

## Overview

Virtual Reality (VR) Haptic Feedback Matrix, abbreviated as the Matrix:

- Provides touch feedback through an array of magnetic actuators.
- Translates in-game interactions into a vicarious experience.
- Toggles individual magnetic actuators to provide dynamic sensations.
- Applies to entertainment, medical training, and physical therapy.

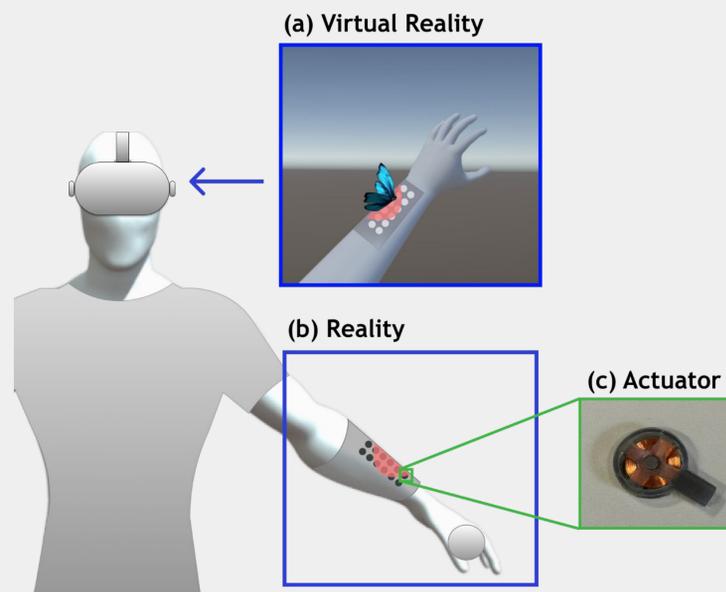


Fig. 1. Interaction between virtual simulation and reality.

## Features

- 6x4 array of magnetic actuators mounted on a flexible PCB on user's forearm.
- 200 Hz square wave to produce an oscillating magnetic field around a static magnet.
- Four H-bridge integrated circuit to toggle actuators independently.
- Actuator Controller to receive virtual interaction in VR simulation and translate it to the matrix
- User can experience a simulated physical interaction with a virtual butterfly.

## Acknowledgements

We would like to extend our thanks to Meta for our initial funding, UROP for supporting the rest of our development, and Naji Tarabay for his lab equipment support.

## Diagram and Model

- The Actuator Controller connects to Meta Quest 2 through TCP.
- VR simulation sends in-game interactions to Actuator Controller.
- Actuator Controller translates the in-game interactions into Matrix coordinates.
- Actuator Controller toggles the magnetic actuators to provide haptic feedback.

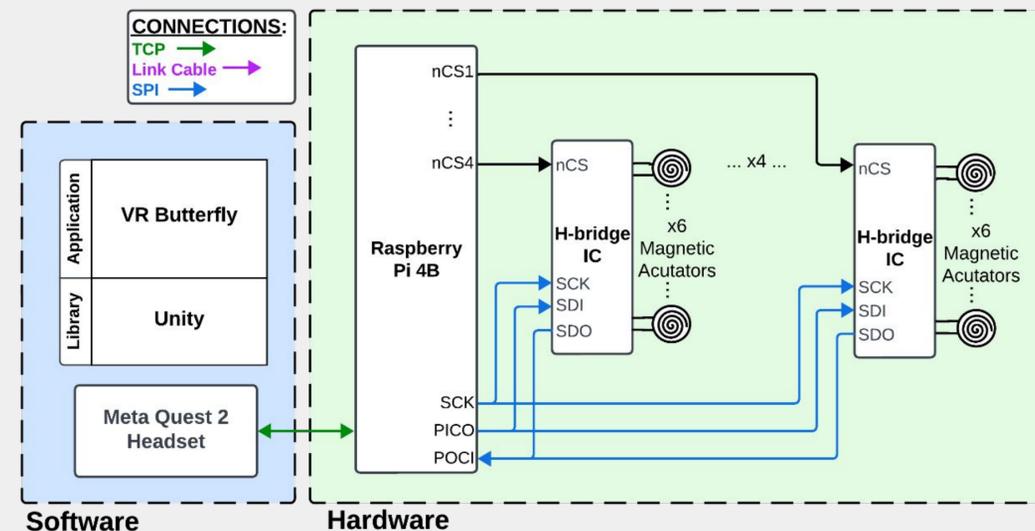


Fig. 2. Block diagram of Hardware and Software Integration.

- A flexible PCB with magnet membrane wraps around user's forearm.
- The flexible Arm Wrap connects to the Actuator Controller via flexible connectors.
- As the Actuator Controller turns on the coils, the static membrane vibrates with the oscillating magnetic field.

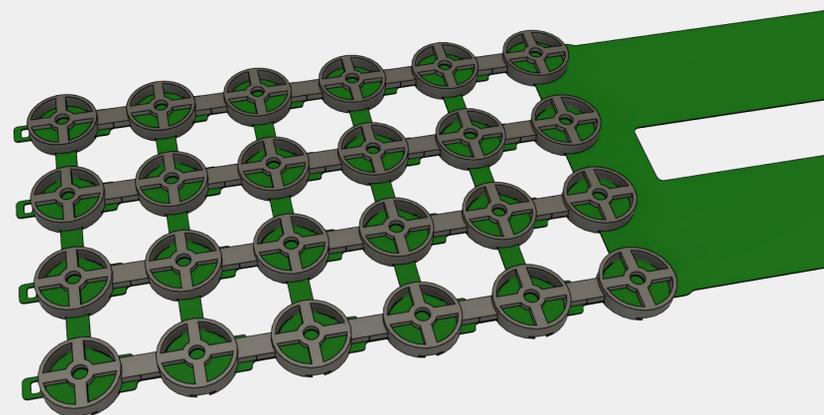


Fig. 3. The Arm Wrap flexible PCB with magnet membrane wraps around user's arm to provide haptic feedback.

## Prototype

Hardware:

- Prototyped magnetic actuators with FlexAR coils.
- Designed 2 x 2 actuator matrix on a breadboard, where pressing a corresponding button activates the actuator at 200 Hz.
- Compared two Actuator Controller designs, one centered on an SPI H-bridges and another with Solid-State Relays (SSR).

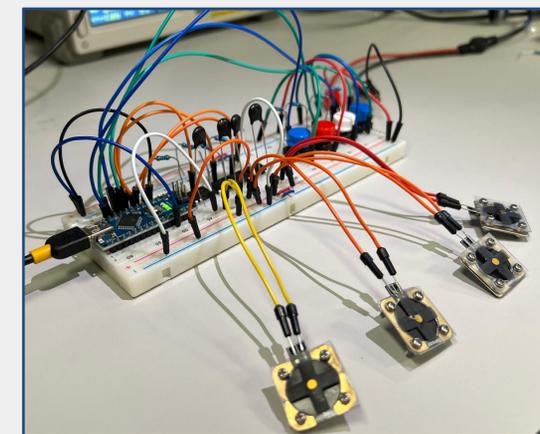


Fig. 4. Prototype 2x2 actuator matrix.

Software:

- Mapped each button of a virtual keypad to the corresponding magnetic actuator on the Matrix.
- Established communication between the Meta Quest 2 and the Actuator Controller through web sockets.

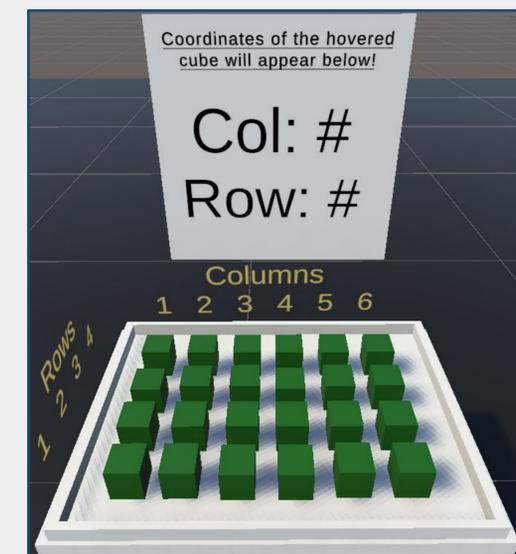


Fig. 5. Prototype 6x4 virtual matrix.