Electromagnetic Haptic Gloves for Realistic VR Interaction

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Abstract

The Smart VR Glove, an affordable innovation in virtual reality technology, offers users an immersive and realistic experience across the multiple VR systems currently available on the market. Its novel electromagnetic braking system and haptic actuators will provide precise tactile feedback, simulating the sensation of touch and grasp in the virtual world. Enhanced by AI-driven software, our flex sensitive resistors offer superior finger-tracking accuracy. This wireless, battery-powered glove is a commercially accessible solution designed to provide VR users with a more natural VR experience, setting a new benchmark for affordability, compatibility, and interactivity in virtual environments.

Need for Product

Current virtual reality (VR) and augmented reality (AR) are currently devoid of an affordable, immersive accessory that offers haptic feedback and finger pullback functionality, leading to less engaging user experience marked by inadequate dexterity and prevalent compatibility issues. The few comprehensive solutions available, like those from HaptX, command prices upwards of $4,000, placing them beyond the reach of a broader audience. This significant cost barrier impedes the universal development and adoption of deeply immersive and personalized VR/AR experiences.

Figure 1: HatpX Glove

Figure 2: Air Compressor Backpack

Product Description

The smart glove provides precise finger tracking via flex sensors, dynamic haptic feedback through strategically placed actuators, and a novel braking system for realistic resistive forces.

- **Electromagnetic braking system for simulated grasping resistance**
- **Integrated motion sensors for accurate hand/finger tracking**
- **Vibrating Actuators at fingertips for touch feedback**
- **Seamless connectivity with standard VR platforms**
- **Lightweight and portable design**

Figure 3: Electromagnetic Braking System

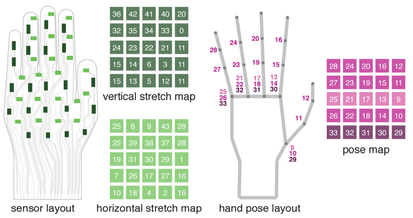

Figure 4: Finger Tracking Maps

Hardware Flowchart

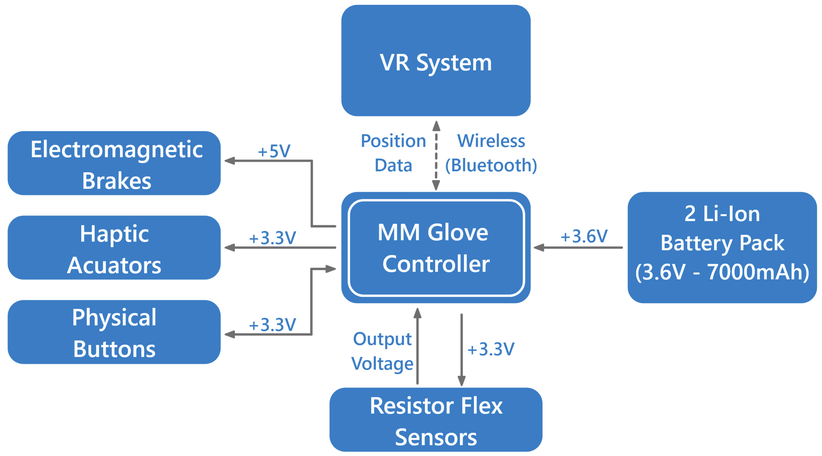

Figure 5: Hardware Block Diagram

Software Flowchart

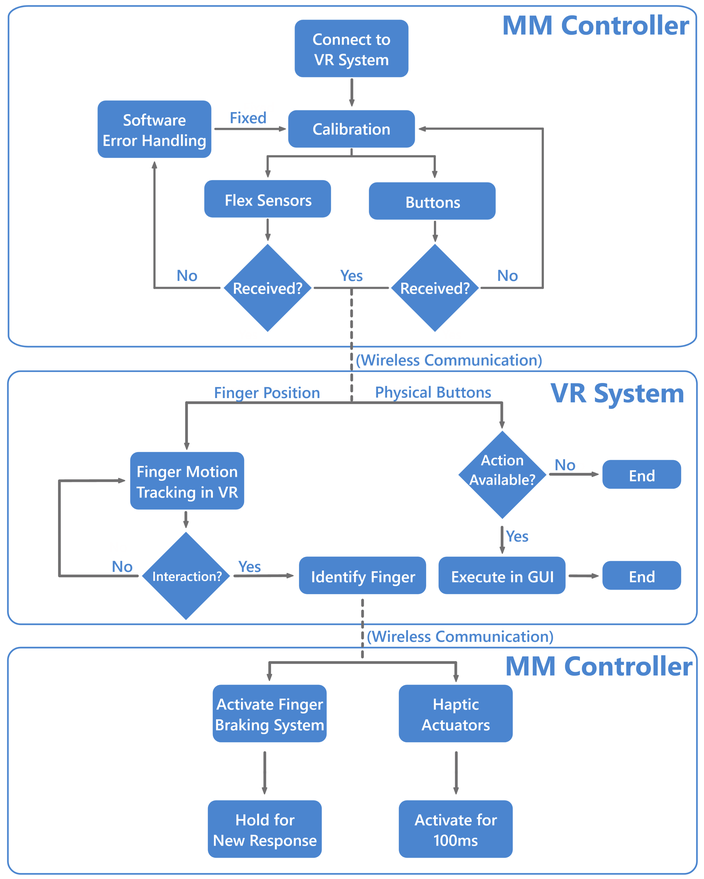

Figure 6: Software Block Diagram

Project Budget

Component	Description	Quanity	Cost
Flex Sensor	Main component for finger tracking	10	$125
Electromangets	To impose restrictive force on users finger	10	$100
Vibrating Actuator	Tactile vibration haptic feedback	10	$20
Li-Ion Batteries	Power Source	4	$40
PCBA	Assembled circuit board to control gloves	3	$750
Glove & Sleeve	Base of the product	2	$50
Miscellaneous	3D Prints, Badge Reels, Ball Bearings, etc.	-	$50
			$1,135

Table 1: Budget

Implementation and Integration

Figure 6: Testing finger/hand tracking, grab detection, and haptics

Figure 5: Electro- magnetic braking full five finger module

Figure 3: Population of flex-sensors on gloves

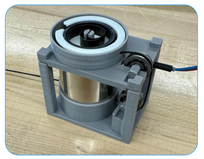

Figure 4: Electromagnetic braking system ball bearing module

Figure 7: Simulation testing

Verification and Validation Testing

Test Case	Test Description	Result
TS-01	Verify that the glove's electromagnetic system consistently applies force to restrict finger movement.	PASS
TS-02	Verify that the glove's haptic feedback actuators provide accurate tactile feedback when virtual objects are touched.	PASS
TS-03	Verify that the glove's flex sensors accurately track the position and movements of each finger in real time.	PASS
TS-04	Verify that the glove's Bluetooth connection with the VR system maintains stability, range, and low latency during usage.	PASS
TS-05	Verify that the glove's battery provides adequate usage time and remains operational during recharging.	PASS
TS-06	Verify that the gloves remain comfortable during prolonged wear and withstand drops, repeated use, and typical daily wear without significant damage.	PASS

Table 2: Verification and Testing

The verification and validation testing process included the Smart VR Glove's core functions—resistance, haptics, tracking, connectivity, power, comfort, and durability—to ensure reliable performance. Rigorous testing and verification was crucial to meet quality standards, user satisfaction, and long-term durability for various VR applications.

Acknowledgements

The Magic Mitts team extends heartfelt gratitude to Ryan Saavedra the CEO of Alt-Bionics, the UTSA Makerspace, LucasVR and our esteemed Professors for their invaluable technical guidance and support throughout our project journey. We also wish to express our sincere appreciation to the UTSA Makerspace, Student Success Center, and the entire faculty and staff of the UTSA ECE department for their generous provision of resources.