Motorized Longboard

Project Proposal

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1.0 Introduction

1.1 Project Vision

Longboarding has been around for over 60 years, but has gained traction amongst younger communities in the last decade. In the last couple of years, there has been an assortment of upstart projects attempting to create a commercially viable motorized longboard. Basic propulsion and even regenerative braking have been achieved, and we look to build on those successes. We look to add assisted turning, the ability to reverse, and a kill switch as new functions.

Some of our group members currently use longboards as their mode of transportation around campus. Like bicycles, it is a cheap, efficient, and environmentally friendly way to travel. We were excited to consider different ways to make longboarding even better. All the functions that we are looking to add are functions that most longboarders have at some point desired. Our ultimate goal is to provide a product that is not only fun to use, but also commercially viable.

1.2 Objectives

1.2.1 Goals

- Develop a kill switch that will deploy in case of emergency
- Enable ability to reverse
- Add regenerative breaking to conserve energy
- Include assisted turning for safer turns

1.2.2 Functions

- Flex sensor to determine whether to enact kill switch and regenerative breaking
- Reversible motor to enable reverse propulsion
- Pulse width modulator to enable assisted turning

1.2.3 Benefits

- Create an environmentally friendly mode of transportation
- Provide a longboard with beginner-friendly functions
- Offer quick transportation in certain locales (few hills)
- Grant speed without physical exertion

1.2.4 Features

- Longboard able to attain speeds up to 20mph
- Longboard able to reverse at up to 7-8mph
- Pulse width modulator that grants assisted turning

2.0 Design

2.1 Top Level Block Diagram

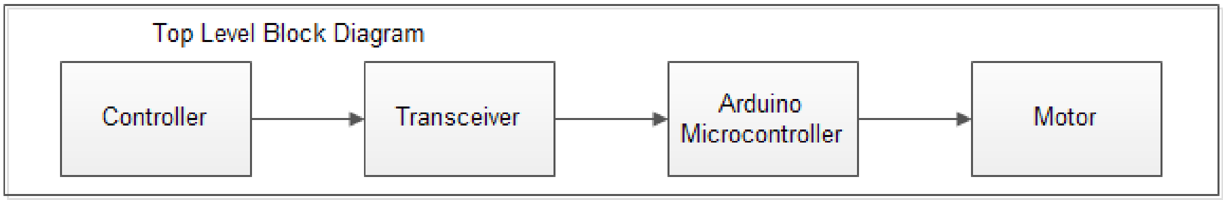
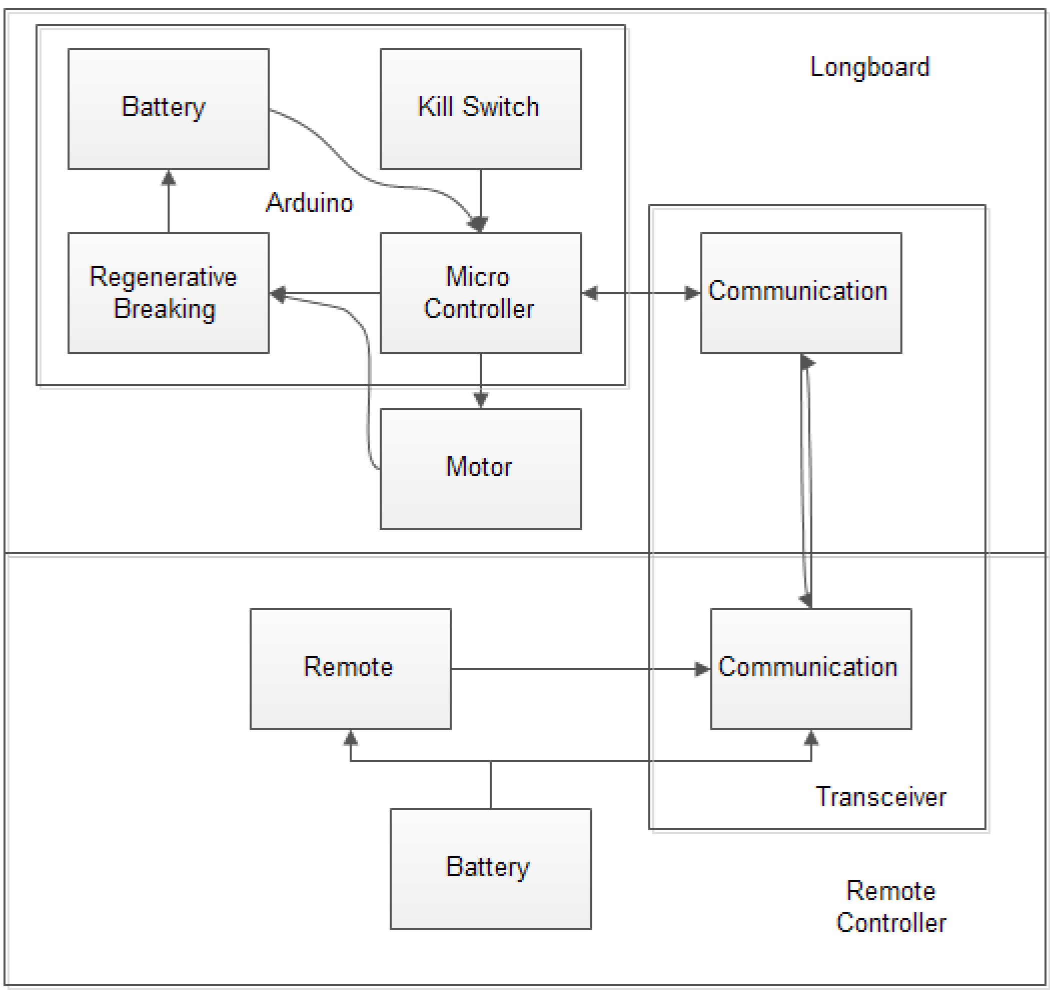


Figure 2.1

2.2 Block Diagram (Specific)



3.0 Requirements and Verification

3.1 Requirements (Top Level)

3.1.1 Remote

The remote is the only user input for the motorized longboard. Three potential inputs exist on the remote: access to acceleration, deceleration, and regenerative breaking. Acceleration and deceleration will be achieved through manipulation of a joystick, with the magnitude of acceleration determined by how far the joystick is pushed. Regenerative breaking will be activated by pressing and holding a button. All input received by the remote will be transmitted wirelessly to the transceiver block.

3.1.2 Transceiver

The transceiver is the waypoint between the remote and Arduino micro-controller. While it does not perform any data manipulation or analysis, it is a vitally distinct section.

3.1.3 Arduino Micro-Controller

The micro-controller is where all the data analysis is performed. For acceleration and deceleration, it decodes the signal and passes the information via pulse width modulator to the motor. When the regenerative breaking button is held down, the micro-controller will decode the signal and activate the regenerative breaking. The last function the micro-controller manages is the kill switch. When the implanted flex sensor senses that the longboard is no longer bent (indicative of a person's weight on the board), the micro-controller will activate the regenerative breaking.

3.1.4 Motor

The motor receives the acceleration and deceleration signals from the Arduino micro-controller. Based on the pulse width modulator signal, the motor outputs the appropriate revolutions per minute. Furthermore, when regenerative breaking is enacted, the motor turns into a generator that will recharge the battery.

3.2 Requirements (Specifics)

3.2.1 Remote

The physical remote will consist of a joystick to control forward and reverse acceleration. There will also be a button that can be held to enact regenerative breaking. The remote is battery powered (separate from longboard battery) and interacts with the wireless transceiver.

3.2.2 Communications (Transceiver)

The transceiver looks to provide instantaneous communication between remote and micro-controller.

3.2.3 Micro-Controller

The micro-controller performs all signal processing from the remote and data analysis from the flex sensor. The micro-controller is directly connected to the kill switch, which is a flex sensor. The micro-controller passes the information of whether the regenerative breaking button is pushed to the regenerative breaking block. Code is then run which sends information on how to transform the motor into a generator. Additionally, when sensors detect that the board is tilted, the micro-controller will use the pulse width modulator to decrease the rate of the motor. The micro-controller is powered by a lithium-ion battery.

3.2.4 Kill Switch

The kill switch consists of a flex sensor that is hard wired into the micro-controller. Because of the flexibility of longboards, the board tends to sink slightly at the center when there is a rider. The flex sensor takes advantage of this information, detecting when the board is no longer flexed (suggesting no rider). When there is no rider, the kill switch sends a signal to the micro-controller, enacting the regenerative breaking. We will institute a reasonable time delay to allow for extenuating circumstances (i.e. the rider jumps).

3.2.5 Regenerative Breaking

This block is a length of code that detects whether the button has been pushed or if the kill switch has been enabled. If so, it will send a signal to the micro-controller changing the motor into a generator.

3.2.6 Battery

The motorized longboard will utilize a lithium battery, with a projected life of 8 miles.

3.2.7 Motor

The motor inputs a signal from the micro-controller. For acceleration/deceleration, the motor will simply run at the required revolutions per minute. When regenerative breaking is activated, the motor will instead act as a generator.

3.3 Verification

3.3.1 Remote

The remote will be tested to verify that it sends the proper signals depending on whether the joystick or regenerative breaking is pressed. The forward/reverse speed and acceleration will be tested to verify that it is proportional to the tilt of the joystick.

3.3.2 Communications (Transceiver)

The transceivers will be tested to ensure that there is proper transmission and reception between the wireless remote and the longboard transceivers.

3.3.3 Micro-Controller

The controller operation will be verified with a voltmeter, making sure that the inputs send the proper outputs to the motor. The code for the kill switch will be tested to make sure that the controller doesn’t stop the motor before the time delay on the switch.

3.3.4 Kill Switch

The kill switch will be mounted along the length of the board. It must be able to detect riders with a body weight over 90 lbs.

3.3.5 Regenerative Breaking

The code for regenerative breaking will be tested to make sure that the motor is running as a generator when the input is high. Experimenting will be done to compare the battery life with and without regenerative breaking.

3.3.6 Battery

The battery life will be tested to make sure that it will run for a distance of 8 miles.

3.3.7 Motor

The motor will be tested to make sure that it will run at the required revolutions per minute and runs as a generator when regenerative breaking is active. The longboard will be tested by the group members to ensure that all components work synchronously and the project works.

3.4 Tolerance Analysis

To perform the requirements, the pulse width modulator must be transmitted properly from the wireless controller to the micro-controller. The magnitude that the joystick is tilted is proportional to the speed at which the motor will run. Tilting the joystick forward will run the motor forward, and vice-versa. The PWM will also be affected by the angle at which the longboard itself is tilted. In order for the assisted turning to be effective, PWM will be increasingly lowered to a soft cap of about 30% speed reduction the more the board is tilted from the neutral position. The PWM will be observed using an oscilloscope. The forward/reverse and assisted turning will be manually tested by the group members.

4.0 Cost and Schedule

4.1 Cost Analysis

4.1.1 Labor

Name	Hourly Rate	Overhead (2.5)	Hours	Total
Daniel Moon	$40	$100	110	$11000
Kevin Lee	$40	$100	110	$11000
Leon Ko	$40	$100	110	$11000
				$33000

4.1.2 Parts

Arduino Uno Revision 3	$30.00
Transceiver nRF2401A with Chip Antenna	$25.00
Loaded Vanguard (Longboard with desired specifications)	$290.00
2000 W, 450 V Motor	$140.00
Motor Controller, 60A	$60.00
Flex Sensor for Kill Switch	$13.00
Lithium Ion Battery, 25.6V, 9.9Ah, 253Wh	$300.00
Miscellaneous Costs (Wiring, batteries, etc)	$100.00
Total for Parts	**$958.00**

4.1.3 Grand Total

Labor: $33000.00
Parts: $958.00

Grand Total: $33958.00

4.2 Schedule

Week	Person	Task
2/4	Daniel	Complete proposal
	Kevin	
	Leon	

2/11	Daniel	Research power supply and review design
	Kevin	Finalize design
	Leon	Learn Eagle CAD software
2/18	Daniel	Order parts: motor, flex sensor, battery
	Kevin	Design and build wireless controller
	Leon	Code Arduino
2/25	Daniel	Mount components onto the board
	Kevin	Output of controller is detected by longboard transceiver
	Leon	Assemble PCB for micro-controller
3/4	Daniel	Begin preliminary testing of board, giving feedback to team members
	Kevin	Assist with preliminary testing of board
	Leon	Verify coding components of project are working as desired
3/11	Daniel	Continue preliminary testing of board
	Kevin	Continue assisting with preliminary testing of board
	Leon	Using feedback from riding experience, optimize code to smooth motor and PWM controls
3/18	Daniel	Debug
	Kevin	
	Leon	
3/25	Daniel	Debug
	Kevin	
	Leon	
4/1	Daniel	Complete Project
	Kevin	
	Leon	
4/8	Daniel	Prepare presentation
	Kevin	Prepare presentation
	Leon	Prepare final paper
4/15	Daniel	Prepare demo
	Kevin	Finish presentation
	Leon	Finish final paper
4/22	Daniel	Demo
	Kevin	Check in supplies
	Leon	Complete final paper