Haptic Gaming Assistant using AI

Presented by: B22

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Problem Statement

Next-generation gaming experience has been revolutionized with VR/AR. This has lead to development of controllers and is active area of research. New users need assistance while playing with these controllers for first time.

- ☐ Use Open-Source model of Haptic Feedback Exoskeleton Hand
- ☐ Create Simulation Environment for Training and Testing using Unity/Python
- ☐ Use AI to control movement of assistant while taking input from Simulation Environment

Specifications

Hardware

- 3D Printing Model (15x15cm)
  - Filament material: ABS
  - Resolution:0.2mm
  - Infill %: 50
  - Quality: Standard
- Arduino Mega 2560
- Bi-directional DC Motors:
  - Voltage:6V, RPM:30
- Flex Sensors
- Nuts & Bolts
  - M6 x 18mm
  - M9 x 50mm
  - M6 x 12mm

Software

- Unity(ver: 2020.1)
  - ml-agents(ver: 1.0)
- TensorFlow(ver: 2.7.2)
- Arduino IDE(ver: 1.8)
- Python(ver: 3.6)
- C#
- .Net Framework(ver: 4)

Applications

- Guides player to play correctly
  - Saves time and extra effort.
- Can Gamification of Prosthetic Rehabitilation
- Extending the idea by using a complete exoskeleton, we can make trainers for:
  - martial arts, dancing, playing instrument, VR gaming, etc.

Advantages

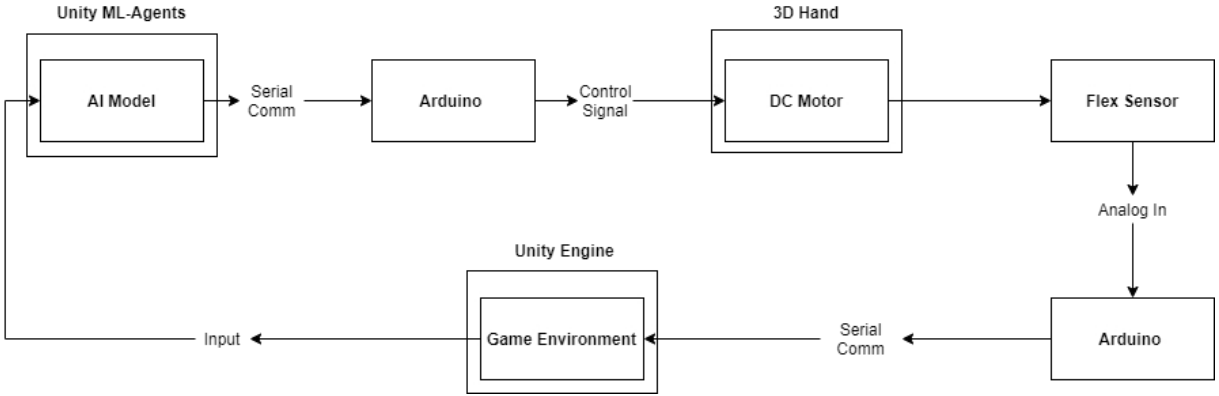
- Using 3D-printed model which can directly interact with hand and improves overall experience.
- This design makes the controller more human friendly and interactive.

Limitations

- Can't play complex games:
  - Feasibe AI models can play simple games
  - Current model has Single DOF for each finger

Introduction

- We are integrating two independent ideas:
  - ✓ Guesture Controlled 3D Printed Exoskeleton Hand
  - ✓ AI playing Game
- We wish to develop assistant that will help new player play the game by moving the required fingers needed using the AI's help.



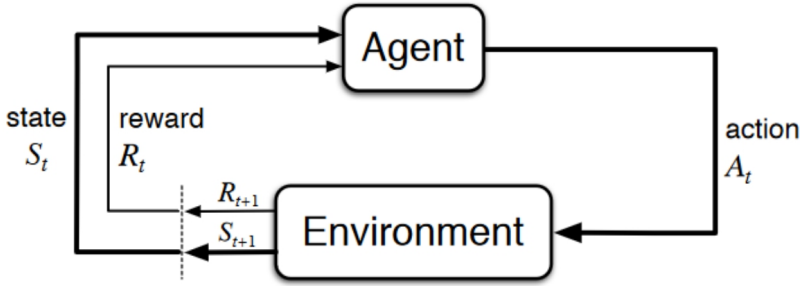
Literature Survey

Haptic Technology - 3D Printing[12][13]

- Haptic feedback using exoskeleton which provides extended experience as body part is guided by its force.
- Adds new layer and freedom for user as compared to traditional controllers.
- We are using model which uses 3D-printing to create sub-parts and is powered by Arduino and stepper motors
- Model has 1 DoF for each Fingers.

AI Playing games[14]

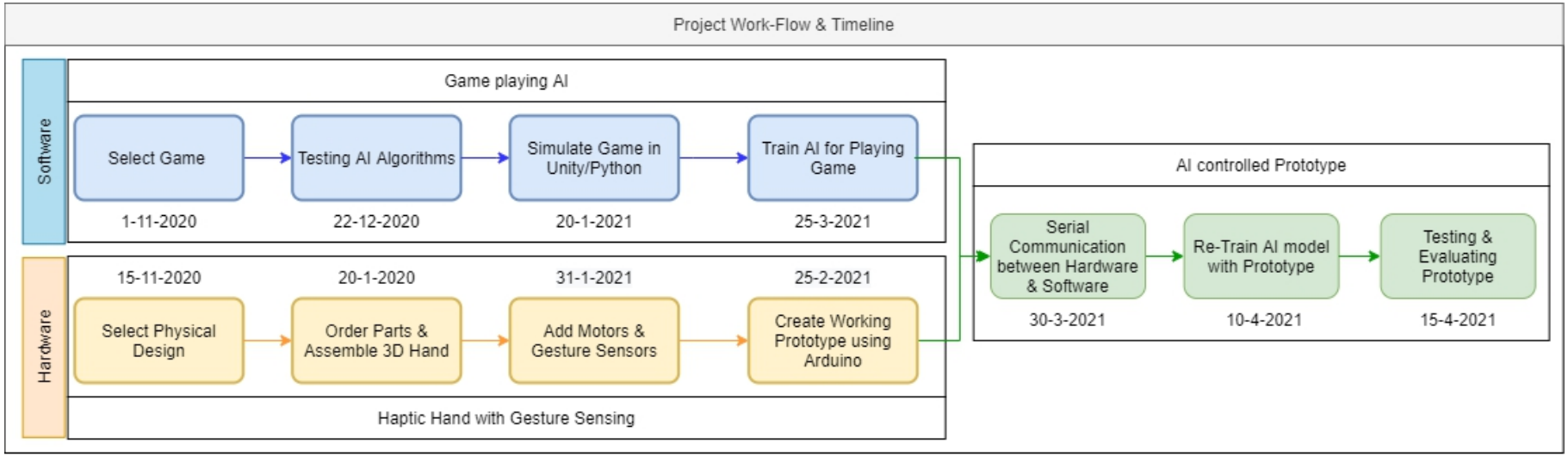
- RL creates network which accumualtes predefined rewards for actions in environment.
- Some acitions are rewarded positively while others negatively.
- Network learns favourable actions by maximizing the accumulated rewards.



Unity for training agents[15][17][18]

- Create Gaming Environment with same functionality for training and testing agents.
- Using Reinforcement Learning algorithms with ml-agents package to train Neural Network.
- Trained Neural Network can be used to control Robotic parts.
- Saves effort of training the robotics manually.

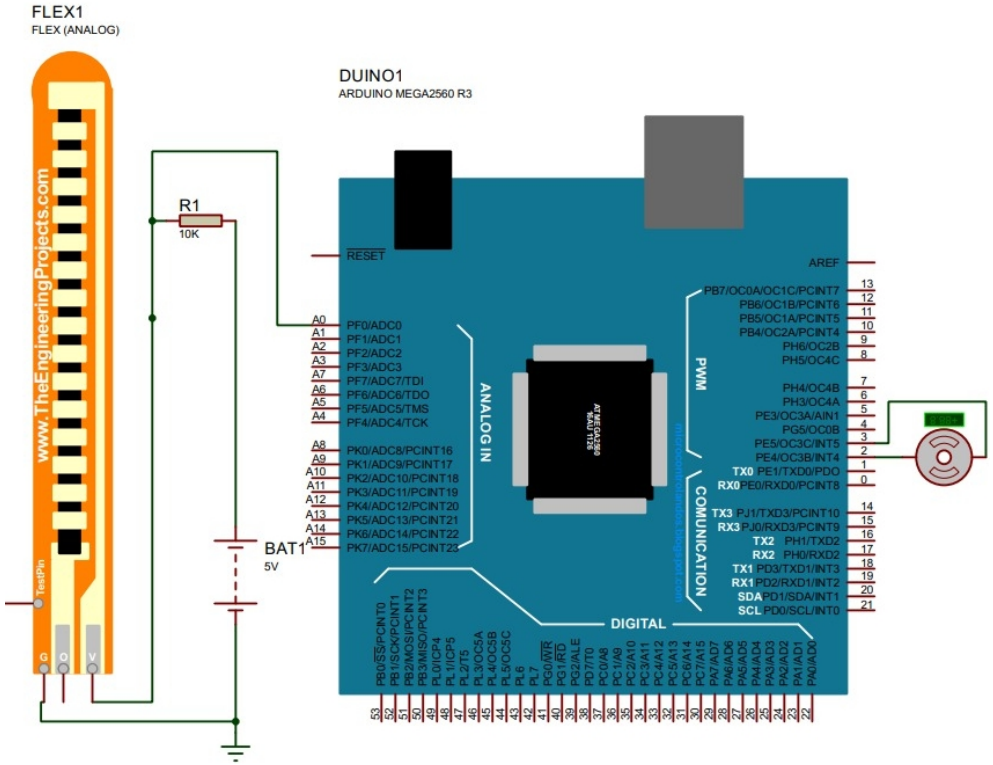
Project Work-Flow



Work Done: Hardware

- ✓ Proposed Circuit for Implementation
- ✓ Defined Limits for Flex Sensors

Threshold	Flex Sensor 1	Flex Sensor 2	Flex Sensor 3	Flex Sensor 4
Max Up	900	900	900	900
Up	860	850	850	850
Max Down	770	770	770	770
Down	800	800	800	795



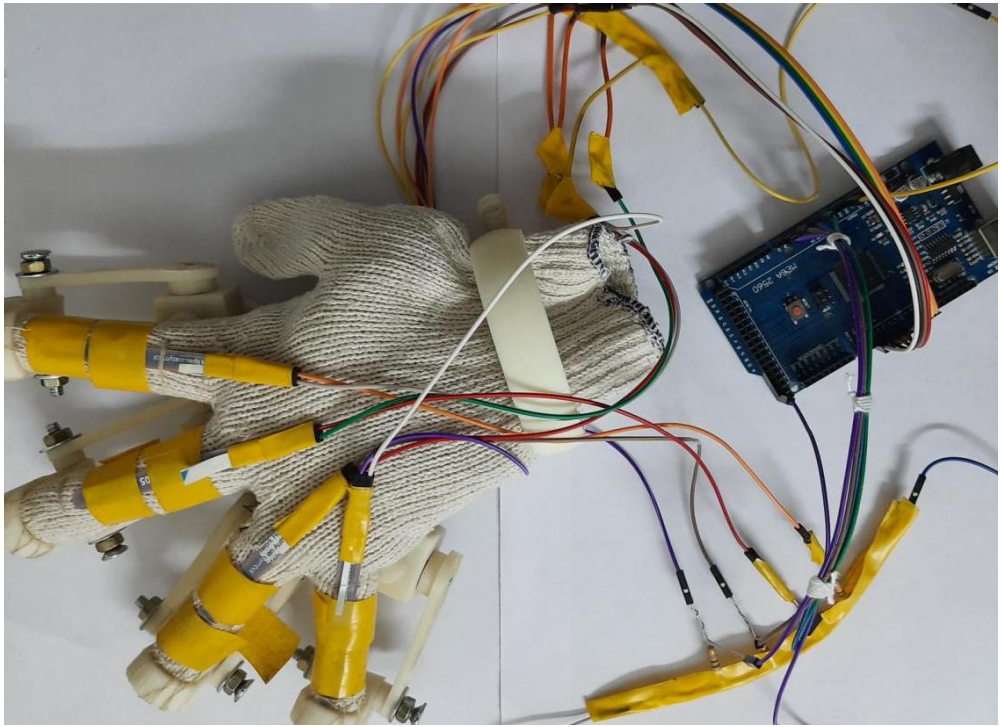
Work Done: Hardware

- ✓Recreated Mechanical Hardware for Assistant
- ✓Installed DC Motors and Flex Sensors on Assistant
- ✓Created Working Prototype using Arduino

Flex Sensors on Assistant

DC Motor Fitting and Wiring Side View

Work Done: Hardware



Completly Assembled Assistant

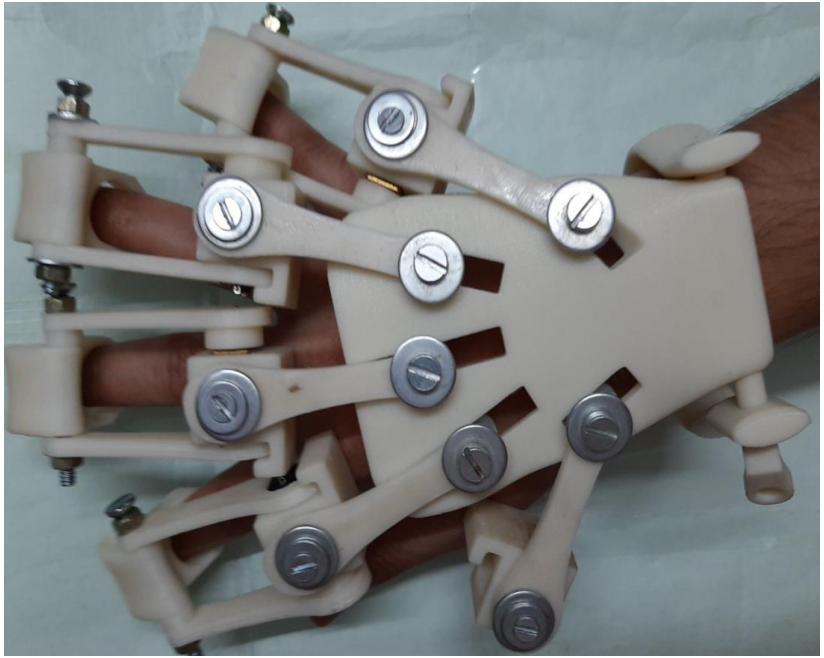
Work Done: Software

- ✓Explored various AI alogorithms
  - Genetic Algorithm: NEAT
  - Reinforcement Learning: DQN
  - Hand Guesture Recognition: 2DConv-NN
- ✓Simulated Unity Environments
  - 3D Ball, Jumping Cars Game
- ✓Created Arduino program for Working Prototype
- ✓Trainied AI models for Unity Environments
- ✓Implemented Serial Communication between Arduino and Unity
- ✓Implemented AI controlled Assistant using Feedback Control

Results: Hardware Implemetation

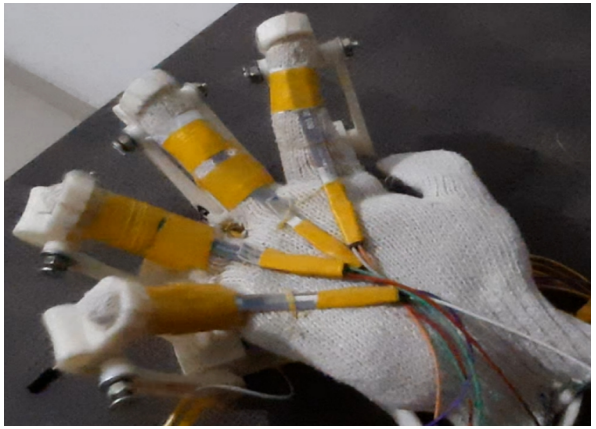
- Recreating Mechanical Parts for Hardware

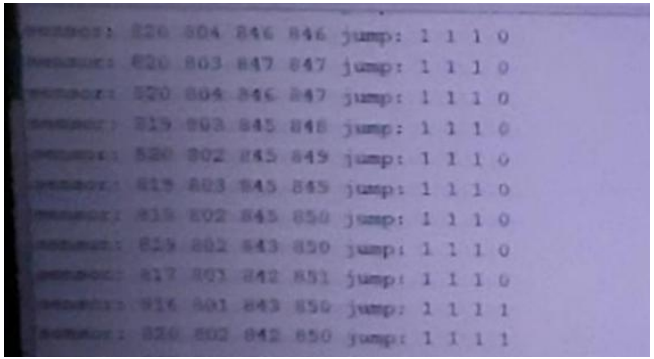
Czech, A., 2015. 3D PRINTED EXOSKELETON HANDS - IN ONE PIECE. [image] Available at: <https://files.cults3d.com/uploaders/3695667/illustration-file/1435670806-19154-8542/Exo-Hand_Left_One_Piece_ISO_View_large.JPG> [Accessed 25 November 2020].



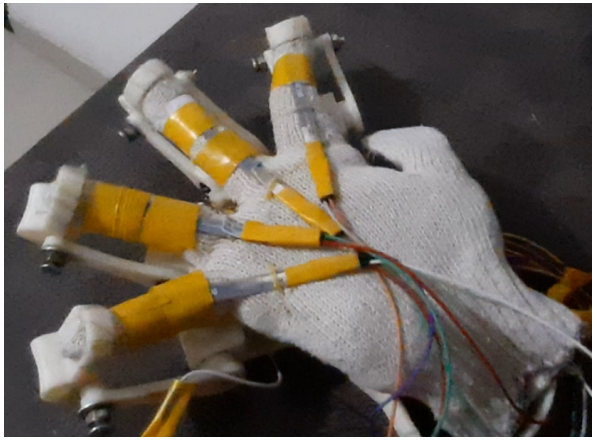
Top View of Assembled Parts

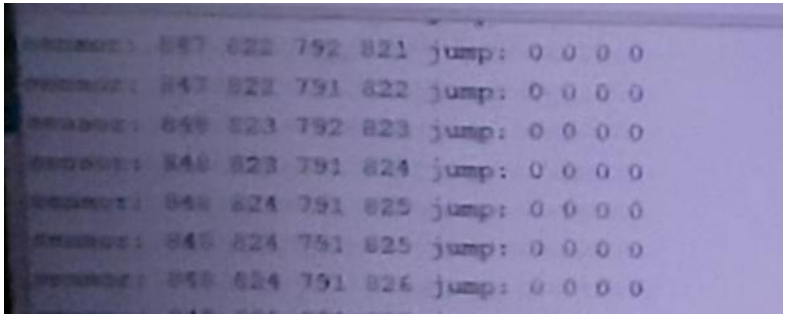
Results: Working Prototype





Arduino Executing Up

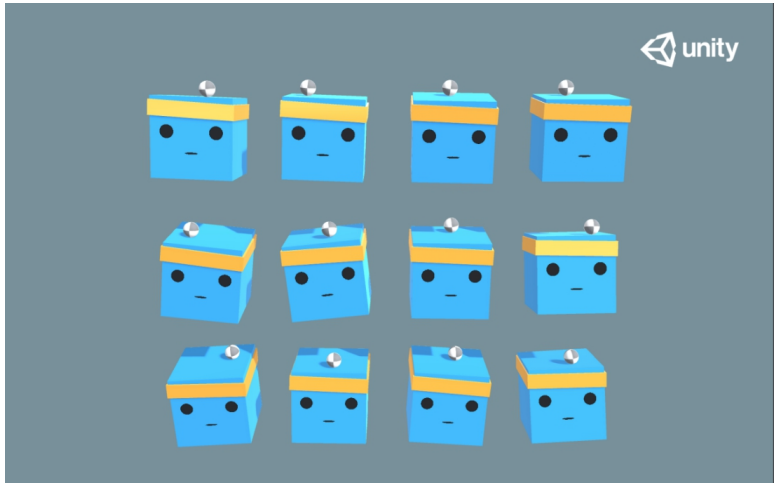




Arduino Executing Down

Results: Simulations

- Simulated Environments in Unity
  - 3D Ball Environment



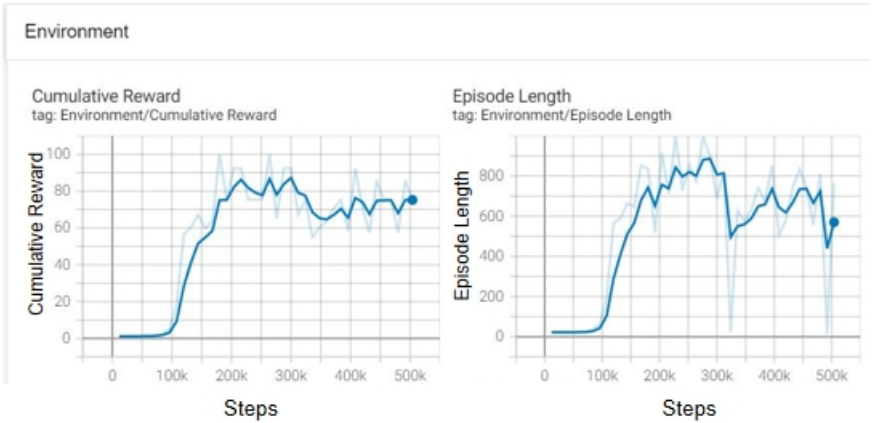
3D Ball Game Still[10]

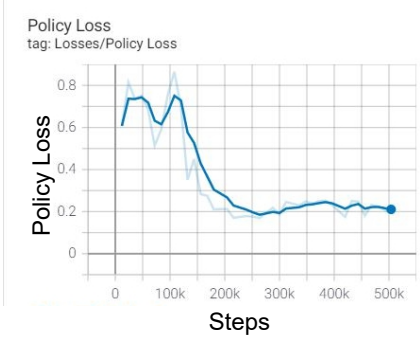
  - Jumping Car[15] Enviroment

Jumping Car Still[15]

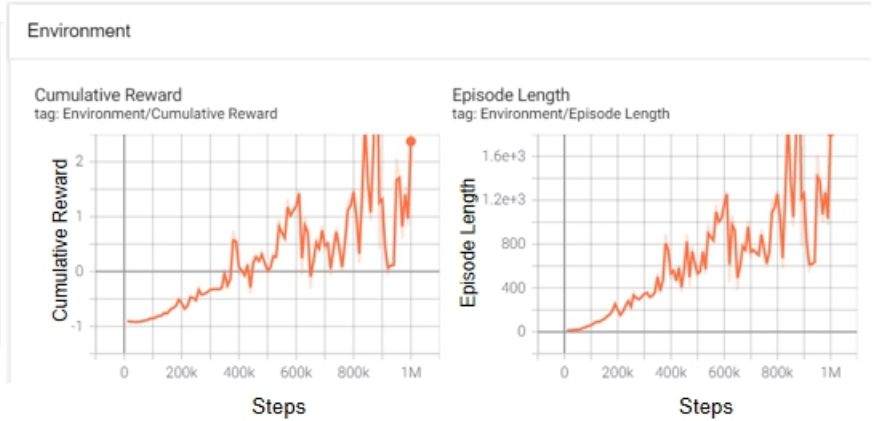
Results: Metrics of AI Models

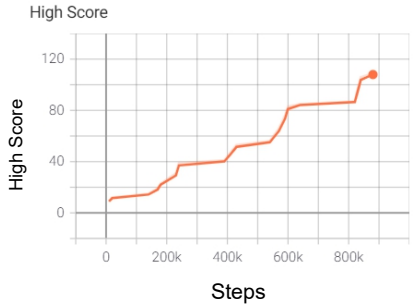
- 3D Ball Environement





- Jumping Car Environment

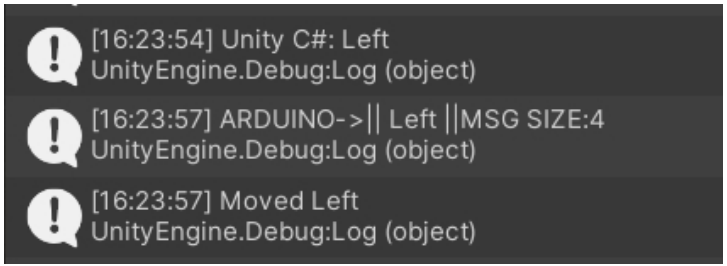




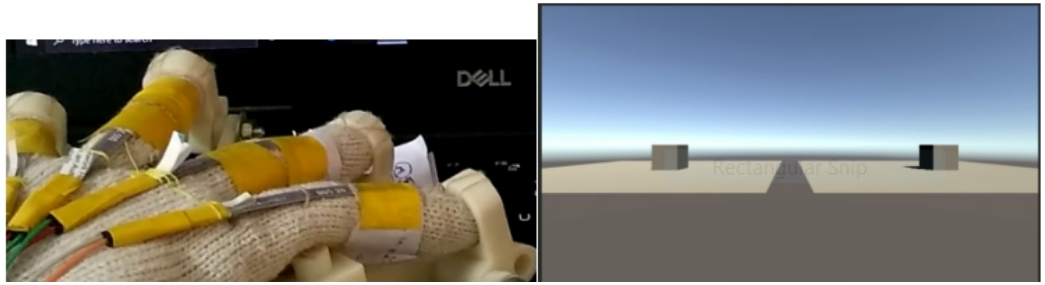
Results: Serial Communication

Arduino	Motor1 (Index)
Unity	Left

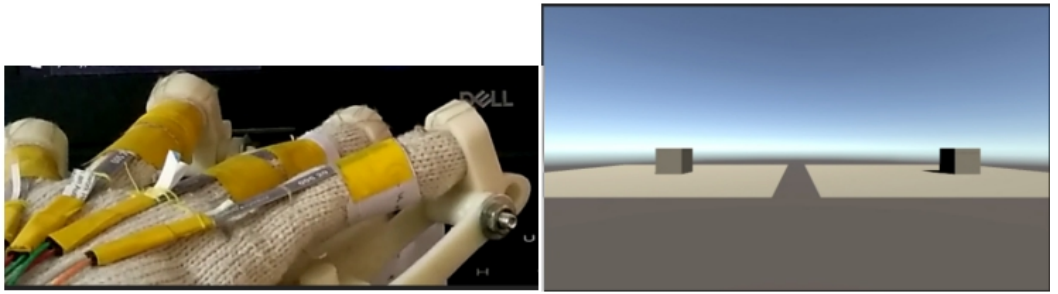
Unity Arduino Lookup Table for Left



Unity Serial Log

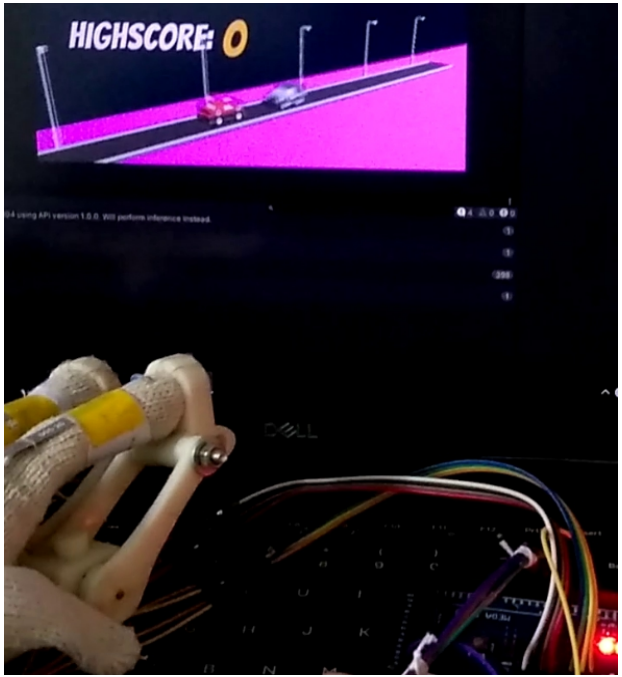


Before ‘Left’ Command Execution

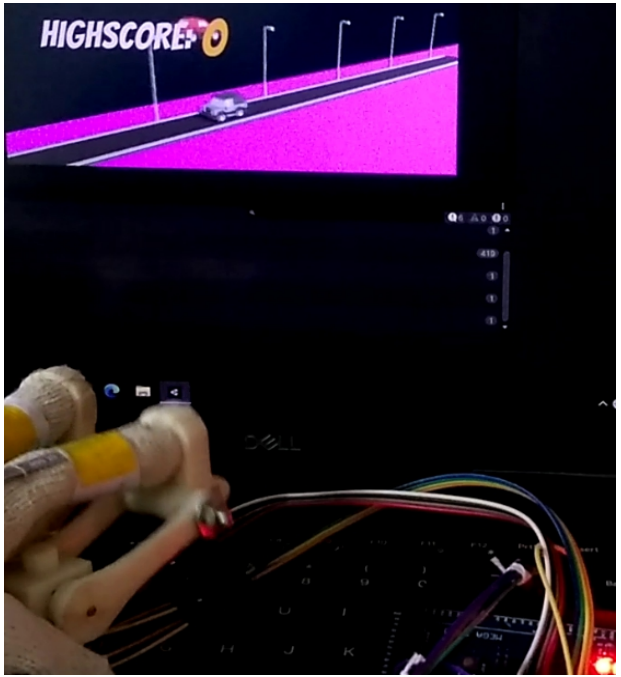


After ‘Left’ Command Execution

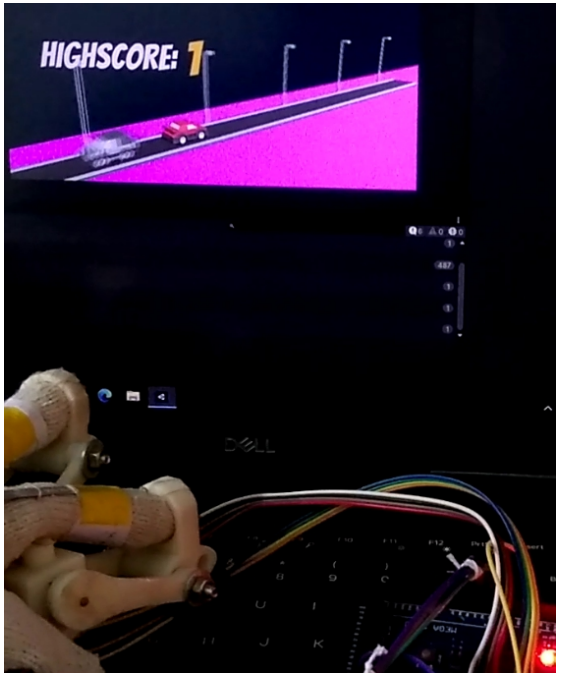
Results: Final Game Implementation



AI Sensing Obstacle & Arduino Executing Command



Arduino Unity Communication & Update in Unity Environment



Obstacle Successfully Escaped and Score Increased

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