VR Haptic Gloves:

Replication of LucidVR haptic glove design with slight modifications

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ABSTRACT:

The goal of this project is to use servo motors in order to produce a force feedback for the user in vr applications with a device worn as a glove. It will serve to enhance the immersion of the user by giving a much better sense of touch in virtual environments. We also wanted to make the design more compact and lower the workload for any replication of the process.

INTRODUCTION:

VR haptic gloves are gloves that act as controllers for virtual reality environments and provide feedback in the sense of touch. We want to model and make these in order to be better immersed in virtual environments for both practical and entertainment uses. They operate with Arduino-controlled servo motors that control the tension of a spring-loaded string to simulate the shape of objects. For example, if the user is holding a cube in vr, the servo motors will activate preventing the users fingers from moving further forward in order to simulate the presence of the cube.

Background:

This project is an open source design created by Lucas VRTech and LucidVR. There are many versions of the project and for our design we will be replicating prototype 4 of the haptic gloves. There is a video detailing how to assemble the project as well as extensive documentation on their github. The github contains 3d files for printed parts as well as the firmware for the project.

Project Goals:

The project described and explained in this paper....

- We replicate the design used in prototype 4 of the LucidVR gloves.
- We change the material of specific 3d parts to make the design more flexible and comfortable.
- We modify the design to separate the motors and finger tracking in order to make the project more modular for different use cases.

This project has two major components:

- Replicating the design of the original project
- Testing and modifying the original design.

What is the project supposed to do?

- Accurately track hand in virtual space and provide force feedback for grabbing objects
- Make improvements to the original design by making it more compact and comfortable

METHODOLOGY:

Utilizing the following materials:

- Wires (22-gauge recommended)
- 3-pin 10k ohm potentiometers
- 9G Servo Motors
- ESP32 dev boards
- Retractable Badge Reel Clips
- Nylon gloves
- Access to a 3d printer and filament (PLA recommended)
- Three Amp portable battery packs
- Elastic Band
- Velcro Straps
- Foam
- Hot glue gun
- Soldering Iron
- Solder
- Crimper
- JST-XH crimps with connectors
- ESP 32 Screw Terminal Breakout Board
- Software can be found on GitHub (There are several files)

Procedure:

Assembling haptic module:

1. Cut off the clip of the badge reel

2. Split badge reel open to reveal the spring and string inside
3. Take the spring from the spool and fix it into a coil
4. Remove string from the spool
5. Put nut included with potentiometer into tensioner part and screw the potentiometer in
6. Fit the spring into the tensioner and coil it up tightly then slide it into the potentiometer
7. Fit the string through the small hole in the haptic spool piece. Using a needle can be very helpful for this
8. Take haptic spool piece and fit it onto the potentiometer using the plastic line on the top as a guide
9. Feed the string through the ridge in the spool cover from the inside of the cover and push the cover and spool piece together until you hear a click. If you feel considerable resistance consider resizing your parts or sanding them down
10. Rotate the cover while holding the string tightly to wind up the string around the potentiometer
11. Get the servo motors out and the included screws and put a small black screw through the open hole on the haptic spool piece
12. Mount the string reel onto the motor holder part
13. Take the servo motor and fit it onto the motor holder part

Assembling the glove:

1. Make 5 haptic modules
2. Use hot glue or super glue to glue end caps to the fingertips of the glove. If using super glue make sure to wear layers of protection under the glove to avoid any glue getting on the skin of the wearer
3. Use hot glue or super glue to glue guide nodes along each finger of the glove
4. Take the rigid mount piece and cut out a piece of foam to match the shape
5. Attach foam to the rigid mount using glue
6. Put Velcro strap through the large holes on the rigid mount piece
7. Use a needle to feed the elastic band through the small holes on the rigid mount.
8. Slide haptic modules onto the rigid mount
9. Follow wiring guide from Lucas VRTech video in references to wire up the glove. Wiring diagram is included in both videos. If you want to replicate our design use a screw terminal breakout board instead of soldering JST connectors to the board.
10. Feed the velcro strap through the gap under the board to mount the entire device to the bottom of the glove
11. Solder wires to the pins of the joysticks and glue the joystick to the glove (optional)

12. Solder wires to the pins of the buttons in accordance to the diagram and glue them to the glove (optional)
13. Install CP210x drivers
14. Install Arduino IDE
15. In the IDE go to file, then preferences
16. Under board manager URLs paste the following: https://raw.githubusercontent.com/espressif/arduino-esp32/gh-pages/package_esp32_index.json
17. Under tools and board manager search ‘esp32’ and install the esp32 board manager
18. Under tools and manage libraries get the esp32servo library
19. Download the firmware from LucidVR github
20. Follow along the with the video to configure the firmware files from the github. The only change that should be needed is switching the force feedback setting from true to false, but you may also need to set the communication method to Comm_BTSerial or change any pin numbers if your circuit varies from that of the wiring diagram
21. Use device manager to find the appropriate COM port and select that port under tools, Port: in the IDE
22. Upload the firmware to the gloves. You may need to hold down the boot button to get the firmware to upload properly depending on your board
23. Open the serial monitor and check that the values get larger as you close your hand and smaller as you open it. If the values are reversed set the flip_pots value to true in the main file of the firmware
24. Download OpenGloves from the steam store
25. Open OpenGloves and follow along with the video to configure the driver for the gloves. Using a button for calibration can also make this step easier

RESULTS:

• We tested the project with the unity demo provided by the creator as well as the mod supporting its use in Half Life Alyx

• We expected the project to accurately track hands and simulate force feedback in virtual environments and it performed both of these tasks well.

• To see the capabilities of the project watch the video linked in reference 5

Future Goals:

- Test Vibrating motors for better immersion.

- Make the entire glove out of TPU to see if a more flexible material helps with user comfort.

- Make a prototype 5 of the glove using hall effect sensors instead of potentiometers

- Test an FPGA as the main processing component for the sensor data.

Conclusions:

• The project was successful in making an immersive controller for virtual reality. We were also able to successfully make the glove more compact and easier to build with the use of screw terminal breakout boards

• The project was not successful at adding more immersion with haptic motors as we felt this idea would take too long to implement in the given time frame.

• Adding vibrating motors to the glove as well as hiding the wiring would be interesting to improve the project. Though the best way to make the idea affordable and mainstream would probably be to get rid of the force feedback and only implement finger tracking. This idea would significantly reduce bulk as the tracking could be done via splay sensors or IR camera tracking in order to make them lighter and they would also have less than half the wires of the current project.

REFERENCES:

[1] https://github.com/LucidVR/lucidgloves
[2] https://www.youtube.com/watch?v=2yF-SJcg3zQ
[3] https://www.youtube.com/watch?v=M4DLpyEQ_SE
[4] https://www.youtube.com/watch?v=2NrTy1Nzf04
[5] https://www.youtube.com/watch?v=rU3i_uedjNU