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Title

Magnetic Actuators for Haptic Feedback in Virtual Reality Applications

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Magnetic Actuators for Haptic Feedback in Virtual Reality Applications

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Overview

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

- Provides touch feedback through magnetic actuators.
- Translates in-game interactions into realistic experiences.
- Activates specific magnetic actuators to link VR with reality.
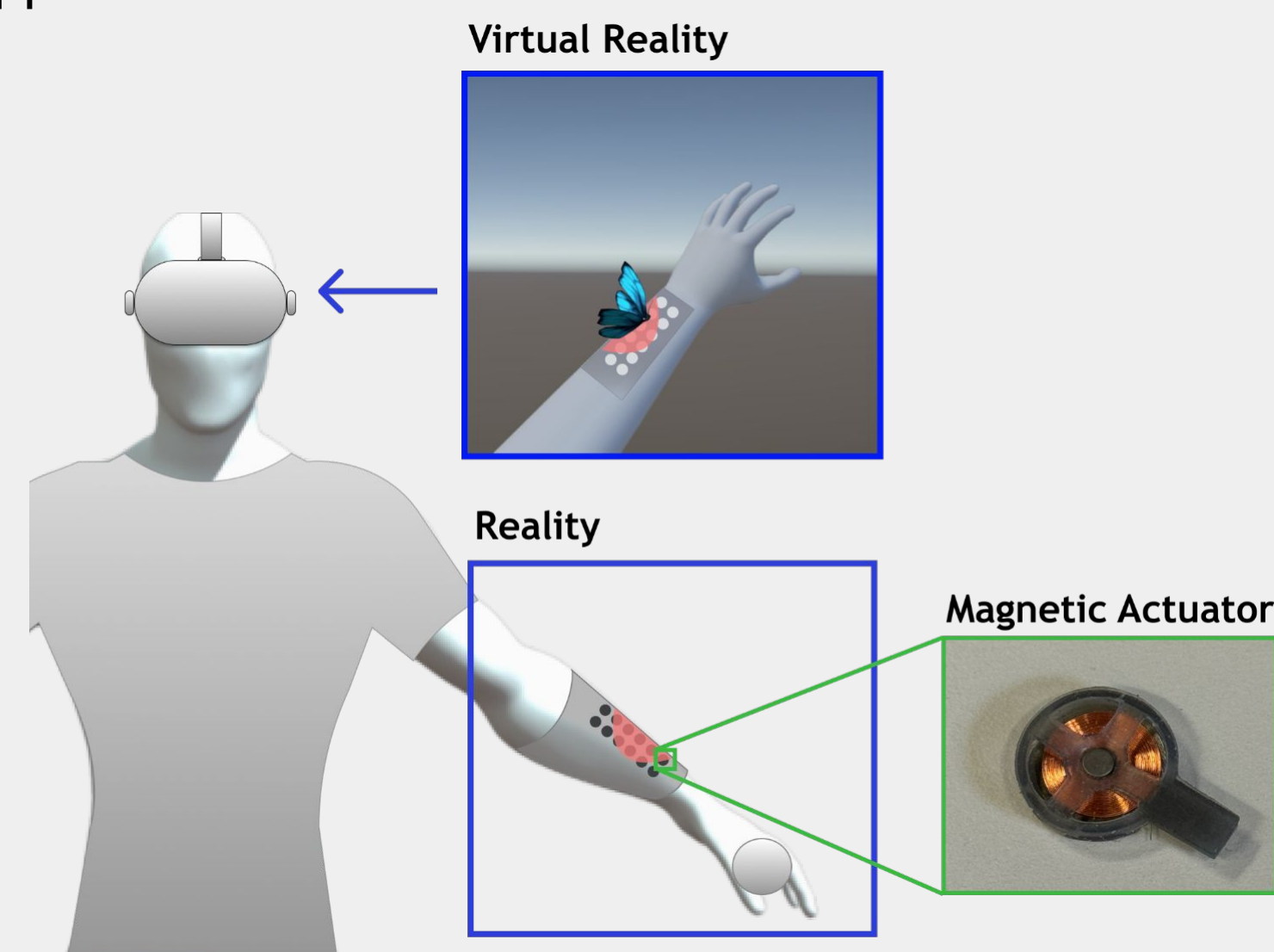- Applies to recreational and medical fields.

Virtual Reality

Reality

Magnetic Actuator

Fig. 1. Magnetic actuators bridges interactions between VR and Reality.

Early Prototype

- **Meta Quest:** Stationary array of buttons and display.
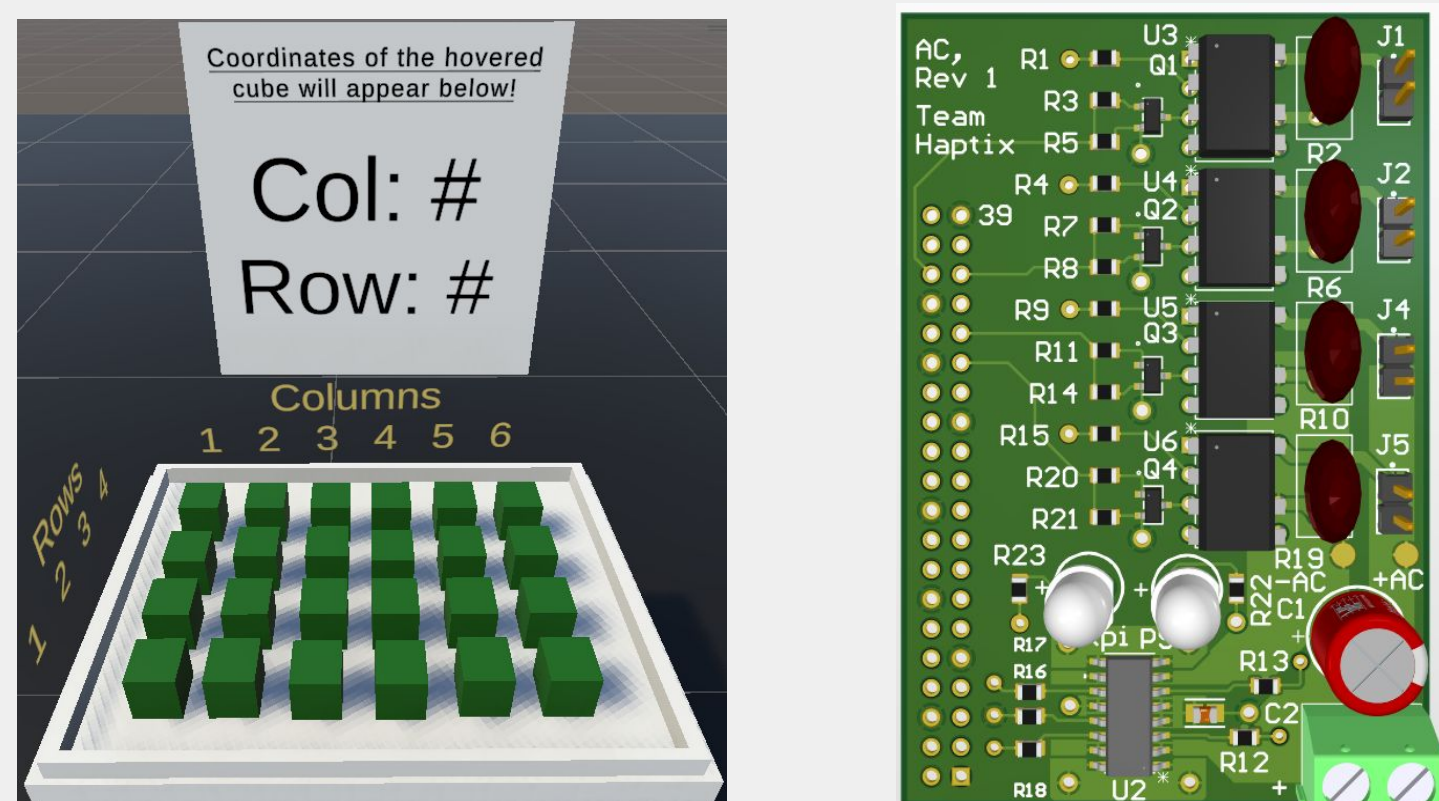- **Actuator Controller:** Solid-state relays toggle each coil independently.

Coordinates of the hovered cube will appear below!

Col: #
Row: #

Columns
1 2 3 4 5 6

Fig. 2. Early prototype of the Matrix.

Diagram and Model

- The Actuator Controller connects to the Meta Quest wirelessly through TCP.
- Haptix World sends in-game interactions to the Actuator Controller.
- The Actuator Controller translates the in-game interactions into actuator coordinates.
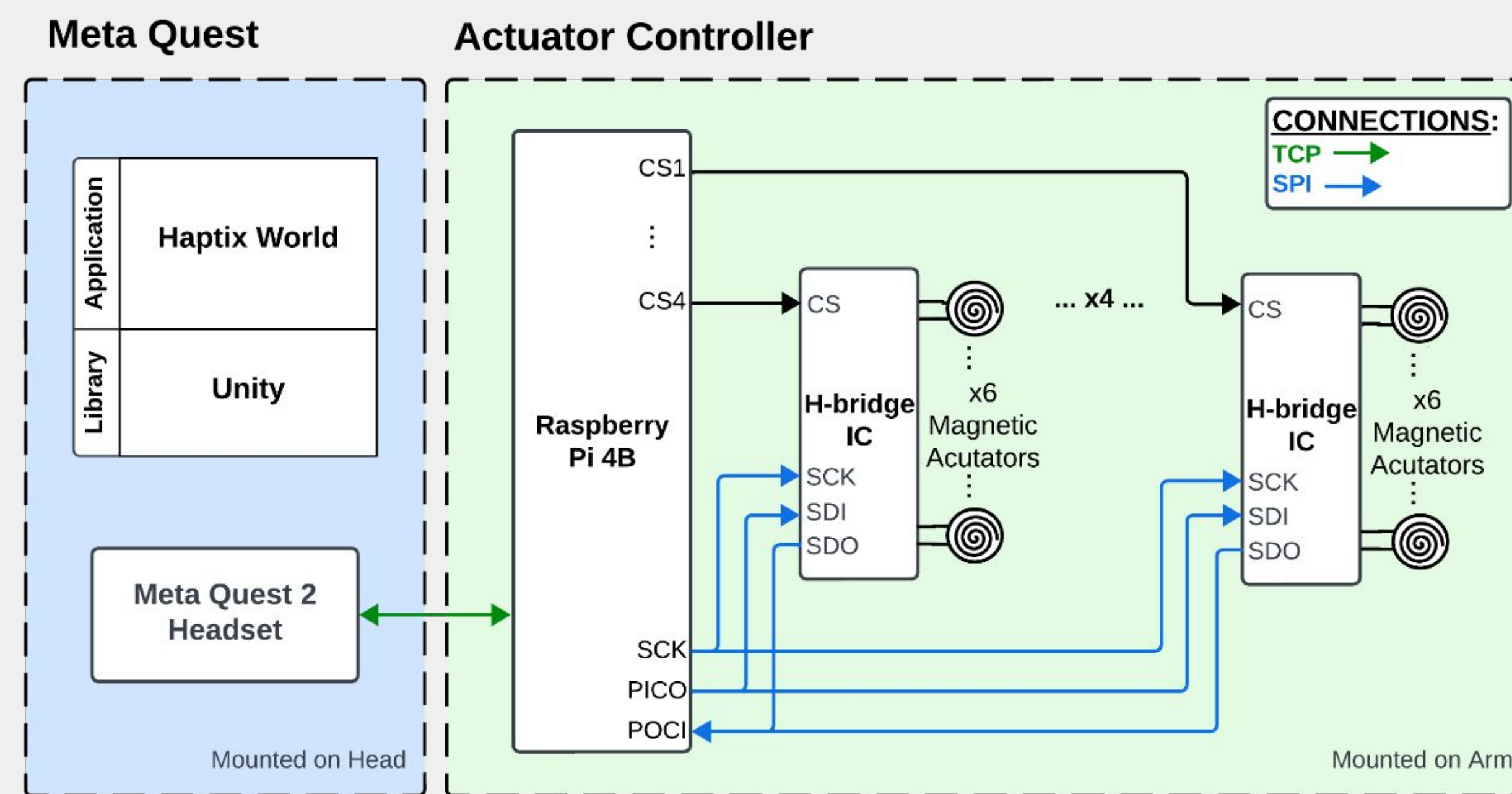- The Actuator Controller toggles the magnetic actuators to provide haptic feedback.

Meta Quest — **Actuator Controller**

CONNECTIONS:
TCP →
SPI →

Application — Haptix World
Library — Unity

Meta Quest 2 Headset

Mounted on Head

Raspberry Pi 4B
CS1 ... CS4
CS
H-bridge IC
SCK SDI SDO
x6 Magnetic Acutators
... x4 ...
CS
H-bridge IC
SCK SDI SDO
x6 Magnetic Acutators
SCK
PICO
POCI

Mounted on Arm

Fig. 3. Block diagram of system integration.

- A magnetic actuator consists of a coil and a membrane with an embedded magnet.
- Each magnetic actuator produces an oscillating magnetic field, vibrating the magnet and applying pressure on the user's skin.
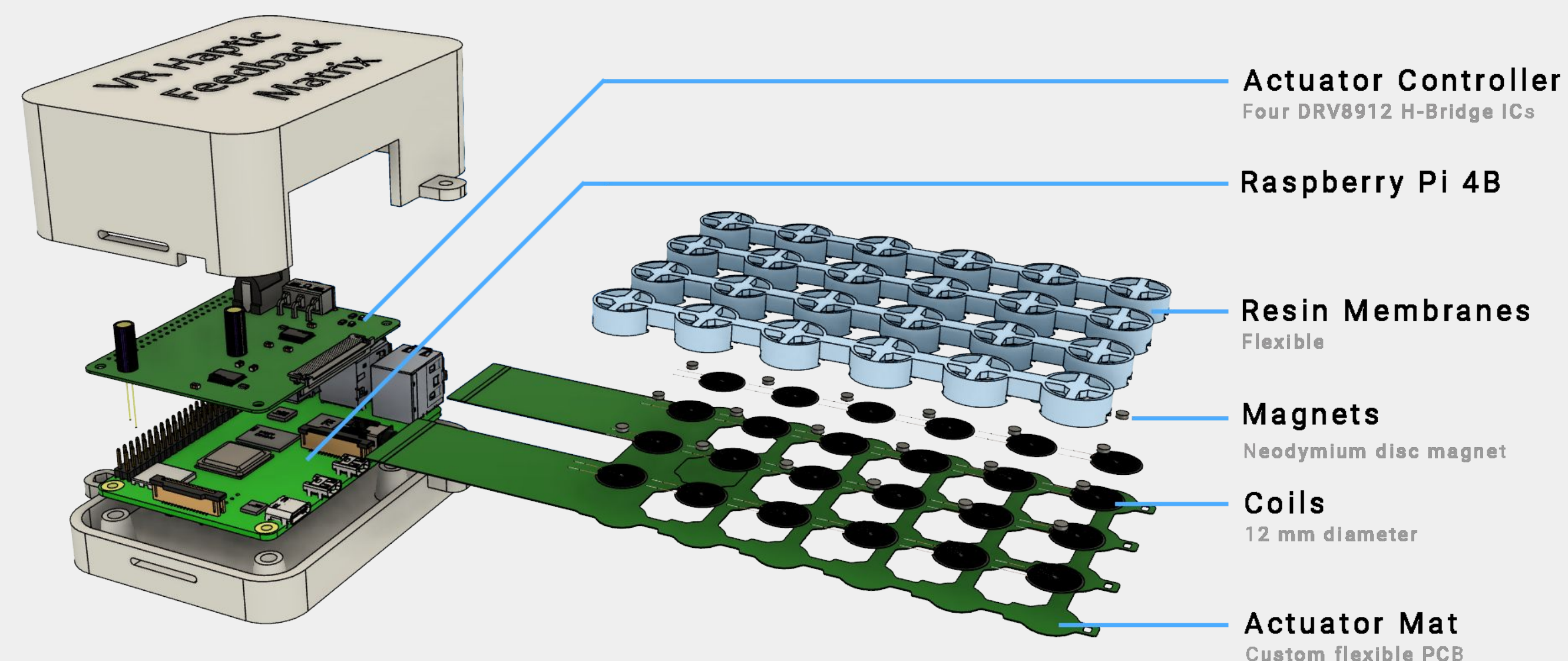- The Actuator Mat connects each magnetic actuator to the Actuator Controller.

VR \ Haptic Feedback Matrix

Actuator Controller — Four DRV8912 H-Bridge ICs

Raspberry Pi 4B

Resin Membranes — Flexible

Magnets — Neodymium disc magnet

Coils — 12 mm diameter

Actuator Mat — Custom flexible PCB

Fig. 4. Exploded view of the Matrix.

Results

Meta Quest:

- In Haptix World, users can interact with a simulation of the Matrix located on the forearm.
- The right-side virtual hand has a laser pointer that can be used to hover over a coil from a distance.
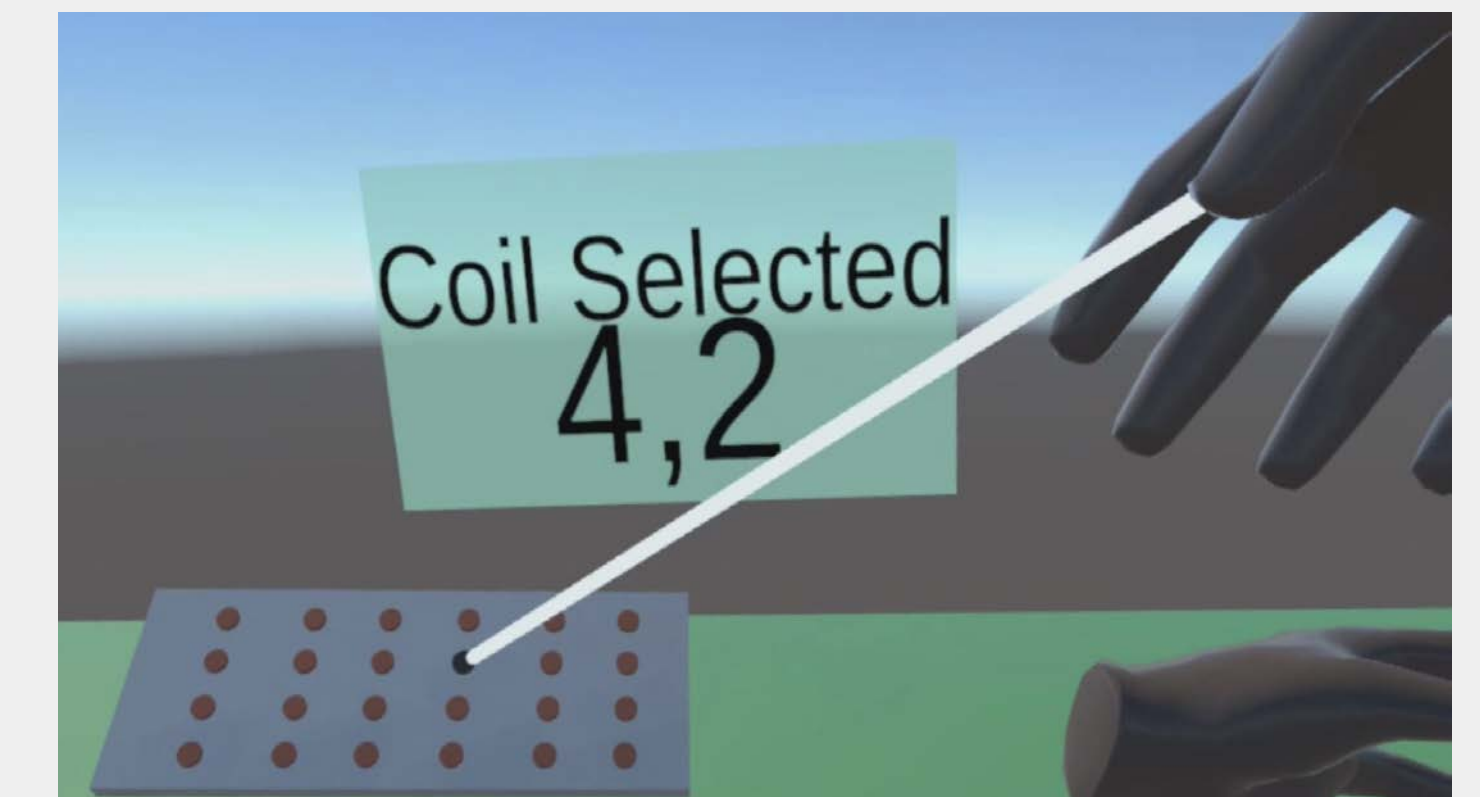- The green display indicates which coil is selected.

Coil Selected 4,2

Fig. 5. 6x4 virtual coil matrix in Haptix World.

Actuator Controller:

- The Actuator Controller PCB uses four h-bridges to output a 200 Hz square wave independently.
- The 6x4 array of coils are assembled on the Actuator Mat, and connected directly to the Actuator Controller.
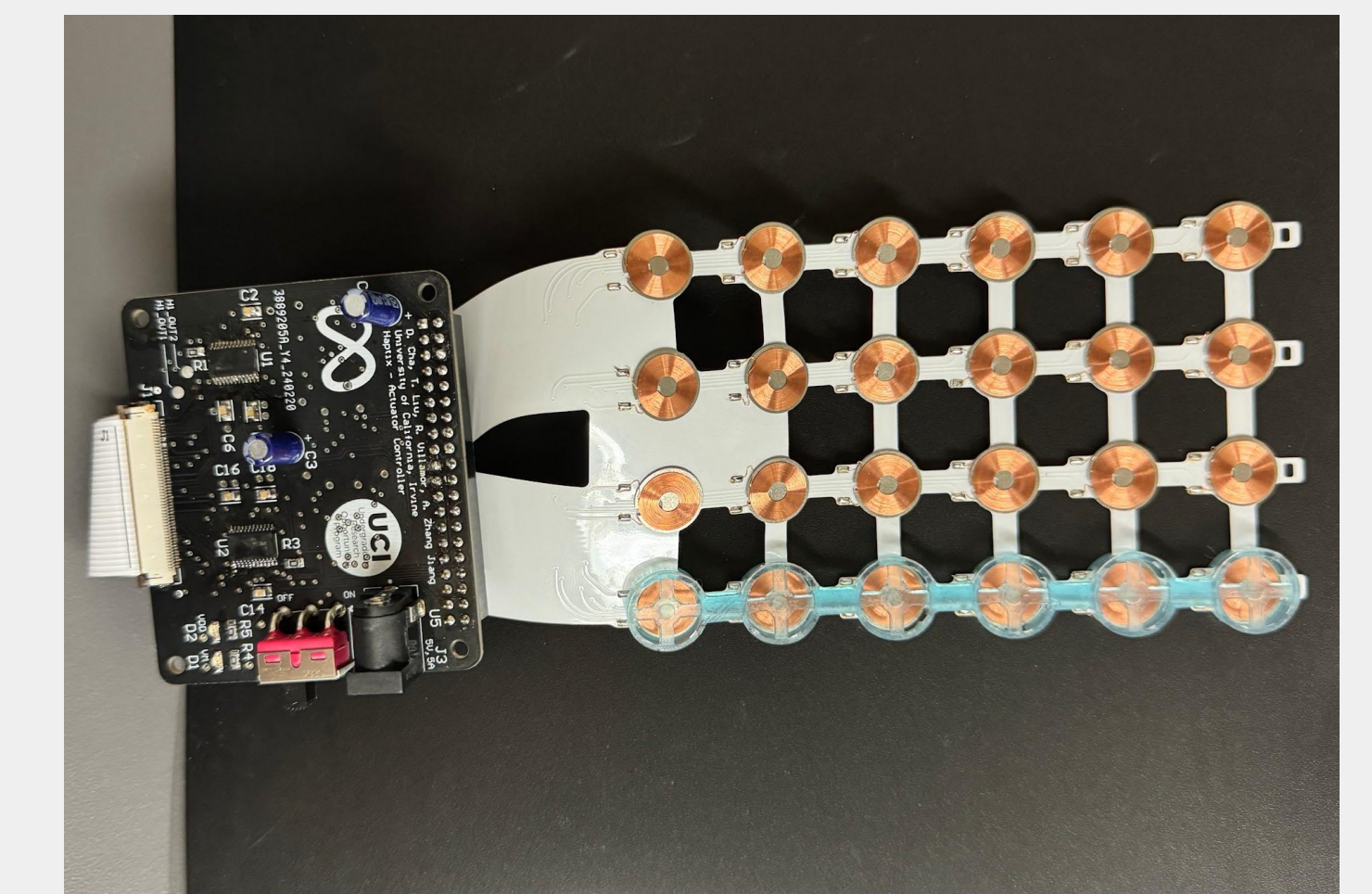

Fig. 6. The Actuator Controller connected to the Actuator Mat.

Acknowledgements