A user interface for evaluating hand force coordination in static and dynamic manipulation tasks

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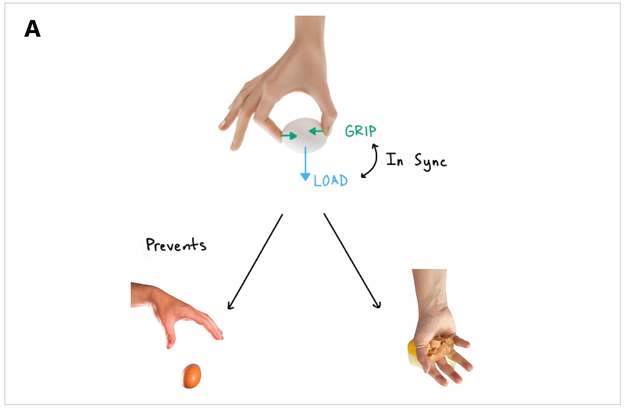


(A) A synchronous coordination of grip force (G; normal to the object contact area) and load force (L; tangential component) is needed to prevent object slippage or breakage **(B)** Visual and haptic feedback play a key role within the central nervous system to produce efficient manipulation **(C)** This work redesigns an interface which includes an adjustable brace to explore the effects of wrist position on grip-load force coordination, a device to measure grip and load, and a GUI for visual feedback.

Introduction

- Hand impairment is common in elderly over the age of 65 due to neuromuscular disorders and loss of skeletal muscle mass[1]
- Previously, a low-cost device was developed to assess grip force vs load force[2]
- Post-stroke individuals suffer from hypertonicity
- Previous literature has investigated grip-load force coordination in static, dynamic, unidirectional, and bidirectional tasks, but there exists a lack of research investigating the effect of wrist position on grip-load force coordination while a user receives visual feedback [3,4,5]


Grip-Load Device

Objective

Redesign a hand assessment interface to:

- improve force measurement accuracy
- provide visual feedback to the user
- design an adjustable wrist brace to investigate the effect of wrist angle on grip-load force coordination

Hardware Redesign

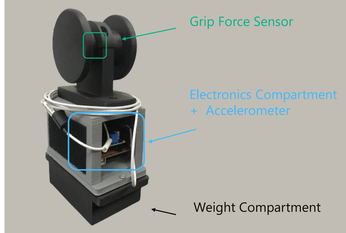
Assembled Device Configurations

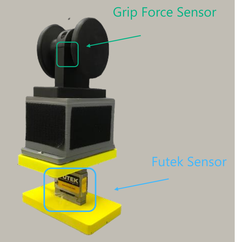
Dynamic (Device in Motion)

- Accelerometer is used to get Load Force due to gravitational changes

Static (Device is Fixed)

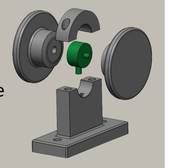
- Futek Sensor outputs Load Force





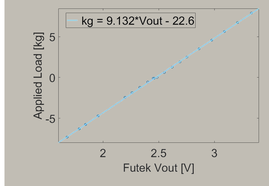
Grip Force Load Cell Attachment

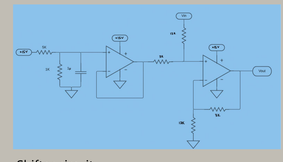
- Collar shaft clamp design
- Interchangeable screw on plates to grip device



Futek Sensor Calibration

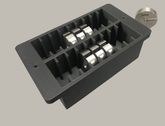
- Calibrated to obtain pushing and pulling forces from voltage
- Shifter circuit is used to read voltage values within Arduino




Shifter circuit

Weight Compartment

- Enables increasing the weight of the device by 50-gram increments



Wrist Brace

- Adjustable at 0, 30, and -30 degrees
- Enables exploring the effect of wrist position on grip-load force coordination


Top View of 3d printed brace prototype


Side View of 3d printed brace prototype

Software Redesign

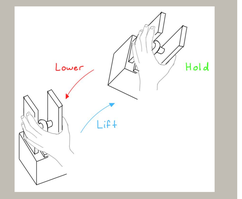
- GUI redesigned in LabVIEW
- Allows for data collection with Arduino microcontroller
- Enables the implementation of visual feedback

Operator view of the GUI

Planned User Study & Ongoing Work

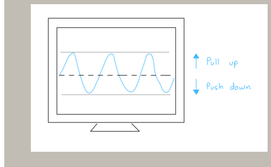
Dynamic Test

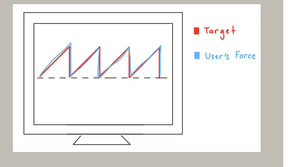
- Evaluating grip-load force coordination
- User performs a lift-hold-lower task based on a metronome
- Weight of device is increased
- Brace is used at the 3 positions



Static Test

- Evaluating grip-load force coordination in unidirectional and bidirectional tasks and at 3 wrist positions
- User performs a pull and push task based on a metronome
- User tracks a ramp force trajectory by pulling on the device





Ongoing Work

- Integrating the visual feedback in LabVIEW
- Redesigning a circuit board to include shifter circuit
- Finalizing the wrist brace design

References & Acknowledgements

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