# Investigation of Electro-tactile Feedback Mechanisms for VR Gloves

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## Summary

In our project, we achieved electro-tactile feedback from VR applications through a textile-based wearable device, allowing users to feel the virtual objects they interact with in their hands. The system was complemented by the necessary software to unlock the full capability of the hardware, and a demo application to showcase the capabilities. The system was tested with volunteering users and received positive feedback.

## Stimulation Methodology

- Stimulating ulnar and median nerves
- Strategically located electrodes
  - 9 on top of fingers
  - 1 on the wrist
  - 2 separate ground electrodes
- Cathodic or anodic currents of ~1mA
- 15 possible stimulation zones



***Figure 1:*** *Placement of electrodes [1]*

## Developed Device

- Glove with embedded textile-based electrodes
  - Textile electrodes created from silver-infused conductive fabric and stainless-steel yarn
- 3D printed box that contains the electronics
  - No exposed internal wiring or components
  - Components soldered onto a custom-manufactured PCB
- Bluetooth support and wireless operation
  - Portable operation



***Figure 2: (Left)*** *The textile-based glove and the electronic parts inside the 3D-printed housing* ***(Right)*** *The device worn by a person*

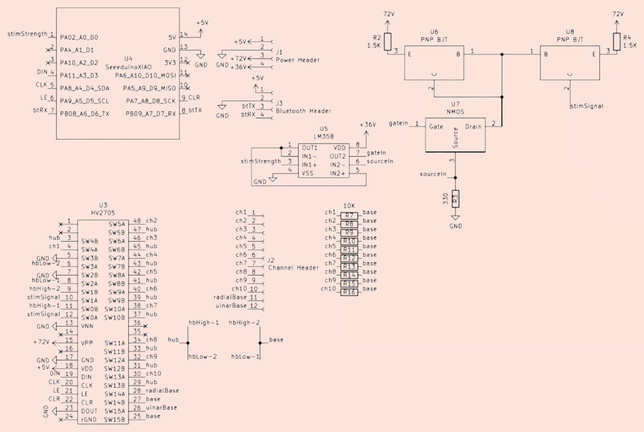



***Figure 3:*** *The hardware schematic*

## Developed Software

Our software covers all stages of use of our device, starting from firmware and drivers to the demo application.

- **Firmware:** Microcontroller firmware for precise control and generation of stimulation signals.
- **Driver:** OpenVR-compatible driver for integration with VR systems that provides an interface for application developers.
- **Demo application:** Unity 3D application to showcase the tactile feedback capabilities.

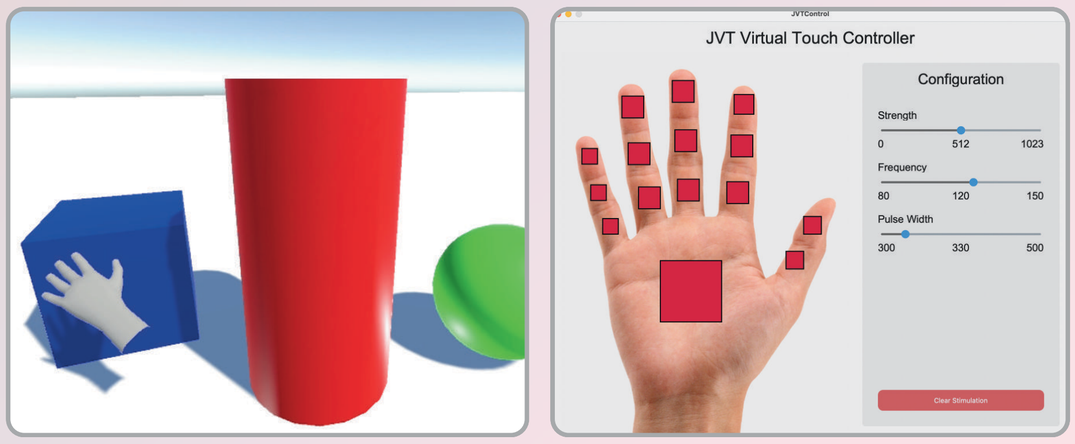



***Figure 4: (Left)*** *A screenshot of our demo application in action* ***(Right)*** *The simulation control interface*

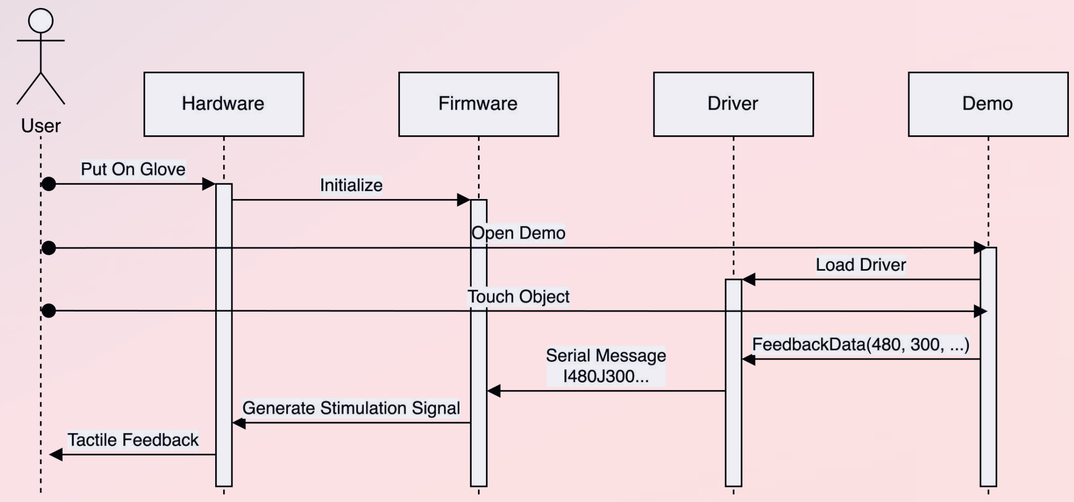



***Figure 5:*** *Sequence diagram of the communications between components of the device*

## Tests and Experiments

- 5 volunteering testers
- Testing Process
  - Accuracy of stimulation and strength ranges

Positive feedback from all testers

## Conclusion

Based on the findings of previous research, an electronic nerve stimulation system was created to achieve precise tactile feedback at several locations at the hands of a user. The hardware required to achieve said tactile feedback was implemented in a compact box with wireless support. The electrodes have been implanted into a glove by utilizing textile technologies to allow seamless use by end users. A robust software stack consisting of firmware and a driver was also created to fully utilize the system. The driver allows for applications that support tactile feedback to be further developed by providing an easy-to-use interface for application developers. A 3D demo application was developed to showcase the capabilities of our system to potential users.

## References

**[1]** Y. Tanaka, A. Shen, A. Kong, and P. Lopes, “Full-hand electro-tactile feedback without obstructing palmar side of hand,” in Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems, ser. CHI ’23. New York, NY, USA: Association for Computing Machinery, 2023. [Online]. Available: https://doi.org/10.1145/3544548.3581382