ELEVATOR CONTROLLER FOR INDIVIDUAL WITH MULTIPLE SCLEROSIS

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abstract

Our project involves the integration of adaptive controls and the development of a mounting strategy for a prototype created in the spring of 2006. This prototype is capable of covering the distance from a wheelchair to an elevator button and exerting a horizontal force sufficient to push a variety of elevator and hallway call buttons. Integrated switches are designed for manipulation by the user's mouth and chin because the user's motor capabilities have been limited by the progression of multiple sclerosis. The mounting arm connecting the user's wheelchair to the device does not hinder the maneuverability or everyday functions of the chair. A removable metal shield is designed to provide protection from physical and environmental damage.

Figure 1. Prototype constructed in spring of 2006 including a linear actuator for height adjustment and a six-bar mechanism to press elevator buttons.

background & motivation

Mechanical component construction: spring 2006

- Linear actuator with 12" stroke covers vertical distance between buttons
- Six-bar mechanism activated by pull-solenoid extends horizontally to press buttons

User information

- Multiple Sclerosis (MS) is an autoimmune disease affecting neuromuscular communication
- User's mobility limited to head and neck as a result of MS
- Voice-activated controls and wheelchair joysticks enhance user's mobility within 2nd story apartment
- Unable to operate elevator buttons without assistance

design specifications

Adaptive controls

- Mount on existing horizontal control bar
  - Must be placed within user's range of motion
  - Location should not limit user's field of vision
  - Prototype in view while using controls
  - Capable of withstanding variable weather conditions
  - Minimal weight of controls and weatherproofing due to limited strength of control bar

Figure 2. Instrument control bar currently in use on user's wheelchair. Components such as the center chin joystick and tilt joystick (the farthest right control) constrain placement of adaptive controls for this project.

- Two switches required
  - Need continuous control of vertical displacement of linear actuator
    - Must provide dual control of bidirectional motor
  - Need momentary control to engage solenoid and extend 6-bar mechanism

- Power supply
  - Power device using chair's existing 12V batteries
  - Circuit elements must withstand 12 Volts DC and current of 1 amp

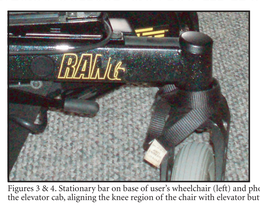
Mounting arm

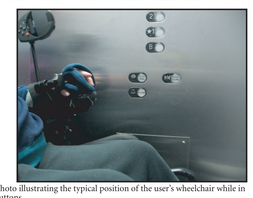
- Entire arm must be removable from device and chair

- Bracket placement
  - Must mount on stationary bar of wheelchair base

- Horizontal extension platforms
  - Move device out from underneath wheelchair arm
  - Minimize width added to chair

- Forward extension platform
  - Include rotary components to avoid interfering with wheelchair footrests
  - Must lock into forward position while in use to prevent unwanted rotation
  - Must center device in front of buttons in elevator





Figures 3 & 4. Stationary bar on base of user's wheelchair (left) and photo illustrating the typical position of the user's wheelchair while in the elevator cab, aligning the knee region of the chair with elevator buttons.

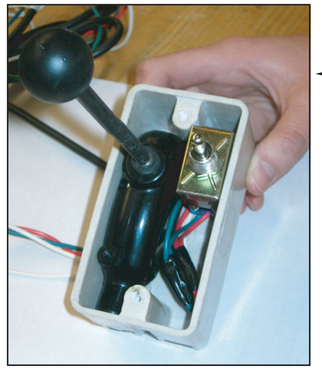
Weatherproof housing

- Must not add unnecessary weight to device

- Should shield device from moderate exposure to weather and physical contact

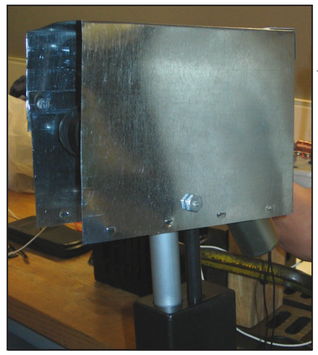
- Removable for device maintenance

final design



Adaptive controls

- Momentary toggle switch
  - Double pole double throw switch controls bidirectional motor
  - Settings: Momentary on (up) – off – momentary on (down)
  - Added 5" extension to toggle arm
  - Rubber stopper increases contact surface
  - Rubber boot weatherproofs junction between toggle arm and control box
- Momentary contact switch
  - Ultimate Switch purchased from Enabling Devices
  - Weatherproof control box protects switch base
  - Leads for battery and solenoid soldered to 1/8" phone jack complimenting 1/8" plug on Ultimate Switch

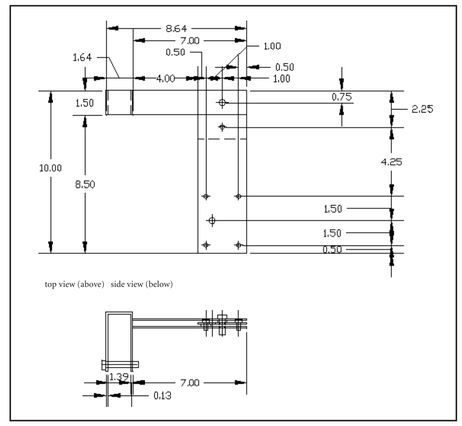


Weatherproof housing

- Constructed of galvanized steel for weight and rust resistance
- Center bolt attaches case to device
- Rubber O-rings (1/4") prevent side-to-side movement

Mounting arm

- Constructed of 1/8" mild steel
- Horizontal extension platforms move device 7" from stationary bar of wheelchair base (only 3" added to width)
- Forward extension platform rotates > 180° + locking bolt maintains position while in use



future work

Short-term: Implementation

- Access and utilize chair's batteries with assistance from Meriter Home Health
- Mark stops on actuator for individual elevator buttons
- Contain slack in solenoid wires with plastic tubing

Long-term: Improvement

- Change controls from manual to voice-activated interface
- Make device more universal: larger actuator stroke, greater extension force
- Lighter, smaller device components

acknowledgements

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