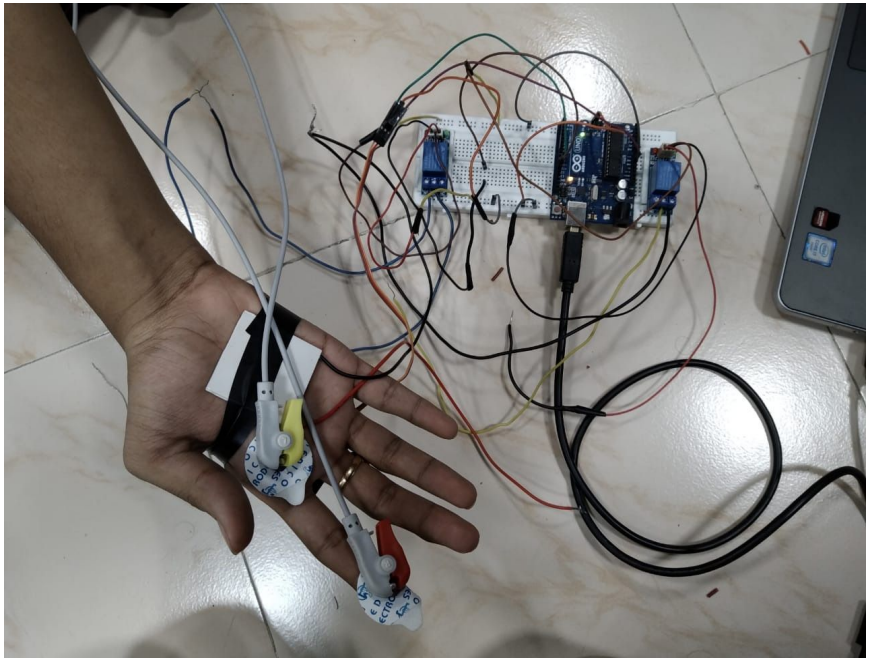
Working

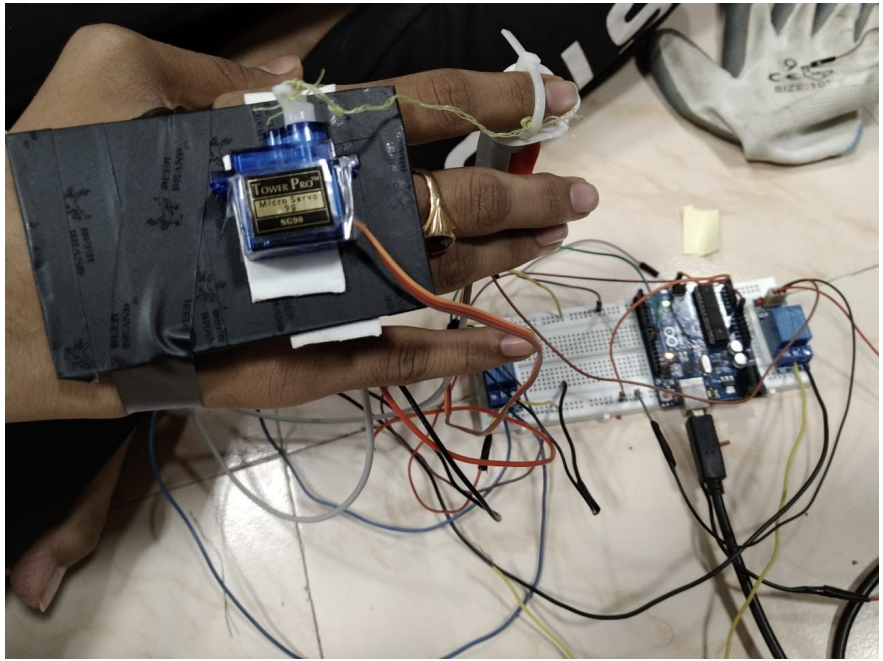
The control comes from Arduino





SUMMARY




TOWER PRO

Results

Index finger-tip considered as the trigger initiator.

Finger contact with virtual object:
Unity recognises the trigger collide, sends output via serial port to Arduino

Arduino reads the output and produces binary output

Relay closes / opens

Closed relay produces corresponding **Tactile, Thermal, Motor feedback**

Future Works

Glove can be made more portable with mobile tactile systems involving harmless voltage requirements

Design of MicroMechanical systems, light enough to not burden the user and also is able to regulate 5 finger motion.

Calibrate the hand motion using universal cameras to give a better range of motion

Reduce time-lag between different sensor sub-systems