Hand Sensory Rehabilitation for Stroke Patients

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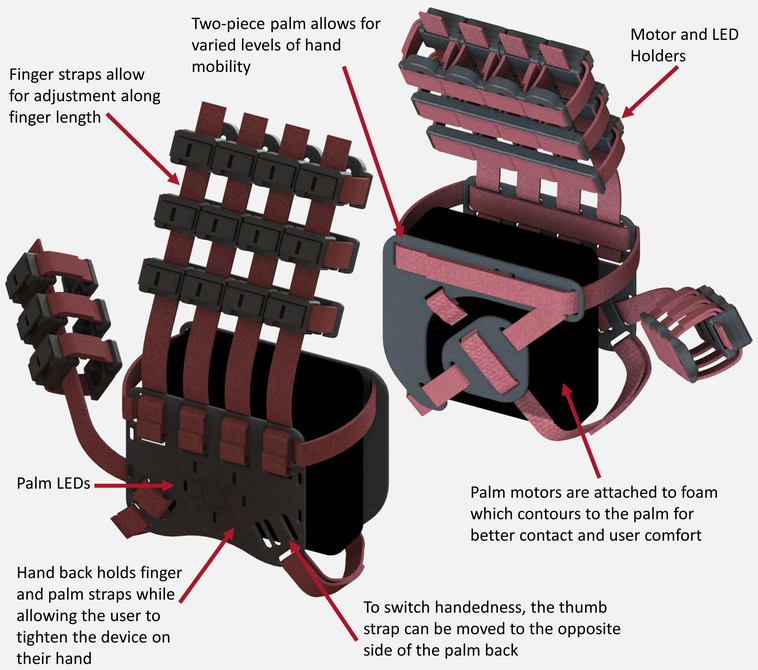


Introduction

As a result of a stroke, cortical pathways in the brain can become scrambled. For example, a patient may experience feeling in their pinky while their index finger is stimulated. This project aimed to create a novel device that will assist patients in re-establishing their cortical paths by applying vibrational and visual stimuli. The device activates 20 vibrational motors with 20 corresponding LEDs to apply sensory inputs to the user. The device adjusts to the user's hand size and was tested for comfort to allow for extended therapy sessions or in potential home use.

Vibrational Motors

Stroke patients can lose feeling in their affected hand, so the vibrational intensity of the actuators needs to be strong enough to be felt by the user with little sensory feedback.

Eccentric Rotating Mass (ERM) motors were chosen as they provide significant tactile sensation without requiring high electrical current or voltage. The motors provide up to 0.75 Gs at 200 Hz, which is sufficient vibration for a patient to feel without reaching sensory exhaustion during sessions.

Three motors are placed on each finger and five on the palm. These motors can be turned on individually or in groups: thumb, index, middle, ring, pinky, or palm.

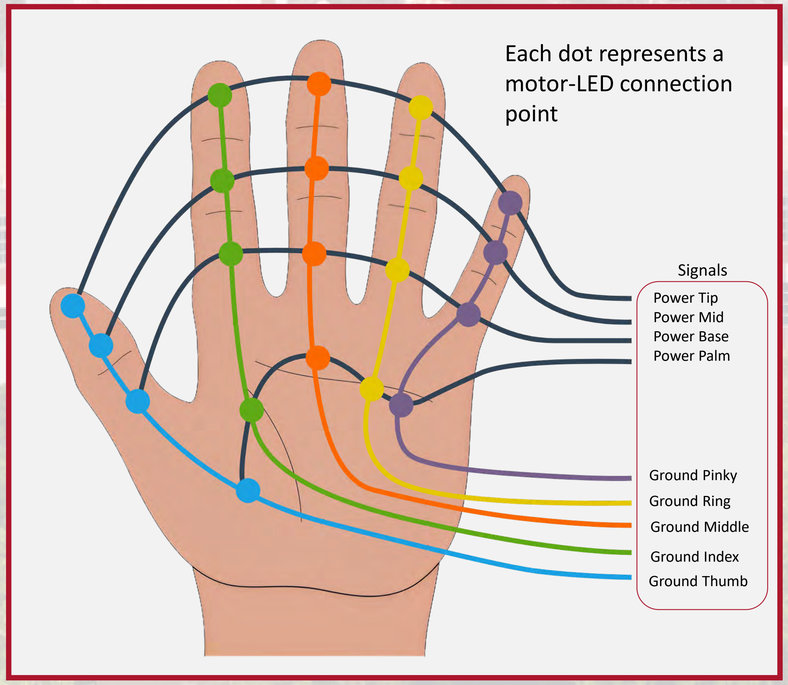
Versatility

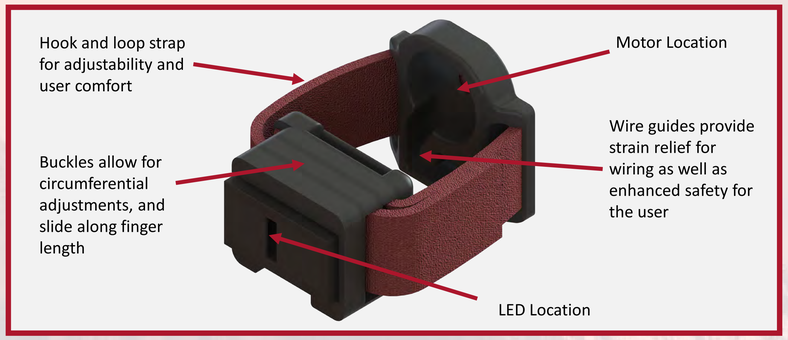
The following table explains what design considerations were needed to complete a design usable by 90% of all users with hand sizing varying from the 5th percentile female to the 95th percentile male and how the team accomplished them.

Design Consideration	Solution
Differing levels of hand mobility and spasticity	Two-piece folding palm design with a foam center that presses the motors into the hand
Different affected hands	Reversible hand design with thumb strap locations on both sides
Hand size variations	Adjustable straps for finger length, finger circumference, palm width
Differing sensation levels	Intensity and pulse time control, physically and digitally

Circuitry

To control the 20 vibrational motors and LED pairs, the circuit utilizes transistors as switches. These “switches” allow the micro-controller to “turn on” and “turn off” the electrical connections for each motor-LED pair in the matrix-like pattern shown below.





LED and Motor Holders

The LED and motor holders ensure that the motor can be fit to any size finger and that the corresponding LED is attached. This design allows for the holders to be adjusted to the desired position along the finger while providing strain relief to prevent the wiring from being pulled.

GUI

The Graphical User Interface (GUI) was designed using LabView to allow the user to operate the device from a computer. Users can control individual motors and groups as well as run different motor sequences with varying intensity and pulse time.

Conclusion

The team was able to design, manufacture, and program a first-of-its-kind device that is adaptable to most patients' needs. This new device and its associated therapies will be tested with stroke patients to determine the effectiveness of the therapy in rehabilitation of sensory problems after a stroke.

Acknowledgments

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