Regenerative Braking Electric Skateboard

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Abstract

The main goal of this project is to create two rechargeable electric skateboards with regenerative braking capabilities. We plan to address two common problems that other electric skateboards have when it comes to regenerative braking. The first and biggest problem is that the braking does not usually work if the system is already fully charged. The second is that it is not uncommon for the regenerative brakes to produce too much current when going down a steep hill for example, which would shut off the system.

Beyond that, we aim to "go the extra mile" by developing an manual/automatic remote truck adjustment system, which would enable the loosening or tightening of the trucks while riding based on the speed of the board or the preference of the rider.

We plan on first building the system with a wired controller, and if time permits, we plan to add a wireless controller after everything else is working. The skateboard will be controlled by an Arduino Uno R3, and the dual brushless electric motors will be controlled by a variable speed controller. We will be developing two prototype boards at the same time in order to maximize our chances of success. Our development plan is to firstly complete each board so that it is functioning with the bare minimum functionalities, each with a simple wired controller with no braking capabilities. Once we have this completed for each board, we will then start to add more functionally and address the problems previously mentioned. By dividing our development plan up into steps, we will be able to test each step and troubleshoot individual parts before moving on to the next step.

Problem

Most electric skateboards suffer from two common problems when it comes to regenerative braking capabilities. The first and largest problem is that there usually is not a system in place that allows for braking once the batteries of the electric skateboard are fully charged. This can be a problem especially down large hills which would quickly recharge the battery and then not allow the user to brake at all. The second problem is that it is not uncommon for the regenerative braking system to output too much current, when going down a large hill for example, that the system would overload and shut off. Once again, this would shut off the capabilities to use the brakes.

Our system would address these two issues. The first problem will be addressed by adding a system that would allow excess current to flow away from the battery when it is fully charged, and would dissipate in the form of heat energy. We plan to accomplish this with a series of large resistors. The second problem will have to be solved using the combination of our resistor array and some programing of the arduino control unit. If the system senses that there is too much current, then the excess current will be directed towards the resistor array once again. The combination of these two solutions will make the prototype boards much safer for use, especially in hilly areas where braking is frequently required. These problems mostly go ignored when it comes to electric skateboards. Most people argue that normal skateboards do not have brakes to begin with. In our opinion however, once you are used to using the braking system on a skateboard, you would want it to be completely reliable in all situations, especially when you are traveling at high speeds down a hill.

The other aim of this project (automatic truck adjustment) comes from a well known problem in longboarding. The trucks are what connect the wheels to the board, and can be loosened or tightened manually in order to change the turning radius of the board. Normally, loose trucks are good for low speeds, as they are highly maneuverable and easy to control. However, at high speeds, loose trucks can be dangerously unstable, often resulting in "speed wobbles." Tight trucks, on the other hand, are much more stable at high speeds, but are not good for tight maneuvers at low speeds. Since our electric longboard will be designed for use at all the speeds a rider might typically see on a commute, we seek to add automatic adjustment to the trucks for safety and functionality.

Current Art

In the past, there have been multiple patents for various electric skateboard designs, most of which do not include regenerative braking. U.S. Pat. No. 6724165 covers regenerative braking but does not target issues regarding power cut-off and failure to operate correctly when fully charged. CN Pat. No. 103230671A discusses the ability to control the motor using a wireless remote controller. In our design, we will be developing a smartphone controlled electric skateboard by coding an Arduino Uno R3. U.S. Pat. No. 5893425A is another design of a remote controller which powers only one wheel of the skateboard. In our design, both motors will be controllable and engage at separate timings during the acceleration to ensure a fast but smooth acceleration.

As far as self adjusting trucks go, our research seemed to suggest that no one has yet attempted such a design application.

Description of Invention

For a large portion of our invention, our design will follow that of conventional electric skateboards. The skateboard will consist of a central processing unit, which will be an Arduino Uno R3 for our boards. It will be connected to the controller, the resistor array, and then a separate Electric Speed Controller. We will be using a bluetooth module (HC-05) to connect the Arduino Uno R3 to a handheld controller. This speed controller will connect both to the dual BLDC motors which connect to the rear wheels, as well as to the battery pack array. The main difference with our board will be the resistor array that will allow for braking when the batteries are completely charged. Special machined parts will need to be designed and produced to house and secure the motor shafts to the boards.

Prototype Development Budget and Scope

We would begin our budget and scope by establishing a baseline of two prototype electric skateboards. Building two prototypes reduces the risk of our design failing last minute, and giving us a higher probability of success. The first board will be a more basic longboard design. We will focus on this one first in order to get a working prototype. The second board will be a miniature board which will be much more compact, providing a much larger challenge for our mechanical engineering members. This means that we will need to double our parts and costs however, with the second board consuming more of our budget. Some parts we will have extra of, in order to replace any parts that fail or that we break. A table of estimated costs is included below.

Unit 1: Basic	**Cost**
Full Board Cost:	$280.00
Battery Pack	$400.00
Motors	$500.00
VESC ^ MkV-12s	$350.00
Unit 2: Miniature	
Deck	$250.00
Wheels	$200.00
Battery Pack	$400.00
Motors	$500.00
VESC ^ MkV-12s	$350.00
Other:	
Controller (x2)	$100.00
Arduinos (x3)	$90.00
Miscellaneous	$600.00
Machined Components	$1,200.00
Total Cost:	$5,220.00

Prices include any shipping and handling on any parts that need to be ordered online, which is most of them. We have also included an estimated cost for any machined parts in the budget. This budget is also for two skateboards, one basic longboard and one miniature board. We will also be receiving fundings from the ECE department of $200 per person. This brings our final cost to between $5,220, with $800 in funding already provided for, bringing us down to $4,420 in additional costs.

Two mechanical engineering students have been recruited to the team. Any fabrication of parts would be handled by the two mechanical engineering students participating in the project. The mechanical engineering students participating in the project will help design motor mounts to secure the motor safely. Moreover, this team of mechanical engineers has to research and implement the most efficient way to transfer the power from the motor to the wheels. Lastly, the mechanical team will be in charge of designing and implementing the automatically adjusted trucks for the boards, while the electrical team will be responsible for controlling and powering the system.

With the additional funding of $800 from the department, this brings our required budget down to $4,420 after the department funding. With this budget, we will have much more freedom when it comes to the

mechanical engineering side of the project. Specific components have a small varying cost, depending on the vendor and shipping costs. The bigger variable cost is the cost of manufacturing machined parts ourselves. A higher budget for machined parts allows our mechanical engineers a greater degree of freedom, especially when it comes to the compacted design of the miniature board. The first board will be a test of all electrical components, as well as simple mounting of the hardware. The miniature board will be much more complicated when it comes to mounts, power transfer, and overall design. Given this budget, we believe that we will be better able to create a market competitive product, especially with the miniature design given the addition of the automatic adjusting trucks, and the improvements to the regenerative braking capabilities.

Appendices

Relevant Patents

U.S. Pat. No. 6,724,165 - Regenerative braking system for an electric vehicle
https://patentimages.storage.googleapis.com/f0/08/21/2bd6d4189a9612/US6724165.pdf

CN Pat. No. 103230671A
https://patentimages.storage.googleapis.com/fe/39/b5/c19650ca3cc9ec/CN103230671A.pdf

RU Pat. No. 2690563C - Board for rolling with biaxial suspension, suspension and method of their obtaining and providing
https://patents.google.com/patent/RU2690563C2/en?q=skateboard+suspension&oq=skateboard+suspension

U.S. Pat. No. 5893425A - Remote control electric powered skateboard
https://patentimages.storage.googleapis.com/73/75/18/bfa6bc093f5657/US5893425.pdf