Dynamic Balance Device

10/4/2024

Advisor: Dr. James Trevathan

Client: Mr. Daniel Kutschera

Team: Gabriela, Jack, Kyle, and Gracie

Problem Statement

- Post-stroke patients often experience unawareness of one side of their bodies and balance issues, leading to injuries
- Current rehabilitation tools are expensive, inadequate, or hard to use
- Goal: to design a professional device for visual scanning and balance training

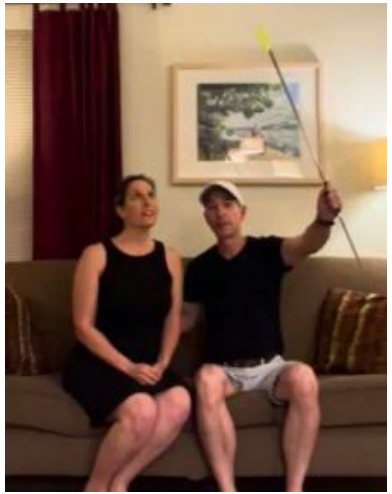

Figure 1: Static visual scanning

Figure 2: Dynamic scanning and reaching

Background

- Stroke spatial neglect syndrome
  - Fail to report, respond or orient to meaningful stimuli presented on the affected side [1]
  - Involves impairments in attention and/or sensory processing [2]
- Patients who participate in rehabilitation perform better than most of those who don't [3]
  - Gives independence and improves quality of life

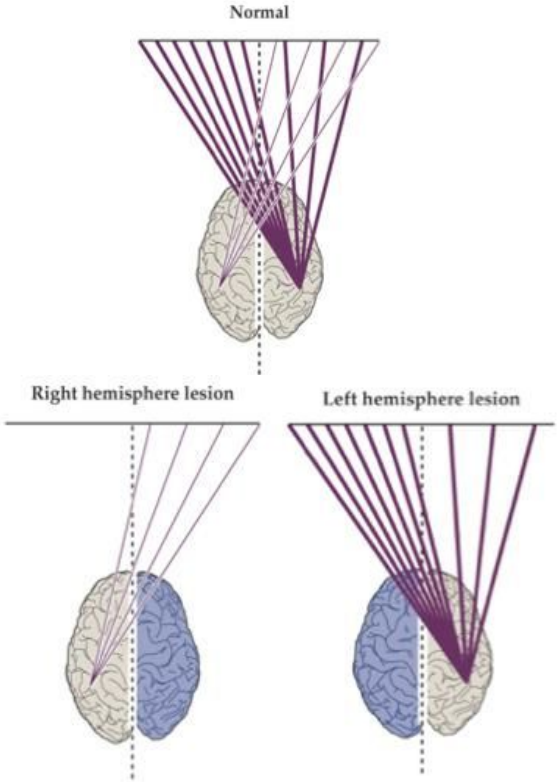

Figure 3: Hemispatial Neglect

3: Gabi

Background

- About the client:
  - Mr. Daniel Kutschera
  - Physical therapist based in Neenah, WI
  - Works with patients who suffer from post-stroke conditions
  - Seeks to develop a professional tool to improve the current method of performing dynamic balance training

Competing Designs

- Yard stick with yellow dot
  - Simple and not interactive
- Client's prototype
  - PVC pipe
  - Pieces of paper attached to the end

Figure 4: Meter stick with a colored dot attached to the end being used by Mr. Kutschera.

Summary of PDS

Client Requirements:

- Weight below 5 lbs
- Easily held/controlled
- Withstands daily sanitization
- Produces vivid, primary colors

Design Requirements:

- Life in service 3-5 years
- Constructed of a durable, lightweight material
- Maximum of 3 feet in length
- Weight located in handle

Shaft Designs

Design 1: Carbon Fiber	Design 2: Aluminium	Design 3: PVC Pipe
 *Figure 5:* Carbon Fiber Rod [4]	 *Figure 6:* Aluminium Rod [5]	 *Figure 7:* PVC Pipe [6]
Advantages: Strength, Durability, Lightweight	Advantages: Strength, Durability	Advantages: Lightweight, Cost
Disadvantages: Cost	Disadvantages: Weight	Disadvantages: Strength, Durability

Shaft Design Matrix

	Design 1: Carbon Fiber		**Design 2:** Aluminum		**Design 3:** PVC Pipe	
Weight (40)	5/5	40	2/5	16	5/5	40
Durability (25)	5/5	25	4/5	20	3/5	15
Ease of Engraving (15)	3/5	9	4/5	12	2/5	6
Cost (10)	2/5	4	3/5	6	5/5	10
Ease of Fabrication (10)	3/5	6	1/5	2	5/5	10
Total (100)	84		56		81	

Figure 8: Shaft Design Matrix

Display Screen Designs

Design 1: RGB LED Matrix Display	Design 2: TFT LCD Touch Screen	Design 3: LED Matrix Panel
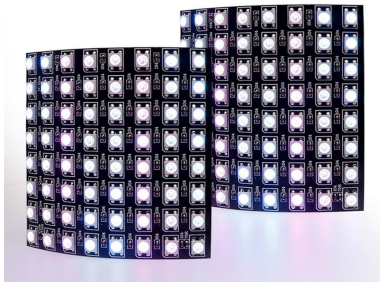		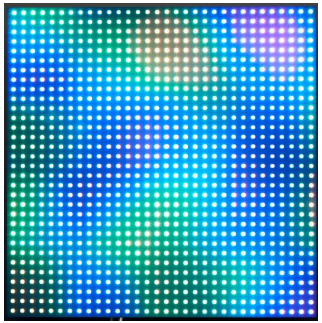
Figure 9: RGB led matrix panel [7]	*Figure 10:* TFT LCD Touch Screen [8]	*Figure 11:* LED Matrix Panel [9]
Advantages: Lightweight, Arduino Compatible, Additive, Bright	Advantages: Display Space, Arduino Compatible, Bright, Interactive	Advantages: Bright, Easy Display
Disadvantages: Limited Display Space	Disadvantages: Heavy, Power Drain	Disadvantages: Wiring, Heavy, Power Source, Non-Arduino

9: Kyle

Display Screen Design Matrix

Criteria (weight)	**Design 1:** RGB LED Matrix Display		**Design 2:** TFT LCD Touch Screen Display		**Design 3:** LED Matrix Panel	
Distinctiveness of Colors (25)	5/5	25	4/5	20	3/5	15
Weight (20)	5/5	20	3/5	12	4/5	16
Size (20)	5/5	20	5/5	20	3/5	12
Power Source (15)	4/5	12	2/5	6	3/5	9
Ease of Fabrication (10)	5/5	10	3/5	6	4/5	8
Cost (10)	4/5	8	5/5	10	4/5	8
Total (100)	95		74		68	

Figure 12: Display Screen Design Matrix

10: Kyle

Handle Designs

Design 1: Finger Grip Handle	Design 2: Support Band Handle	Design 3: Flashlight Handle
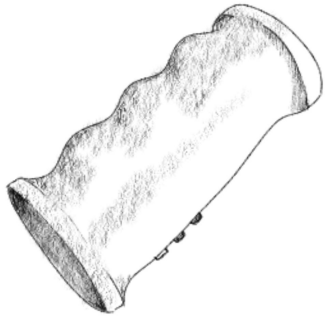	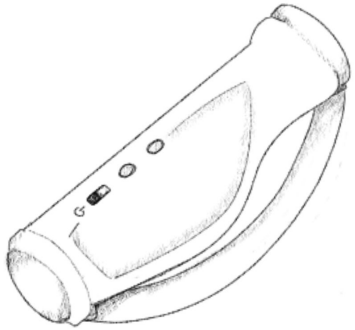	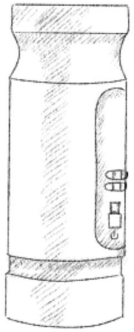
Figure 13: Finger Grip Handle Drawing	*Figure 14:* Support Band Handle Drawing	*Figure 15:* Flashlight Handle Drawing
Molded to client's hand, very ergonomic design	Hand support, good placing of buttons, purchasable online	Simple to manufacture, easily wireable, purchasable online
More complicated to produce	Potentially thinner, harder to wire	Less ergonomic, harder to grip

Handle Design Matrix

	Design 1: Finger Grip		**Design 2:** Support Band		**Design 3:** Flashlight Handle	
Ergonomics (30)	4/5	24	5/5	30	4/5	24
Ease of Use (20)	5/5	20	4/5	16	5/5	20
Size (15)	4/5	12	5/5	15	4/5	12
Ease of Fabrication (15)	3/5	9	4/5	12	5/5	15
Cost (10)	5/5	10	5/5	10	5/5	10
Weight (10)	5/5	10	4/5	8	5/5	10
Total (100)	85		91		91	

Figure 16: Handle Design Matrix

12: Kyle

Final Design

- RGB display screen
- Measurements on pole
- Power source in handle
- Microcontroller behind display screen

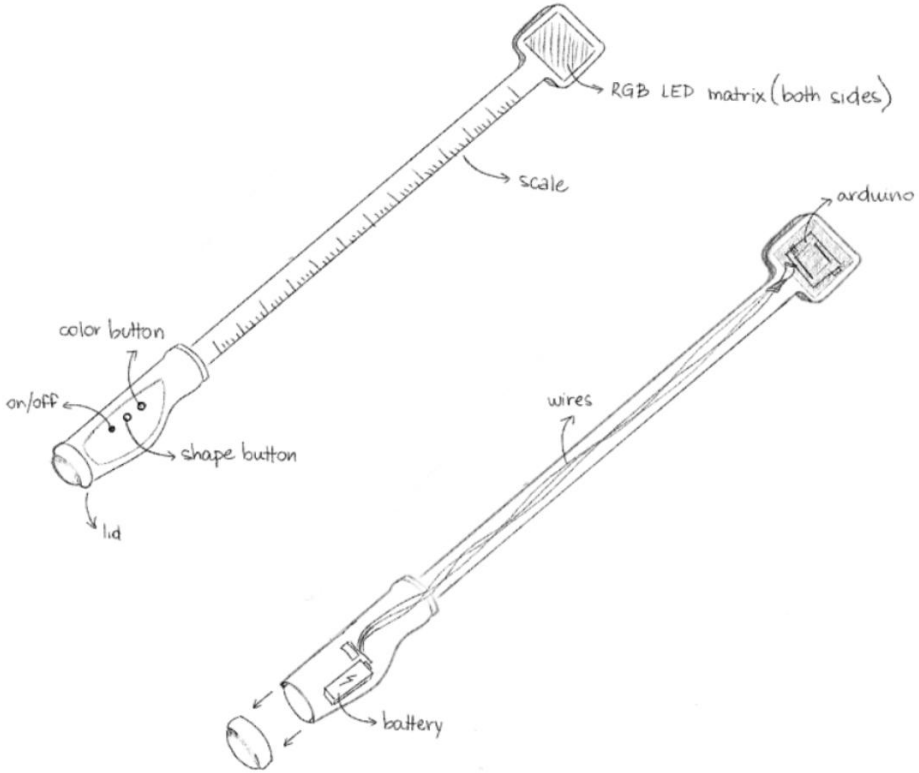

Figure 17: Final Design Sketch

Future Work

- Finalizing and ordering materials
- Creating fabrication plan
- Outline testing procedures
  - Ensure design meets PDS requirements
  - Testing ergonomics
  - Testing weight and size

Acknowledgements

- Mr. Daniel Kutschera
- Dr. James Trevathan
- Dr. John Puccinelli
- BME Department

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Thank You!
Questions?