ABSTRACT
Wheelchair bound paraplegic patients require a rehabilitative therapy device that will help improve their upper body strength over time. An interactive boxing-type device would be able to keep the user engaged and motivated to continue their physical therapy regime. The device should be able to be programmable to present different patterns of stimulus to keep the user interested. The boxing-type device must be able to obtain and output certain quantitative measurements, such as force, reaction time, return time, and accuracy to demonstrate patient improvements over time.

BACKGROUND
Benefits of physical rehabilitation:
- Strength training exercises increase upper body strength of wheelchair bound patients
- Lowers the loss of bone density and muscle mass after injury
- Decreases the risk of bone fracture
- Beneficial to a patient’s emotional health by decreasing negative thoughts from injury
- Pain reducing exercises can reduce the need for prescription drugs

USER NEEDS STATEMENT
Design a device that will measure the upper body rehabilitative progress of a paraplegic patient

DESIGN INPUT
- Must record quantitative data for the punching force with 95% consistency.
- Must convey 95% accuracy for timing
- Information produced should be transferred to a computer for analysis
- Device must be large enough for the 95th percentile male
- Device must not cost more than $1,500
- Device structure should have a minimum of 5 year lifespan
- The punching pads must be easily replaceable
- Must not compromise patient safety
- Must be compatible with a wheelchair

PROTOTYPE
Structural Components:
- 8020 extruded aluminum base wide enough to accommodate for a wheelchair
- Array of 3x3 boxing pads attached to aluminum arms
- LED light strips located on the top of each pad

Functional Components:
- Self-manufactured force sensors that output force of punch connected to Arduino
- LED light strips as a punching stimulus
- Reaction time measurements between light stimulus and force detected
- Wireless data transfer via Bluetooth
- GUI for user interface
- Rechargeable batteries as power supply

TESTING
Accuracy Testing of Sensors
- Employ impact testing and drop testing with predetermined amounts of weights on the force sensors

Software Testing of Data Transfer
- Apply repetitive punches to the device while another team member analyzes the processing speed of the data transfer through the optimum serial output and drive size calculator codes

Hardware Testing of Circuitry
- Conduct a continuity test using a digital multimeter to determine proper flow of current

Engineering Analysis of the Structure
- Simulate the device through a modeling software like NX to obtain information on the longevity of the device

Survey for users
- Provide a survey to mock patients and mock physical therapists to assess their feedback on the device

FUTURE PLANS
Conduct clinical testing to determine improvements in patients’ upper body strength over time

REFERENCES
7. Engineering Department for prototype funding!

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