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DESIGN AND DEVELOP AN ELECTRIC HOVER BOARD USING RELAY

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Abstract

This paper discusses the procedure and steps followed to design and develop an electric hover-board. The design for the mechanical chassis, an approach to calculate the required motor power rating depending on the load, the possibilities of using different motors, methods to control the rotation of the BLDC motor and closed speed control algorithms for BLDC motor are all presented. Design and development of motor driver required to build a hover board is also discussed. The development of motor driver includes design of inverter, DC-DC converter, level shifter and fabrication of the PCB. On completion of fabrication, the motor is tested for open loop control and closed loop control using hysteresis. The device was to move using motorized wheels and would be able to turn using swivel caster wheels. The batteries were to be mounted on the device underneath the device next to the wheels and off the ground, or otherwise concealed from the audience. The device was to be controlled via either remote control by another person or via switches by the user. A hover board has two large wheels separated by a long board, is powered by battery and electricity, and allows riders to move across the ground without pedaling or pushing off with their feet. Self-balancing electric scooters, commonly known as hover boards, are a new and popular consumer item with recognized fall hazards

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INTRODUCTION

construct a device that would allow a person to move slowly without performing walking movements with their legs. It is a hover board with raw material available in market as well as reused. We took a 250w motor and the electronic parts so the motor would be able to perform correctly. The next stage was to make an axle using the lathe, where we put two tires. Then we placed the electronic parts the motor and the wheels on a metal frame and the hover board started getting shape. It is difficult to keep our balance without the use of gyroscope sensor when tried. So we have placed a small wheels in the corners and the balance was achieved. The device's width and length could not exceed shoulder length as it could not be concealed beneath the costume otherwise. Its height from the ground could not than a few inches for the same reason. It was important for the user to have good balance while standing on the device. The device was to move using motorized wheels and would be able to turn using swivel caster wheels. The batteries were to be mounted on the device underneath the device next to the wheels and off the ground, or otherwise concealed from the audience. The device was to be controlled via either remote control by another person or via switches by the user. The device must allow the user to move forward and turn in both directions all while balancing. It is not necessary for it to go backwards. It must also be considerably quiet, as the audience is only a few feet away from the performers and loud motor noise would give away the smooth and every movement.

LITERATURE REVIEW

The available methods for personal mobility were learned such as Kick scooter, Seg way, Hover boards, Stand on scooters, Unicycle. There are rules and regulation for them followed in other countries. Currently the biggest disadvantage of EMCs is their higher price. Higher price could be compensated by lower operational costs. The Socio technical transition proves that the people are changing towards electric personal transporters. Many factors like the Demographic data, Health status, Mobility habits, Attitudes about Mobility scooters, Life quality were studied. Nearly 88% people were found normal with the Mobility scooters. The feasibility of implementing it in the market were analysed. The project required survey and learning exposure to some related projects. The following projects were referred. Two-Wheeled Balancing Robot Controller Designed Using PID: In this paper, the use of PID Controller with IMU Sensor for an elevated wheeled-platform was justified. The paper deals with counteracting with effect of gravity on the platform. The PID Controller was deployed to sense the inclination of the platform against the ground level, and compute control variables for counteract the fall with providing sufficient counter-torque, so that the platform stays parallel with respect to ground. Speed Control of D.C. Motor Using Chopper: The use of chopper drive was observed in the paper. The performance of the four- quadrant chopper drive is observed, which concludes the effectiveness of the driver for closed loop operation. The operations motoring and braking anointed in the paper increases the likelihood of the deployment of the Four-Quadrant-Chopper drive for the overall drive purpose of the DC Motor. Design and Development of a Prototype Super-Capacitor Powered Electric Bicycle: The use of PMDC motor for traction purpose, instead of the traditional BLDC motor is justified in this paper. The paper deals of equipping a bicycle with a PMDC Motor and Super -Capacitors for long-distance commute. The motor driver exhibits regenerative braking, which is a significant feature of our project. Self-Balancing Scooter: This final year project is important from the standpoint of our project. The project gives a clear picture of the physics, coding and electronics required to make a self-balancing Macro-entity. The project deals with the use of higher traction DC motors, critical operation of the motor driver and its safety, and complexity of the coding to implement self-balancing operation.

DESCRIPTION OF THE FINAL DESIGN

This section describes each component's geometry and material selection. The design consists of a platform for the user to stand on with two switches near the toes to control movement. Attached to the underside of the platform are the batteries, motors, wheels, and all necessary wiring. The selected parts are detailed in Table 1 below. Further explanations and reasoning is explained in the subsequent sections.

Table 1. Part Selection

Component	Selection
Platform	23/32”x15”x12” cast iron
Motors	437 RPM HD Precision Planetary Gear Motor
Motorized Wheels	4” Diameter Heavy Duty Wheel
Casters	3” Diameter Swivel Plate Caster
Batteries	3700 mAh 12V NiMH Battery Pack
Switches	Single-Pole Momentary Contact Push-Button Switch

The device components are broken down and detailed in three categories: platform,structural, and electrical.

Platform Details:

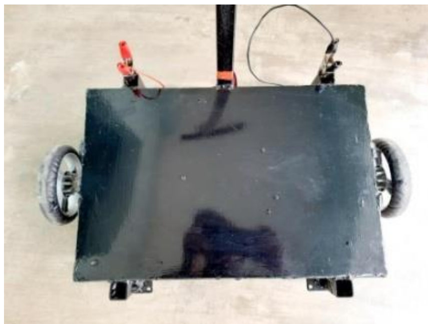


Figure 1 15”x12” platform

Figure 2 Aluminum channel

Seeing as the device would use four wheels in total, it made sense for the platform to be rectangular. The chosen dimensions were 15”x12”. The 15” width allowed for comfortable feet placement on the platform, with the user placing their heels together and pointing their feet slightly outward. The 12” length allowed for more room on the underside of the platform for electrical and other structural components. As for the material, simple plywood was selected due to its high strength and resistance to cracking and bending. Its light weight was also a positive factor as it helped exert a lower load on the wheels. A 23/32” height was selected.

STRUCTURAL DESIGN

The total height of the device had to be considered. It should be kept as low as possible due to costume concerns. Increasing the height would make it more difficult to conceal the device using the angelic cloth costume. 4” diameter motorized wheels. 3" diameter swivel casters were selected. The casters were directly attached to the underside of the platform by screwing the attached metal plate to the plywood.

Figure 3: 4" Diameter Motorized Wheel

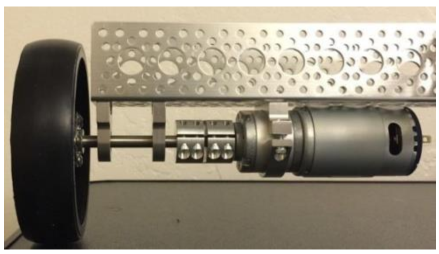
Figure 4: 3" Diameter Swivel Caster

CONTROL

The most straightforward and simple solution to control the device was via toggle switches. Controlling two separate circuits would involve two SPST switches, one for each circuit. Turning would involve turning one switch on while leaving the other off. The other option is having an assistant control the device remotely. Switches controlled by the user would give them complete control of the device. The benefit of this is that it gives the performer a degree of freedom and correction in case they unintentionally move to a wrong location on the stage. The downside is that it gives the performer an additional thing to think about on top of their scripted gestures and locations based on lighting and timing of the music. This further complicates things for the user and divides their attention further, likely resulting in suboptimal theatrical performance. A remote-controlled device would allow the performer to further focus their attention on the hand gestures. However, it would cause complications with balancing by the user. Giving control of the device to a different person means the performer may move unexpectedly, without having their feet set and body weight balanced appropriately for the transmitted movement. Another issue is that the assistant controlling the device would need a good view of the stage. It is important that the stage managers for the production are out of the audience's sight. Additionally, seeing the assistant remote controlling the device with a controller would "ruin the magic" of the angel's eery movement and detract from the show.

CONSTRUCTION

Once the plywood was acquired, the 15"x12" platform was created using a table saw. The edges were sanded in order to prevent wood splinters, as the device was to be picked up from its sides and moved during blackout scenes in the production. In order to find the best placement of the switches, I stood on the platform with my feet slightly pointed outwards. I marked the location of my big toes on the platform. A rotary tool was used to drill a half inch hole through the wood on the marked locations. The switches were then fitted through the holes, with the button poking out of the surface and the terminals on the underside of the platform. The switches were then attached to the platform with super glue. The channel was attached by connecting it with three 90 degree brackets which were screwed onto the underside of the platform on the opposite edge of the casters. The casters were attached to the device by screwing the attached metal plate onto the underside of the platform, half an inch from the edges.



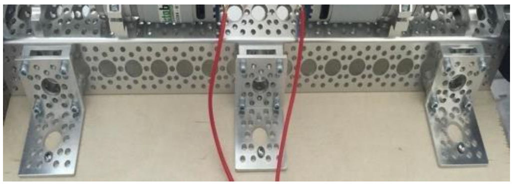


Figure 5: Channel Attachment with 90° Brackets

The motors were attached to the channel with clamping mounts, which were then screwed into the channel. The motor's shaft was connected to a 1/4" shaft with a coupler. The 1/4" shaft was attached to the channel with two pillow block bearings. The shaft was finally connected to the heavy duty wheel with a clamping hub The batteries were attached to the underside of the platform with duct tape. Wire was soldered onto the terminals of the motors and switches, and bullet connectors were used to connect it to the batteries. The wire was then taped onto the platform in order to prevent it from dragging along the floor and potentially getting stuck under a wheel.

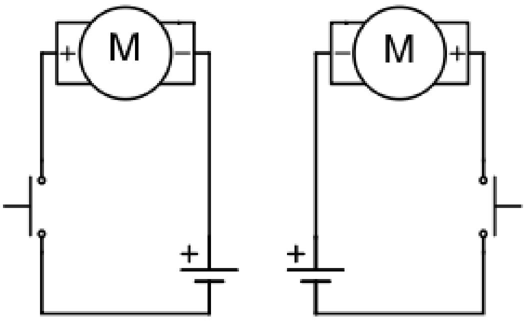


Figure 6: Circuit Schematic

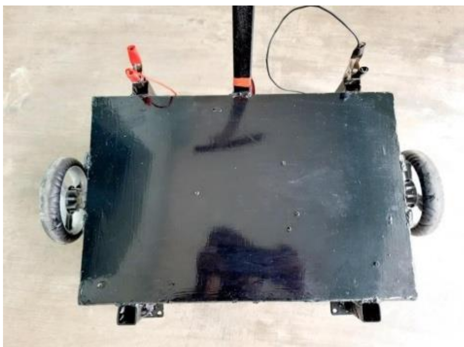


Figure 7: Top View

SCOPE FOR FUTURE MANUFACTURING

Noise Reduction:

The device was designed to be hidden from sight by covering it with the loose fabric of the angel's costume. This provided a small amount of noise reduction to the motors while the device is moving. In order to further suppress the sound of the operating motors, I recommend adding other means of sound insulation to the device.

Wheel Protection:

During testing, the wheels collected any dust and small materials on the ground. This prevented the device from working to its full potential. The casters were more reluctant to swivel due to debris and random dust they collected. I suggest adding some way to easily brush off these inconveniences when not in use, or some way to prevent the dirt from becoming attached to the wheels.

Backwards Movement:

It was not necessary for the purposes of the production for the device to move backwards. However, in the case that is desired, one could design more elaborate circuitry to make it happen. Using the remote-control idea would alleviate some pressure on the performer by giving them less things to think about while performing. Self-balancing scooterate system like Hover board is the simplest mathematical model for the study. The Validation of above mathematical model can be made possible using simulation software like Simulink block model. And therefore the parameters related to systems, subsystem (example: stability, poles etc.) can easily be identify for making the model usable for design of suitable and proper controller. The system can be made more realistic if one can go for study related to Model extensions, which will more exhaustive and interesting. The evaluated model can also be analyzed from the above mathematical model parameters, where Driver will have few degree of freedom w.r.t. the angle of the base using above references. Using model's parameters regarding the Driver and its nature of driving –A Block model can be prepared using physiological parameter. The mathematical model presented as a system model is used for the "self-balancing Robotized System" problems that consist of a rigid body erected on two wheels.

TESTING PROCEDURE

The device performed worse than expected. With a little practice, I was able to move smoothly for a short who to perform poorly after that period. The right motor would frequently stall, which left me immobile for the remainder of the scene. I was able to turn right by just using the left motor, which was not enough to move me to the necessary location. I noticed that the right motor would heat up quickly compared to the left motor. The device would work again after a period of inactivity to let it cool down, before once again stalling after continued use. It was difficult for me to concentrate on both the movement of the device.

CONCLUSION

The project began with exploring ideas for the design inspired by similar devices in the market. Ultimately, a rectangular platform with two motor-powered wheels and two casters was chosen. Parts were purchased and connected, and the device was built and tested. During testing, it was found that the device did not perform as well as expected. A motor would frequently stall and cause me to become immobile or move in a jittery fashion, which was not desired. The project was eventually chosen to not be included in the show, and I would go on to successfully perform in the show without the need of a device.

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