Alternative Designs Report

All-Terrain Power Chair

Team 10

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Project for Nathan Lamb

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Design Three

This design of the all-terrain powerchair will be as lightweight and compact as possible, while also being modular. Unlike most other four-wheeled designs, this powerchair will have an individual motor for each wheel, allowing for four-wheel drive. This design will furthermore be different from other all-terrain wheelchair designs in the ease with which it may be disassembled.

To ensure stability of the wheelchair, the four large wheels will be spread lengthwise from the center of the chair using one lever arm per wheel. This provides forward and backward tilt stability without using a six-wheeled base. All four wheels will be full-sized power wheels, and no casters will be utilized. Individual suspension for each wheel will allow the device to safely travel over rough terrain without tipping the entire chair. The wheels will be mounted with Hall Effect sensors to determine their rotational velocity and report it back to the microcontroller.

Four DC motors will be mounted directly beneath the seat. Each will use a U-Joint to axel to U-joint configuration to transfer power to a gear. This gear will be mounted on the lever arm. A chain will then transfer power from the gear to the wheel. This will allow us to fine-tune the gear ratio from the motor to the wheel, as well as allow the end user to easily swap out the gears. By making the gear removable, the DC motors can be removed easily as well. The DC motors will be mounted in a lightweight sheet aluminum casing, form-fitted and welded shut to prevent environmental damage. The top of this casing will be the attachment point to the chair and will remain open at the top to allow removal and servicing of the DC motors.

Two rechargeable, high charge-density 12V lithium-ion batteries will be mounted to the back of the wheelchair to provide power to these motors. A high-current four-channel H-Bridge will allow the microcontroller to provide CMOS pulse-width modulated signals to power each of the wheels in both the forward and backward direction. This will allow the chair to be turned without requiring casters, and will also allow us to provide four-wheel drive to the chair. Because the chair will not be designed to move above walking speed, power consumption of the batteries should be relatively low. A separate nine volt power supply will provide power for the microcontroller using standard batteries. A charge indicator will tell the family when they must replace the microcontroller’s power supply. Furthermore, the motor power supply will have a physical cutoff switch. This will cut power to the motors as well as
send a CMOS-high voltage input to an IO pin of the microcontroller, indicating that the cutoff has been activated and ceasing all motor control output.

The frame will be made from 2 by 2 square tube 6061-T6 stock. The hollow nature greatly reduces the weight of the chair, as well as the price of the frame, while retaining a great deal of strength. By custom-fabricating a simple frame we can precisely ensure size requirements of the family as well as size requirements of our components. A simple frame will be used - a square 24 inch by 16 inch square base under which the motors may be mounted, and to which the lever-arms of the wheels will be attached. The edges of this will also provide attachment points for the shock absorbers of the wheels. The back of this square will provide the mounting point for the 'spine' of the chair, to which push handles will be attached, as well as the seat itself.

For the audio jack, a Dayton RS100T-8 4-inch woofer will be used in conjunction with an STA540 audio amplifier kit. The Dayton RS100T-8 woofer is capable of producing audio frequencies from 20Hz to 20kHz. This is a sufficiently large range for an mp3 player. Furthermore the wattage for the Dayton RS100T-8 is low enough that the woofer can easily be limited in volume so as to not damage the client's hearing.

The chair will be controlled by a joystick mounted on the left arm of the seat, as the client is unable to utilize his right hand. The joystick will be a two-axis potentiometer model, and its output will be converted to digital signals by the microcontroller.

The powerchair will use a PIC microcontroller as its main computational device. The microcontroller will be programmed in embedded C. Embedded C is easier to use and test than assembly, and allows for more complex mathematical functions without the need for extra packages and strenuous programming. The microcontroller will receive input from both the joystick for control, and the Hall Effect sensors on the wheels. The Hall Effect sensors of the wheels will be used to measure relative rotational velocity of each of the wheels. If the relative rotational velocity of one wheel exceeds that of the others intended to be rotating in the same direction, that is indicative of the tire losing traction. The microcontroller will then transmit less power to that slipping wheel, and more to the others.

The seat for the chair will be an ergonomic, comfortable design with a harness designed to keep the client in the chair. High arms of the chair will help to support his trunk and prevent his slouching. The headrest of the chair represents a potential mounting point for the Dayton RS100T-8. Because of
our client’s tendency to press his right hand to his ear, mounting the speaker in a position where he can rest his ear, while keeping the volume very low, represents a potential way to free his right hand and make the chair more comfortable for him. The seat will be mounted on an extendable boom so our client may be at eye-level when on the chair, yet the chair can also be collapsed to take up less space and fit in our client’s family’s minivan.

To one of the rear wheels will be mounted a mechanical disc brake. This will be operated via a lever on one of the push-arms of the powerchair. This will provide added safety when the electronic failsafe is triggered, as well as provide a brake for the chair when the motors are removed and the family wishes to use it as a rugged push-chair.

References: