EEL 4914 -- Initial Project Document
Senior Design I

Group #6

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The Smart Skateboard

INTRODUCTION:

Very rarely have the skateboarding world and the electrical engineering world ever met. Even in our fast-paced, open-minded society skateboarding is still somewhat thought of as an "underground" activity within most intellectual circles. This and tradition may be the reasons why skateboarding really hasn't much innovation, technologically speaking, in our great culture. We don't see very many scientists working on new skateboard materials, or doctors deriving formulas for sturdier joints for when skaters fall down a flight of stairs. We want to be the generation that brings the skateboarding industry a new light.

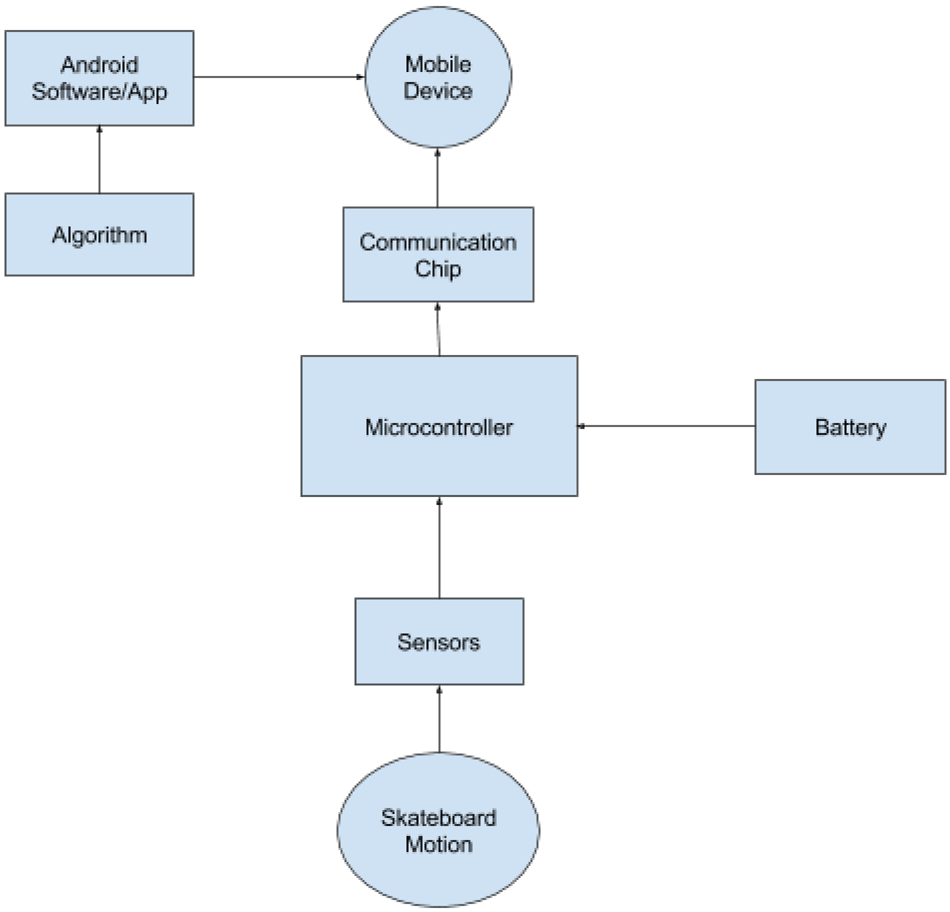
Our idea is to design a smart chip that anyone can attach to the bottom of their skateboard and, by linking it to a mobile app, it will keep track of the past tricks the user has landed. The application will also keep track of the user's speed, acceleration, as well as jump height. All this data should be readily available on a mobile phone application to skate with your friends.

Before this great idea (Original Intellectual Property: Syrmo), skaters had no way of logging their "gnarly" tricks unless there was a cameraman nearby. Our focus was to change this nuisance. By implementing a mobile app, where skaters can save every ridiculously dangerous trick they have ever landed, we can progress this very traditional culture towards the 21st century. No longer will skaters have to break bones to prove to their friends that they indeed did land the triple kickflip, now they can just pull it up on their phones.

Obviously, this idea has a lot of different complications and implementations, yet nothing will quite be able to stop a "skater" from just grabbing the board with his hands and showing off a trick he didn't really land on the fancy new app he just downloaded. Nonetheless, the application will be a great tool for honest skateboarders.

Since we are on a quite strict time restraint with this project, we can't really take this device as far as we would like. We have decided to implement only "flat-ground tricks" meaning that there will be no ramps or railings to worry about, and we can just focus on the considerably simpler flat ground. Also due to time constraints, we will not be able to log every single trick ever landed. Although we would like to do this and it will be attempted, a reasonable goal for this project will be storing the last 5-10 minutes worth of tricks. The ultimate goal for this project is to design a device that can be attached to the bottom of a skateboard, link with a mobile application, and tell the user what tricks he landed in his previous skating session. If we can accomplish all of this within the timeframe provided, we would also like to work on a possible way to link multiple devices to play a good old fashioned game of H.O.R.S.E. (or S.K.A.T.E. in the skateboarding world). However this addition would just be the "cherry on top" so-to-speak.

BLOCK DIAGRAM:



REQUIREMENTS:

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- PCB (EagleCAD design, ExpressPCB, or PCB123)
    - One of the major requirements for this senior design project is to implement a PCB. We have yet to decide exactly which software we will be using to design our PCB in order to optimize performance.
- Sensors
    - We know that the PCB attachment on the skateboard will have to have certain sensors installed on the chip in order to transmit data in real time to the user.
- Power Supply
    - The PCB will need to have some source of power attached to it as well.
- Wireless Communication
    - We will implement a wireless communication sequence between the designed device and the mobile phone used in the demonstration.
- Mobile Application
    - The mobile phone we use to implement this project will be running on either Java or Swift language. We will choose one of these two to create a simple application to show that the design works just fine.
- Embedded Code (Preferably Arduino)
    - We prefer to use an Arduino due to the fact that our group members have the most experience and know-how with it. However, we understand that compromises might have to made in order to make our project function, so the embedded code and the type of board we use has not been finalized yet.
- Processor (Most Likely Arduino)
    - Once again, our team feels the most comfortable using the Arduino, but we are prepared to make changes to our plans to see the design work properly.

SPECS:

- Battery should be “safe” (Withstand impacts)
    - Battery type needs to meet this requirement
- Battery Powered -- 5 Volt Supply
- Under 32 oz total weight
- 2-Layer PCB Design (Eagle CAD -- user design)
- Bluetooth or possibly Wifi for wireless communication
- Device Holster (plate mount underneath skateboard)
    - Or adhesive to hold device
- Device (PCB) Dimensions: 2.5 X 2.5 in. Max
- Holster Dimensions (if using holster method): 3 x 3 Max.

- List View of Tricks Performed during the session
  - Toggle session using mobile app.
- Use mobile device's memory for trick storage
- Gyroscope to measure 3-axis rotation of the board
- Accelerometer to measure speed, distance, acceleration
  - Typical current consumption = 2.5 mA
- Barometer (or other sensor) to detect altitude of each jump
- Mobile app will distinguish between basic tricks performed on flat ground and display the results to the user.

WHEN EVENTS OCCUR:

- Sensors track skateboard orientation
  - If power is on
- Transmit sensor readings to mobile device
  - If START SESSION is toggled ON from the mobile device
- Classify trick performed and display result on mobile device
  - If sensor readings correspond to maneuver known to algorithm

POSSIBLE CHALLENGES:

- Designing the most optimal PCB
- Integrating all sensors with the communication protocols
  - I2C data
  - These chips have tons of registers, which basically provide interface code for functionality and precision
- Power optimization
  - Minimize the power being drawn from device
- Designing device holster
  - Weight restraint
  - Durable/robust
- Developing the embedded code

Number	Task	Start	End	Duration (weeks)	Responsible
Senior Design I					
1	**Introduction and Project Selection**	05/20/2016	05/27/2016	1	Everyone
2	**Initial Document (10 pages)**	05/27/2016	06/03/2016	1	Everyone
3	**Table Of Contents Due**	05/27/2016	07/01/2016	4	Everyone
4	**Current draft due (Document)**	05/27/2016	07/08/2016	5	Everyone
5	**Final Document Due**	05/27/2016	08/02/2016		Everyone
6	**Meeting With Instructor**	06/07/2016	06/07/2016		Everyone
	Research parts & software				
7	Accelerometer	06/03/2016	06/17/2016	2	Taymas
8	Gyroscope	06/03/2016	06/17/2016	2	Nick
9	Barometer/Altimeter	06/03/2016	06/17/2016	2	John
10	Bluetooth/Wi-Fi	06/03/2016	06/17/2016	2	Brandon
11	Power/ Battery	06/03/2016	06/17/2016	2	Brandon
12	Software/code	06/03/2016	06/17/2016	2	Taymas
13	PCB parts	06/03/2016	06/17/2016	2	John
14	Microcontroller	06/03/2016	06/17/2016	2	Everyone
15	Case	06/03/2016	06/17/2016	2	Nick
	Design PCB & Software				
16	Accelerometer	06/17/2016	07/22/2016	5	Taymas
17	Gyroscope	06/17/2016	07/22/2016	5	Nick

18	Barometer/Altimeter	06/17/2016	07/22/2016	5	John
19	Bluetooth/Wi-Fi	06/17/2016	07/22/2016	5	Brandon
20	Power/ Battery	06/17/2016	07/22/2016	5	Brandon
21	Software/code	06/17/2016	07/22/2016	5	Taymas
22	PCB parts	06/17/2016	07/22/2016	5	John
23	Microcontroller	06/17/2016	07/22/2016	5	Everyone
24	Case	06/17/2016	07/22/2016	5	Nick
Senior Design II					
25	**Order parts**	07/22/2016	08/22/2016	4	Everyone
26	**Build prototype**	08/22/2016	10/13/2016	7	Everyone
27	**Test Prototype**	10/13/2016	10/27/2016	8	Everyone
28	**Enhance prototype**	10/27/2016	11/10/2016	2	Everyone
29	**Peer Presentation**	TBA	TBA		Everyone
30	**Final Report**	TBA	TBA		Everyone
31	**Final Presentation**	TBA	TBA		Everyone

BUDGET	
Component	**Price**
Processor/Microcontroller	$25.00
Accelerometer	$10.00
Gyroscope	$9.95
Barometer	$8.50
Battery	$12.95
Wireless Communication	$22.00
PCB Manufacturing	$30.00
Harness	$25.00
Miscellaneous	$35.00
Total Cost	$178.40

TRADEOFF MATRIX:

- The following shows the correlation between each of the engineering specifics (top) and the marketing specifics (left) of our senior design project.

- Here are the **seven engineering specifics** we implemented into the matrix:

  1.) **Stress Endured**: we want to be able to maximize the amount of stress and force that the device can handle.
  2.) **Power Out**: our device does not look to deliver any power to anything except for the PCB and its sensors. Therefore, we want to be able to minimize the amount of power being drawn by the device itself.
  3.) **Efficiency**: this one seems a bit obvious. We want to maximize the overall efficiency of the device and the application.
  4.) **Install Time**: the user should be able to install the device in the least amount of time possible.
  5.) **Dimensions**: the device should be as small as possible.

6.) **Cost**: the overall cost of the device needs to be minimized.
7.) **Wireless Communication**: the quality of the wireless communication technology need to be as high as possible.

- Here are the **seven marketing specifics** we implemented into the matrix:

1.) **Durability**: it is crucial to maximize the durability of this device.
2.) **Power Use**: this category, as mentioned earlier, needs to be minimized to allow optimal usage.
3.) **Install Ease**: the ease of instal with this device is also critical as far as marketing the device towards the user.
4.) **Cost**: the cost of the device needs to be as small as possible.
5.) **Latency**: latency is defined as the time or delay between the analog signal and the final outcome on the user's application. This category should be minimized to ensure the least amount of delay or "lag" for the user. Responsiveness is crucial.
6.) **Communication Range**: the effective range between the device and the mobile phone should be maximized. This is due to the fact that sometimes phones fall out of pockets, or a peer is holding the device while the user is skateboarding.
7.) **User Satisfaction**: this is the most crucial marketing specific. If the user is not maximally satisfied, the product fails in the market. Everything we create must fully satisfy users.

- The +/- besides each category indicates whether we are trying to maximize or minimize the respective category for optimal design.

- The upward green arrows within the matrix indicate that the two categories being represented have a direct positive correlation, meaning the optimization of one category immediately leads to the optimization of the other. (ex: A lower latency is directly connected to a greater quality in wireless communication technology)

- The downward red arrows within the matrix indicate that the two categories being represented are inversely related, meaning that optimization in one area would immediately lead to a decrease in quality in the other. (ex: The more durable we make the device, the larger the device will be and the greater the overall cost)

		Stress Endured	Power Out	Efficiency	Install Time	Dimensions	Cost	Wireless Comm.
		+	−	+	−	−	−	+
Durability	+	↑			↓	↓	↓	
Power Use	−		↑	↑	↓	↓	↓	↓
Install Ease	+	↓			↑	↑	↓	
Cost	−	↓	↓	↓	↓	↓	↑	↓
Latency	−		↓	↓			↓	↑
Comm. Range	+		↓	↓			↓	↑
User Satisfaction	+	↑	↑	↑	↑	↑	↑	↑