Wheelchair Power Add-On

Mechanical Engineering

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Abstract

Manual wheelchairs provide mobility for disabled people from either accidental injuries or lifelong disabilities. However, the main downfall for manual wheelchairs is that the user must propel themselves or have assistance provided by another person at all times. Self-propulsion has often resulted in health problems when the user lacks the required upper body strength. To help mitigate the possible health risks imposed by manual propulsion, a power add-on units were explored, designed, prototyped, and tested. The goal of this project was to design a power add-on system that could be retrofitted to a manual wheelchair and provide power and steering to the user, whenever manual operation was undesirable. The system developed offers key features, such as ease of installation, usability, portability as well as operating inside the existing footprint of the chair.

Scope

- Mounts to popular types of manual wheelchairs (both folding and rigid types)
- Attaches for use with no tools
- Should not increase the "Footprint" of the wheelchair
- User mounted with user in/out of wheelchair
- User be able to transfer in/out of chair while module mounted
- Docking system that is lightweight and can stay on frame
- Modularity between system and mount point
- Foot clearance during operation
- Must be able to be driven (steered/guided) from center (abducted position) or side (right-hand/left-hand configuration)
- Must have ability to accelerate & brake with hand-controls (tiller style or otherwise)
- Lifting front casters for power module drive contact acceptable
- Work on different terrains

Design

Drive Unit

- 2 in-hub brushless dc motors
- 2 Electronic Speed Controllers
- 8000 mAh 6S Li-Polymer battery
- Arduino Uno
- nRF24 Transceiver module
- Lockable Gas Spring
- 3/8" Aluminum Frame
- ABS 3D Printed Housing
- Attachment Clamps

Steering Unit

- Full Twist Throttle
- 100 kΩ Posentiometer
- Arduino Uno
- nRF24 Transceiver Module
- ABS 3D Printed House and Adapters
- Aluminum Attachment Clamp
- 1/2" PVC Pipe
- Adjustable Base

Circuit Diagrams & Logic Flow Chart

Drive Unit

Steering Unit

Drive unit

CAD Model

Prototype

Steering Unit

CAD Model

Prototype

Equations

Using the equation for electrical power, we can estimate the amount of amperage each motor will draw from our battery. By knowing the amperage draw, we are able to estimate our battery life, as well as the appropriate Electronic Speed Controllers (ESC).

$$P = IV$$

$$M1, M2 = T \pm TX\ (P\text{-}A)$$

Where M1 and M2 are motor inputs T is the throttle output, X is an experimental variable, P in the potentiometer output, and A is the average value for the potentiometer. This equation will give more power to one motor while decreasing the power to the other which results in a turn.

Assembly

CAD Model

Prototype

Conclusion

Although there are other tiller style power add-on systems currently in the market, what makes our system unique are the combined elements compact design and wireless control integration. Along with a per unit cost of $600 for mass production, our system is the most affordable power add-on unit. A mass production ready version of our system would have further improvements such as optimized aluminum frame to reduce weight and increase stability and strength, increased battery capacity for longer range, improved latching system, encased by a molded plastic integrated housing. Also a main LCD display screen mounted to tiller for optimum functionality that operates as well as provider user friendly information during operation about system functions such as battery life percentage, range, speed and temperature.

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