Backpack E-Skate

Group F - Spring/Fall 2020
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Project Description

The Backpack E-Skate project is a foldable electric skateboard. It makes use of light sensors to automatically increase visibility in the dark and motion sensors to provide warnings in case of pedestrians and unexpected obstacles. The E-Skate is controlled with a remote with simple controls to make operation intuitive. In addition, it is made to fit standards set by other electric skateboards on the market, such as battery life and capable travel distance.

Objective

Technological advancements provide new ways of improving safety and entertainment in any type of vehicle. In recent years, skateboards and scooters have seen massive changes such as motorization, which eliminates human work, and bluetooth and LED integration for entertainment and aesthetics.

The Backpack E-Skate is a motorized vehicle, which provides ease of use and added portability through folding. Its sensors provide safety through mid-range trips, just like the LEDs, which also give you a cool, flashy look.

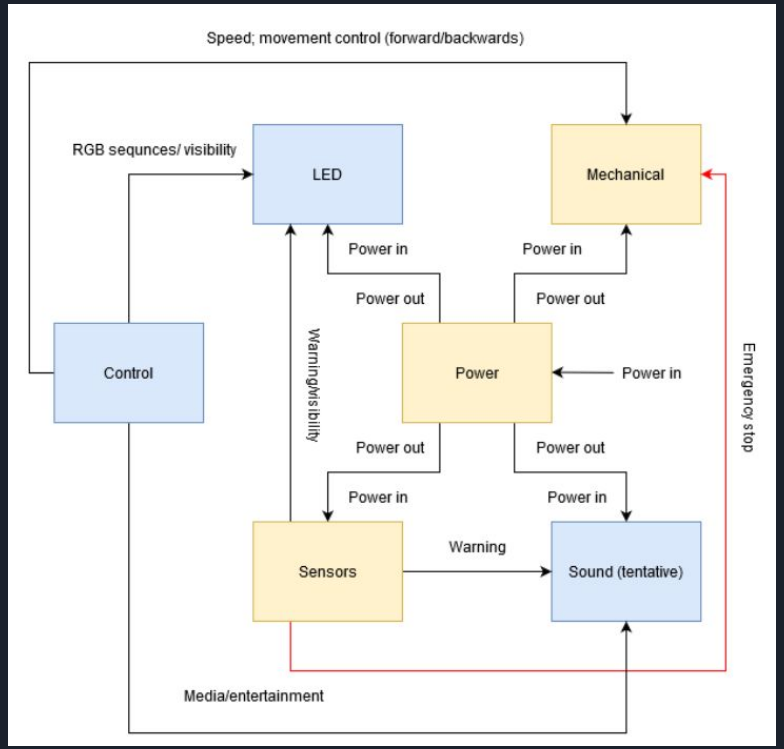
Goals

- Maximize performance and battery life
- Provide safety through sensors
- Enhance aesthetics through LEDs
- Provide aesthetic functions through mobile application
- Increase portability through folding

Design Specification and Requirements

Description	Value
Application will be written in java or C#; it must control movement, LEDs and bluetooth, display battery charge and travel distance available	n/a
Board must be able to fold in half and turn based on rider's lateral inclination	n/a
Motor performance must be optimal for any rider of a certain weight	200 lbs
Motor top speed	15 mph
Battery charge allows a certain minimum travel distance range	10 miles
Proximity sensor capture distance	15 ft
LED headlight provides visibility up to certain distance	25 ft
LED strips are RGB capable	n/a

Block Diagram



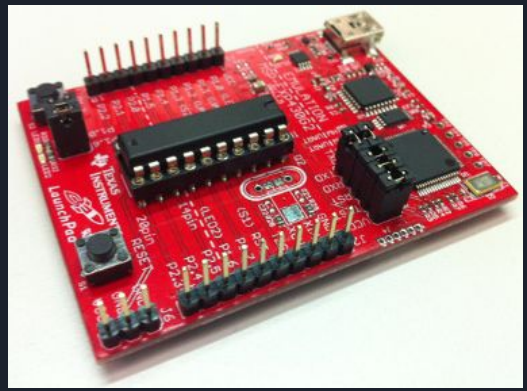
Implementation Choices

Hardware Choice: Microcontroller

MSP430G2553

- 20 Pins, 16KB Flash memory, 512B RAM
- Control System (Bluetooth, Read Sensors, Trigger LEDs)

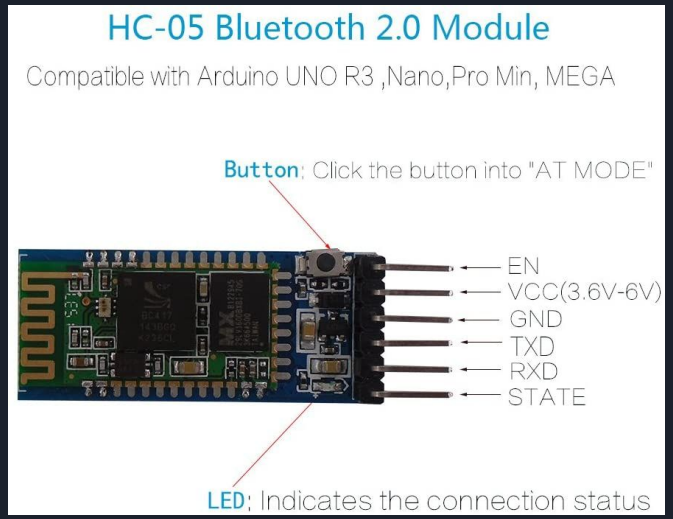
Developed in C (programming language) using Code Composer Studio and the MSP430 Launchpad Development board.



Hardware Choice: Bluetooth Module

HC-05 Bluetooth 2.0 Module

- Advertised compatibility with Arduino, but works with the MSP430 microcontrollers as well
- Slave/Master
- AT-Mode



Hardware Choice: Battery

25.2V 7S2P Lithium-ion Battery

- 29.4V at Full Charge
- Capacity of 4 Ah
- Area of 4.25in x 3.5in x 1.5in
- Weight of 1.76 lbs

Hardware Choice: Motors, Trucks, and Wheels

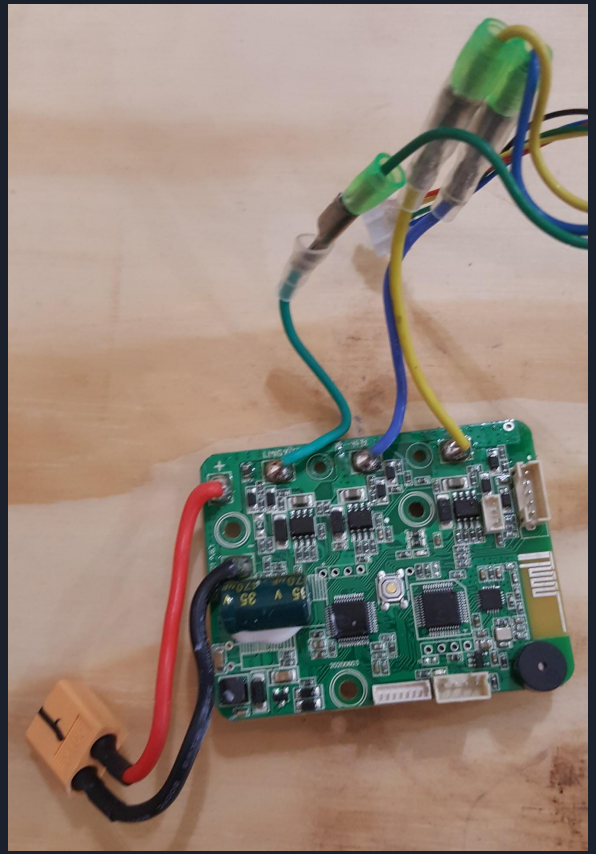
75mm 350W Brushless Hub Motor Kit

- Cheaper than buying motors, wheels, and trucks separately
- Top speed of ~16mph (Safe for amateurs)
- Space efficiency (compared to belt motors)
- Brushless Motors are more Energy Efficient
- Hub motors allow normal skateboard riding experience when powered off

Hardware Choice: Motor Driver

24v/36v Single Drive ESC (Electronic Speed Controller)

- Can handle 650W
- Rotates motor by charging electromagnets in phases
- Included power button, battery indicator, and remote



Hardware Choice: Board

- DIY with lumber
- Level deck to place components safely
- 10 inches wide, 40 inches long, and 1/2 inch thick
- Can be achieved by layering plywood to the desired thickness

Folding mechanism uses 2x 4-inch Steel Door Hinges

Hardware Choice: Sensors

Light: Photoresistor

- Cost-effective
- Small
- Can detect different levels of light

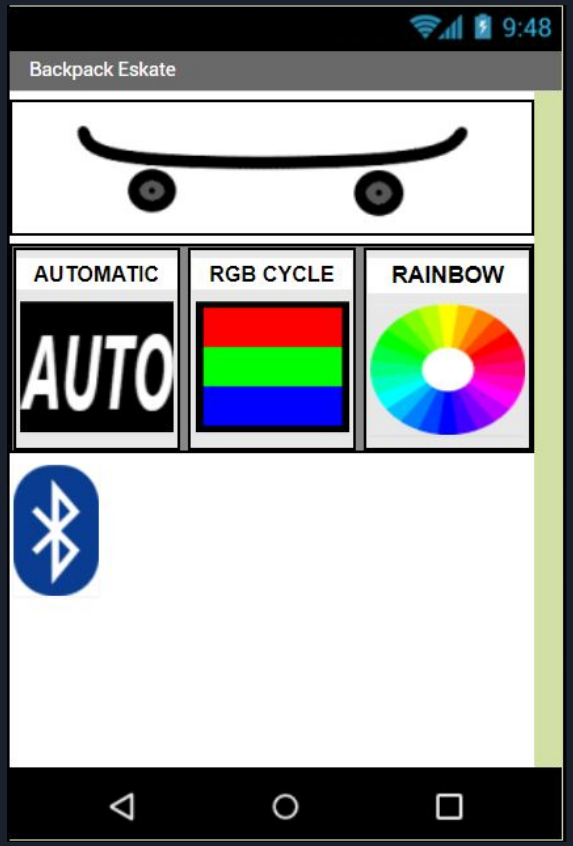
Motion: Wide Angle PIR Sensor

- Cost-effective
- Small
- 30 ft detection distance
- ~180° detection

Software Choice: Mobile Application

Android 5.0 (API level 21)

- Compatible with ~94.1% of Android users
- Java
- Cheaper than iOS development (Apple Development Program costs $99 per year)
- Compatible with Bluetooth 2.0



Android Application UI

Design Constraints

Economic: Due to budgeting, we had to compromise certain parts, e.g. battery choice. Also, less time was spent on app development to prioritize other functions of the skateboard,

Environmental, Social, and Political: Ensure security of mobile application to not be a gateway to security compromises of the user's phone

Ethical, Health, and Safety: Board is driven with remote, app is only for aesthetics, sensors to provide safety, top speed limited for safety

Manufacturability and Sustainability: Our budget vs MSRP of current electronic skateboards, lifespan of battery

Design Standards

Battery

- XT-60 connectors are standard for replacement if necessary
- AC/DC Charger uses standard connections

Bluetooth and Android standards

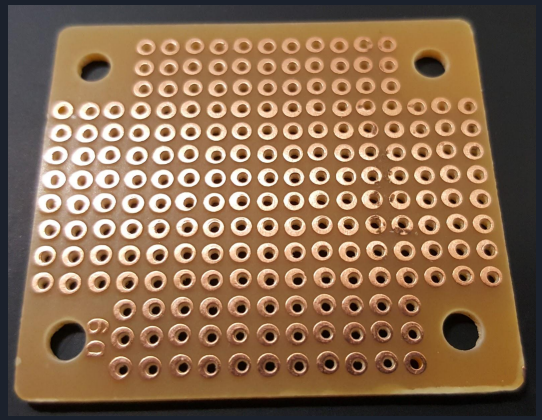
- All versions of Android support Bluetooth 2.0
- The chosen Android 5.0 (Lollipop) is a level 21 API compatible with 94.1% of devices

Successes

- Folding
- LED installations
- Battery test
- Motor test
- Sensor tests
- Application development

Difficulties

- Damaged first hub motor kit
  - Learned about brushless motors and need for ESC
- Unable to get custom PCB
  - Used Solderable Perf Boards instead



Budget

Components	Price
Battery and charger	$40
Microcontroller and sensors	$30
Wood for deck	$40
Single Hub Motor Drive Kit	$85
ESC	$50
LEDs	$20
Bluetooth Module	$10
Misc. PCB Components	$20
PCB Manufacturing	$25
TOTAL	$320

End.