Dynamic Balance Device

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MOTIVATION

- Stroke Neglect Syndrome affects 40% of stroke patients [1]
- Current lack of affordable rehabilitation equipment necessary for recovery [1]
- Most patients are aged 65+ with vision, balance, and perception challenges [2]
- Expensive equipment is affordable by hospitals but not outpatient centers
- The goal is to address the gaps in neurological and post-stroke patient care and provide an adequate tool for visual scanning and balance rehabilitation

PROBLEM STATEMENT

- Elderly stroke survivors often face neurological conditions and mobility issues during recovery [1]
- Existing equipment is expensive or insufficient for effective support
- Alternative solutions lack professionalism of specialized devices
- This project aims to develop a cost-effective, professional device to test visual scanning, balance, and flexibility while allowing doctors to assist patients as needed

BACKGROUND

- Stroke Spatial Neglect Syndrome affects ~40% of stroke patients, often from right-brain damage [1][3].
- Causes distorted object perception, balance, and movement issues, especially in elderly patients [1].
- Neurological rehabilitation hospitals handle initial recovery but smaller clinics lack specialized equipment.
- Clinician Daniel Kutschera requested an affordable, ergonomic device to assist patients in visual scanning and balance training.
- Device to include performance measurement and bright colors for enhanced patient engagement.

Figure 1: Spatial Neglect Syndrome.

DESIGN CRITERIA

- Weighs under 5 pounds, with most of the weight located in the handle
- The shaft needs to be 3 feet long, lightweight, and durable
- The screen needs to be at least 3 inches in diameter and emit bright, primary colors
- The handle needs to be ergonomic with accessible buttons
- Must be waterproof and withstand multiple sanitations daily
- Withstand daily use (8 hours a day, 5 days a week) and function effectively for at least 1 year with minimal maintenance
- Product cost should be under $200

FINAL DESIGN

- The design consists of various components including the display screen box, the handle, and the shaft.
  - Display screen
    - 8x8 LED Matrix
  - Handle
    - Switch to turn the display screen on and off
    - Buttons to control the colors displayed on the screen
  - Shaft
    - Carbon fiber rod
    - Measurement markings
- Electronics
  - Arduino UNO microcontroller
  - One button is programmed to switch colors of the display screen between red and green
  - Another button switches between random colors
  - Arduino UNO powered by a 9V battery

Figure 2: OnShape Model of Final Design

Figure 3: Fritzing Diagram of the Electronics

TESTING

- Final round of testing was conducted on a volunteer sample of ten individuals
- Testing until failure was deemed unnecessary for prototyping purposes
- Testing has been broken down into different components:
  - Weight Distribution
    - Different Comfortability Ranges
  - LED Color Panel
    - Rough Testing → Formal
  - Handle Preference
    - Preference for cylindrical model
- Device would likely be Class I, subject to fewer regulations [4]
- No advanced biomaterials,chemistry,etc.
  - Simply need to prove positive outcome
- Potential for an open source project [5]
- Future comparison to BITS [6]

Figure 4: Color Preferences

RESULTS

- Overall, positive testing results
- Comfortability for base model ranked highly →
  - Weight Distribution was viewed favorably
- Button pattern results
- Final design tweaked
- slightly based on results
- Improvements to design
- Extra functionalities
- Prove positive outcome
- Solid overall functionality

Figure 5: Weight Distribution Preferences

Figure 6: Testing results for overall comfortability & ease of use

DISCUSSION

- Weight distribution improvements
  - Balancing ergonomics vs overall weight
- Problems with current reading from touchscreen
  - Limited Arduino capabilities
- Adaptation to current materials
  - Secondary goals added throughout project
- Shapes vs clarity of picture

FUTURE WORK

- Improvements to the design:
  - Minimize the size of the electronics to ensure a lightweight design.
  - Modify the display screen to display a more solid, less pixelated looking color.
  - Program the screen to display shapes.
  - Incorporate sensor on display screen and audio feedback mechanism when the screen is touched.

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