Team 205: Robotic Arm to Assist Motorized Chair Users

Sponsor: Mr. Keith Van Houten, PPMD
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Faculty Advisors: Mr. Stephen Moyer, Mr. Jim Hess

Parent Project Muscular Dystrophy

College of Engineering Mechanical Engineering Virginia Tech

Background

Duchenne muscular dystrophy (DMD) is a progressive disorder that deteriorates muscles over time.

- Users with DMD often require the use of motorized wheelchairs (Permobil M3)
- People with DMD have limited range of motion (ROM) and often require a caretaker or robotic device to help with everyday tasks

Problem Statement

Current assistive devices are too expensive, cover a large footprint, and are difficult for people with DMD to control. People with DMD would benefit from a simple to control, affordable robotic aid that executes specific high value functions.

Customer Needs

Safety – Robot doesn't hit user or other people	System withstands rainfall whilst maintaining normal operation
Ease of assembly, installation, and maintenance	Easily portable and self-contained for travel
Intuitive Controls that are like controls found on the wheelchair	Attached system fits through ADA compliant doorframe
Affordability (current market solutions >$60,000)	Ability to save custom, frequently-visited locations using buttons

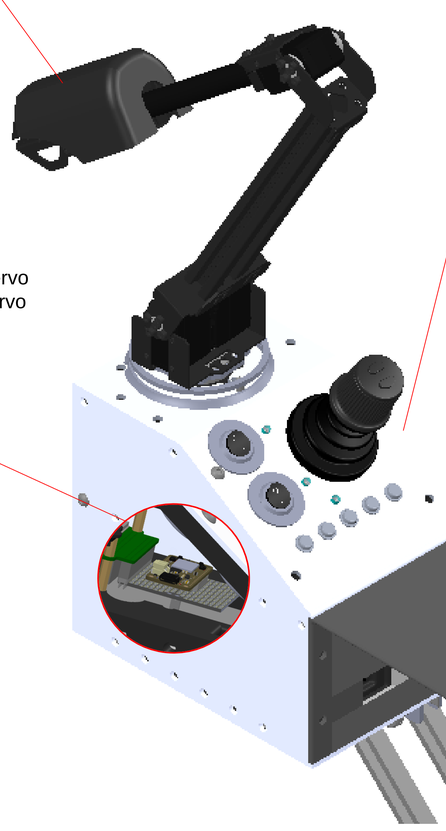
Complete Two High Value Functions

- Push an ADA compliant elevator button
- Retrieve and return a drink to and from the user from a user programmed location

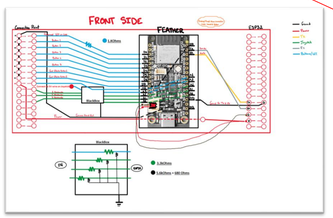
Waterproofing

- End-effector cover protects wrist servo
- Sleeve protects elbow and base servo
- Well protects internal electronics

Waveshare Ro-Arm



Protoboard



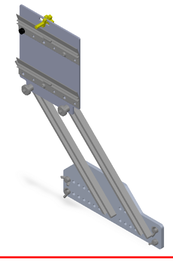
Control Panel

- 1 joystick (3 axis, 2 buttons)
- 2 switches for system & joystick enable
- 5 buttons for stored functions/location

Mounting

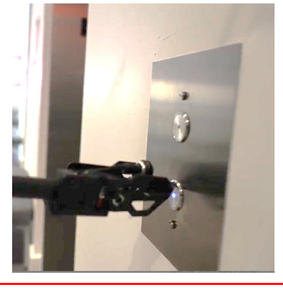
Mounting Assembly Features:

- Locking pin
- Vertical and horizontal adjustment
- Easy tightening
- French cleat system



Colin testing:

- Mounting position
- User interface
- Retrieving a drink
- Ergonomics
- Fitting through an ADA compliant door



Team testing:

- Accuracy of robot to hit elevator button
- End effector slipping
- Visibility, ease of maneuverability

Team Testing

Test	Results / Outcome
End Effector Load Capacity	✓ 0.5 kg at max distance ✓ 0.6 kg at min distance
Verification of Safety Measures	✓ Stayed within designated 300° of rotation
Joystick-Robot Accuracy	X Failed team standards ✓ Met ADA standards
Installation Time	✓ 58.52 sec
Maintenance Time	✓ 22 min 5 sec

End User Testing

Team 205 meeting with Colin Werth for testing

End User Comments:

- Move the joystick closer to the edge to be in line with the armrest
- Joystick with twisting motion may not be ideal for people with DMD
- End-effector tip requires non-slip material for button pressing
- Armrest attachment for additional support

Conclusions

- ✓ Completes high value functions and meets user requirements
- ✓ Affordable at < $2,000
- ✓ Compatible mounting with Permobil wheelchair
- ✓ Open source – GitHub

Recommendations & What we'd do differently

- Possible better robot arm choices – more research
- Refined case design
- Reworked electronics: different microcontroller and printable circuit board instead of protoboard

Special Thanks!

The Werth Family and the Team at PPMD
Mr. Jim Hess,
Mr. Stephen Moyer,
Mr. Rick and Ms. Kristie from QL+

Images

GitHub Information

- Code
- CAD Files
- Tutorials

For others to reproduce our project and expand upon our work

GitHub