Project Title

Marvel Arm: Enhancing Master of Powered Wheelchair Skills Through a Suite of Training Tools to Improve User Confidence

Project Lead(s) and Members

Project leads: Kellie Tedjo, Petrina Chia

Project members: Wilson Chin, Keith Lee

Organisation(s) Involved

Tan Tock Seng Hospital

Healthcare Family Group(s) Involved in this Project

Allied Health, Healthcare Administration

Applicable Specialty or Discipline

Occupational Therapy

Project Period

Start date: 14 December 2020

Completed date: 30 October 2022

Aims

The objectives of the project are to facilitate motorised wheelchair training by:

1) Detecting obstacles while reversing through the use of reverse sensors, and
2) Ease in teaching and learning to use the joystick control, through the use of a joystick directional cue.

These are to improve the confidence of motorised wheelchair users post training.

Background

Personal mobility aid (PMA) (e.g. powered wheelchair) prescription and training is part of occupational therapists' interventions to enable community integration for people with mobility difficulties. It is noted that personal mobility aid users have difficulty performing meaningful everyday activities. In addition, functionality of the PMA has been found to limit access in public areas and impacting activity performance and social involvement. Through a user centric design approach, we aim to co-create creative solutions to enhance the mobility experience of users. An observational study was conducted with 10 PMA users to understand their needs and aspirations. One of the challenges highlighted includes the confidence and competence to navigate the PMA in their environment. Many novice wheelchair users experience difficulties with acquisition of powered wheelchair manoeuvrability skills, potentially leading to a decreased quality of life and increased isolation. A further survey was conducted with occupational therapists and therapy assistants, identifying specific problem areas such as difficulty in teaching and mastering skills to reverse safely so as to avoid obstacles.

These are the main challenges identified:

1) Difficulty reversing backwards and avoiding obstacles; and
2) Difficulty using joystick control in terms of direction when navigating

Methods

<u>Sensors</u>

- A first working prototype was developed on April 2021 with Kaizen.
- Next the team sourced for partners with technical expertise in software programming with the support of CRIO and CAPE.
- 2 vendors were identified for further engagement.
- BMEC Pte Ltd collaborated with the team to further develop the prototype in November 2021. A collaboration agreement was initially in negotiation. However, in

view of the vendor's manpower and technical limitations, and project duration, a service agreement was concluded.

Joystick Directional Cues

- After user testing and feedback from occupational therapists, the joystick directional cues were developed from a sticker prototype to a 3D print working prototype on January 2022.
- Service engagement with vendor, Eye2eye, assisted in the finalising of the 3D print directional cue on September 2022.

Post-completion of the 2 prototypes, user testing was done on 4 occupational therapists with varied years of PMA training experience, and 1 PMA user. Occupational therapists were given $10 vouchers, while users were given $20 vouchers as a token of appreciation for their participation.

The project timeline included Research and Ideation, Prototype Development and Iterations, User Testing and Prototype Improvement and Evaluation and Selection of Proof of Concept.

Results

Upon termination of the project collaboration with BMEC, the sensor prototype remained as a proof of concept, with potential uses for training new occupational therapists in PMA training, and suitable new users who may have difficulty reversing.

The 2 prototypes, the sensor and the joystick directional cues were developed, are at proof of concept and proof of value stage respectively. (Refer to pictures of prototypes).

Sensor

Based on the user tests, the sensors provide some usefulness in identifying obstacles at the back of the motorised wheelchair. The concept of car reverse system which included a traffic light display were also easy to understand. Due to the limitations of the prototype, there was feedback that the sensors remained too sensitive and also the presence of the screen could distract the user from attending to surrounding environment.

Joystick Directional Cue

The joystick directional cues allow for easier navigation and learning as a training tool especially when turning and reversing backwards. The cues in the form of a clockface also helps to simplify instruction giving and facilitate learning of the joystick manoeuvres.

From the user tests and surveys conducted, general feedback was that the cues were easy to understand, teach and mount, and that therapists were highly likely to recommend it to others.

Lessons Learnt

- Difficulty in sourcing and identifying suitable companies for collaboration or service models.
- Negotiation of partnership and legal terms for collaboration with vendor.
- Personnel-related challenges in view of reduced meetings in October/November 2021 due to COVID-19 response (i.e. prioritisation of clinical load and ongoing segregation limiting physical prototyping sessions at CHILL).
- Service collaboration changed to procurement route due to:
    - Lack of vendor capabilities to meet the software requirements for the sensor based on the vendor alignment guide set by the project team; and
    - Lengthy RCA process with delays from BMEC side during negotiation.
- Consider further sourcing of vendors with technical capabilities, i.e. rationalising collaborating with PMA vendor with ability to commercialise product vs software engineer with technical expertise to make adjustments to prototype.

- Difficulty in recruiting a significant number of clients for user testing, due to challenges with coming separately to TTSH for user test or lack of time post PMA training to trial prototypes.
    - To consider starting grant only when service agreement finalised to avoid potential need for extensions.

Conclusion

In conclusion, these prototypes do help to facilitate motorised wheelchair training to a certain extent, and in addition, the joystick directional cue may be used as a training tool in the clinical setting. Both prototypes will benefit from further iterations post user testing.

Additional Information

This project is funded under the Ng Teng Fong Healthcare Innovation Programme (Track 2: Innovation).

Project Category

Technology

Prototyping Resources, Product Development, Product Evaluation, Safety Evaluation

Care & Process Redesign

Quality Improvement, Design Thinking

Keywords

Personal Mobility Aid, Sensor, Joystick

Name and Email of Project Contact Person(s)

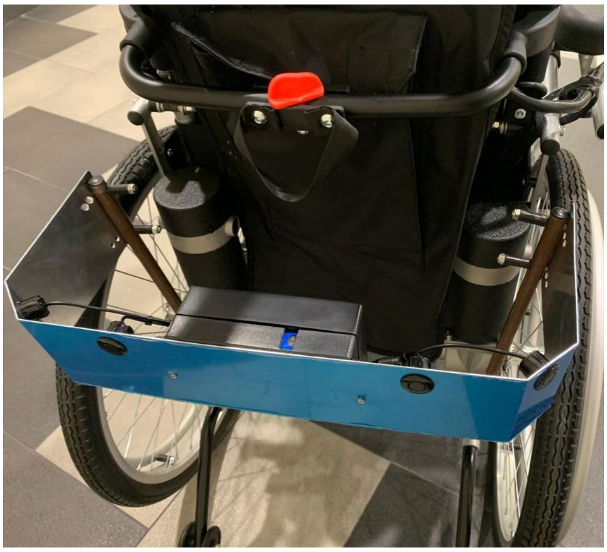
Name: Kellie Tedjo; Petrina Chia

Email: kellie_tedjo@ttsh.com.sg; petrina_sh_chia@ttsh.com.sg

Prototype details

1. Sensor prototype (consists of 2 parts: LCD screen and sensor compartment)

- Sensor compartment

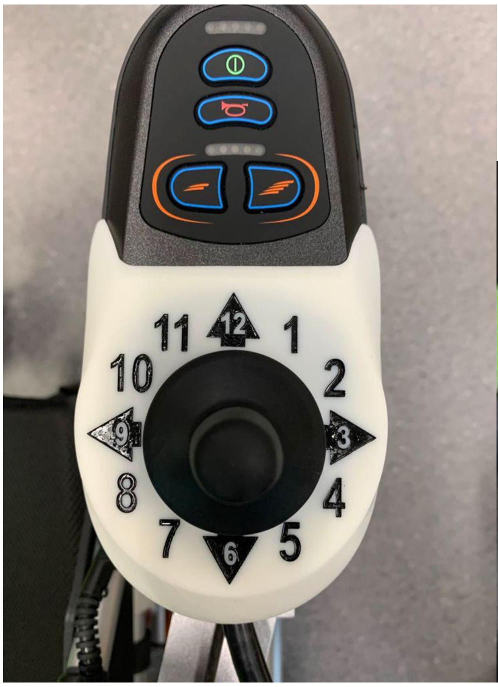


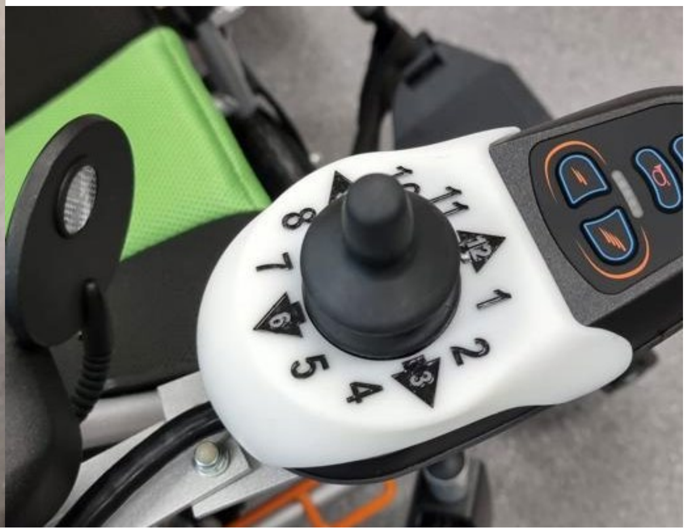
  - 4 sensors located at back of motorised wheelchair with mount
  - Mount is secured by quick lock mechanism clips
  - Detects obstacles 2m away, which is displayed on LCD screen

- LCD screen display

  - Screen holder attached to foot rest of motorised wheelchair, with quick lock mechanism clips
  - Screen display is connected to back sensors via bluetooth
  - Traffic light system displays proximity of obstacles according to distance (Red if wheelchair is very near obstacle and green if adequate distance still available)
  - STOP sign is flashed to alert user to stop motorised wheelchair once is too near obstacle
  - Flashing “signals” indicate rough location of obstacles
    - Right- Right signal flashes
    - Left- Left signal flashes
    - Directly behind- Both signal will flash

2. Joystick directional cue





- Joystick cue is attached to the existing joystick control by snapping it onto the control
- Uses clockface design, with arrows depicting up/ down/ left/ right directions