BRAKE: Bike Real-time Actions in Kinetic Environment

18-549 Project Proposal - Team 16

Team Name:

Hitchhikers

Team Members:

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Revision Date:

Feb 11th, 2015

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1. Prefatory Information

Team name	Hitchhikers
Team members	Ji Hye Lee Karen Zeng Jiaxin Yu Joanne Tse
Project title	BRAKE: Bike Real-time Actions in Kinetic Environment
Revision date	Feb 11th, 2015

2. Project Description

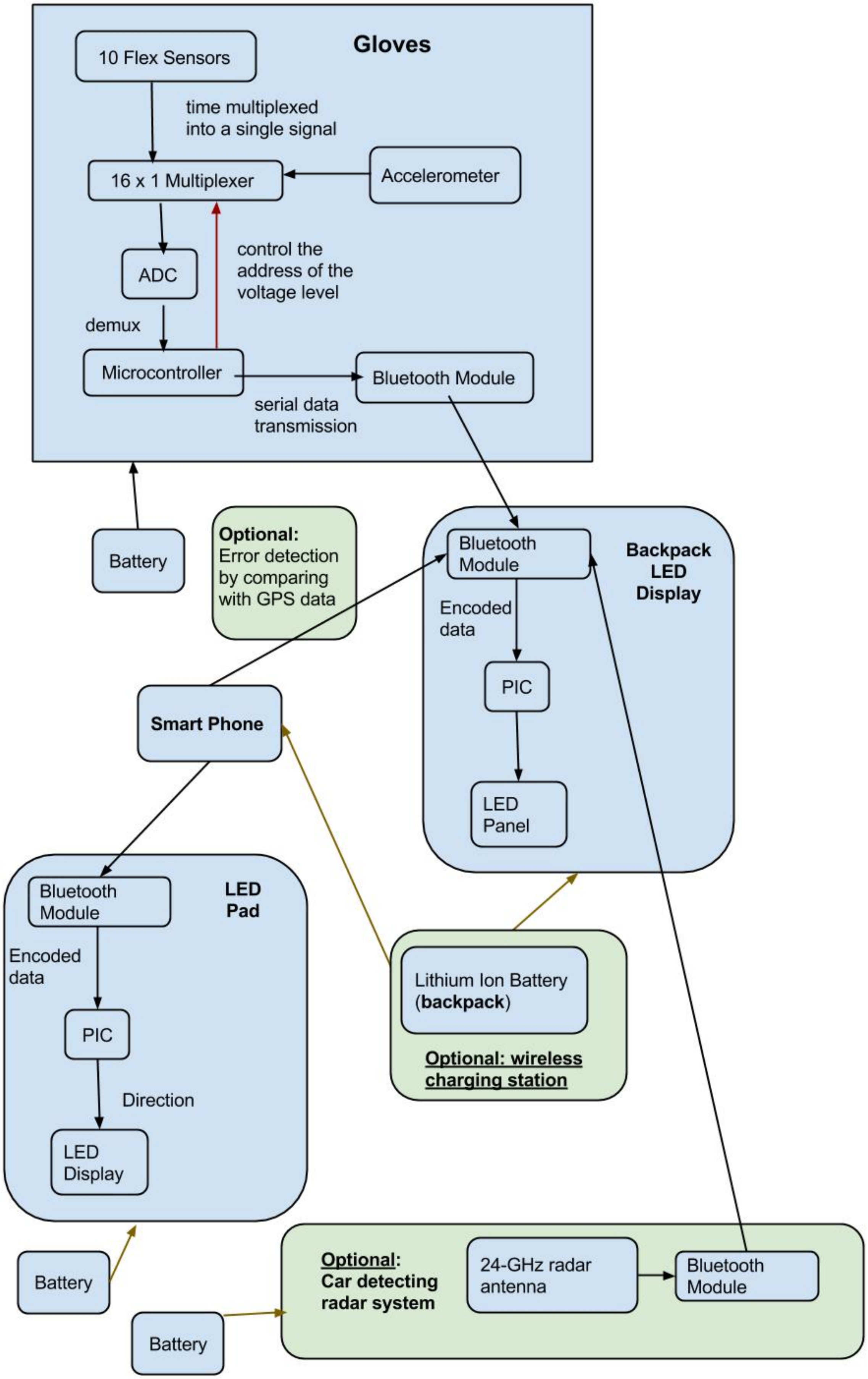
Our project aims to create a system that helps bikers travel on the road in a more convenient and safe manner. In our system, the biker wears gloves that recognize the gestures of the hand and a backpack with an LED display, and equips the bike with a small LED pad clipped onto the handlebars. All the components mentioned above communicate with each other and with an Android smartphone over a bluetooth connection. The hand gestures the biker makes will animate the backpack's LED display, signaling to others behind that the biker is about to turn left, right, or stop. The biker can input a destination into a mobile application, which will find directions from the biker's location and guide by displaying arrows on the LED pad during the ride. Our stretch goals include adding a radar sensing mechanism that detects and warns vehicles behind the biker that they are too close in proximity, and a inductive charging pocket for the phone to wirelessly charge inside the backpack.

3. Design Requirements

- **Gloves**
  - Determines biker's intentions from flex sensor and accelerometer readings
  - Communicates these intentions to the the backpack LED display through bluetooth for determining which signal to display on backpack
  - Includes a confirmation LED that lights up to let the biker know that a turn signal on the backpack has been lit up
- **Backpack LED display**
  - Communicates with gloves to determine which turn or stopping signal to light up next
  - Lights up left turn signal when biker taps left hand twice on the handlebar
  - Lights up right turn signal when biker taps left hand twice on the handlebar
  - Lights up stopping signal when accelerometer reading from the gloves indicates that the biker is coming to a stop
  - Signals turn off after a turn or increased biking speed is detected through the gloves
  - Communicates with radar mechanism through bluetooth to determine if it is necessary to light up warning signal if another vehicle is too close (optional)
- **LED pad**
  - Clips onto and can reliably stay on handlebars
  - Communicates with the Android smartphone through bluetooth to receive directions on which arrow to light up next to guide the biker to destination
- **Android Smartphone**
  - Includes a mobile application that allows the biker to input a destination for navigation purposes
  - Uses Google Directions API to determine how to guide the biker to specified destination

- Communicates with the LED pad through bluetooth to light up an arrow corresponding to the direction the biker needs to take next
    - Route recalculations on the go
- **Radar Sensing Mechanism (optional)**
    - Measures the radar reading for an indication that another vehicle is less than 15 feet away from behind
    - Communicates to the backpack LED display through bluetooth when a warning sign needs to be lit up
- **Wireless Charging Pocket (optional)**
    - Charges the smartphone battery with an induction coil inside a small panel in an outer pocket of the backpack

4. Functional Architecture


Gloves
10 Flex Sensors
time multiplexed into a single signal
16 x 1 Multiplexer
Accelerometer
ADC
control the address of the voltage level
demux
Microcontroller
Bluetooth Module
serial data transmission
Battery
Optional: Error detection by comparing with GPS data
Bluetooth Module
Backpack LED Display
Encoded data
PIC
LED Panel
Smart Phone
Bluetooth Module
LED Pad
Encoded data
PIC
Direction
LED Display
Lithium Ion Battery (backpack)
Optional: wireless charging station
Battery
Optional: Car detecting radar system
24-GHz radar antenna
Bluetooth Module
Battery

5. Design Trade studies

1) How to communicate between smartphone and LED panel microcontroller:

Name	*Range*	*Power usage*	*Data rate*	*Size*	*Cost*
			Wifi		
RN-XV WiFly Module - Wire Antenna	Depends on router	240mA @ 3.3v	54Mbit/s	1*1.3 inch	$35
			Bluetooth		
Bluetooth SMD Module - RN-42	10m	30mA @ 3.3v	2 Mbit/s	size of quarter	$19
			Radio		
Transceiver nRF24L01+ Module with Chip Antenna	100m	13mA @ 3.3v	2 Mbit/s		$20

Analysis

Wifi: Pros: Can transmit large amounts of data

Cons: Uses more power, larger in component size, needs access to wifi router

Bluetooth: Pros: Easy to serialize data

Cons: Uses more power

Radio: Pros: Low power

Cons: Difficult to serialize, need to write own communication protocol

Conclusion

For this project, the components will be relatively close to each other, so the range of all three communication methods are acceptable. However a lot of data needs to be serialized and sent to/from different components, making radio a less desirable method. Also as the system is used outdoors on bikes, access to a wireless router is not guaranteed, thus communication using Bluetooth is the best option.

2) How to alert biker of turn directions from GPS:

Design	*Pros*	*Cons*
Vibrations on a glove signal the corresponding turn	Does not require biker to take his/her eyes off the road	Not very obvious, biker may not be able to feel the vibrations
1 dimensional LED panel that lights up signalling left, right, go straight directions	Clear indication of direction, easy for biker to see and interpret	Does not work if there are more than 2 possible ways to turn
Compass-like pointer that points in the direction of intended route	Very accurate indication of direction	Difficult to program and control

Conclusion

The goal of the system is to give clear notifications to the biker to achieve turn-by-turn navigation, therefore vibrations on gloves are not preferred as they can easily be ignored or misread. The pointer is the most accurate representation of the navigation direction, but it is a difficult component to control. There the final solution is to use a 2D LED panel that can display more complicated signals while being easy to program.

3) How to get GPS data:

	Pros	Cons
Use separate GPS component	High accuracy	Adds extra volume and weight to the system, requires extra bluetooth component to send data to LED panel microcontrollers

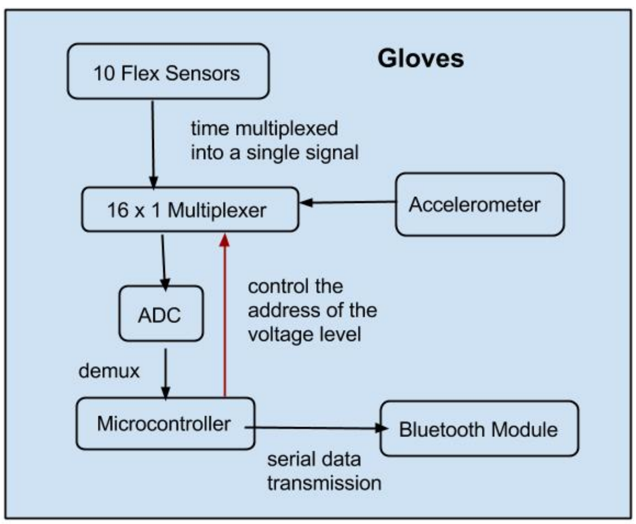
Use GPS data from smartphone	Smartphones have built in bluetooth for data transmission	Constantly requesting for GPS data drains battery from the smartphone

Conclusion

As the system is used outdoors, the GPS data provided by the smartphone is accurate enough for the purpose of the project. The smartphone can be charged by the power pack while it is in use. As the system should be as lightweight as possible, using data from the smartphone is the better option.

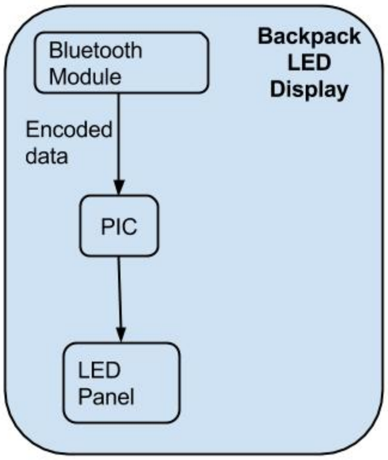
6. System description/Depiction

[1] Gloves



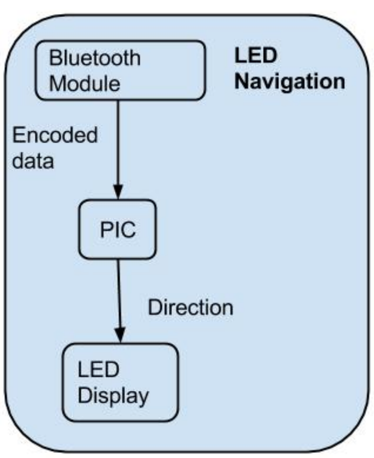
a. Flex Sensors - Display a change in resistance when bent
b. Accelerometer - Find out the angle the device is tilted
c. Multiplexor - Multiplex multiple analog sensor inputs into 10 time slots
d. ADC - Analog to digital converter
e. Microcontroller - Make a data packet with flex sensor and accelerometer data by controlling the address of the voltage level of the multiplexer
f. Bluetooth Module - Connects to the bike turn signal bluetooth module

[2] Bike Turn signal



a. Bluetooth Module - Receives the data packet from gloves and gps data from the smartphone.
b. PIC - The received data would contain the encoded values corresponding to 10 joints and accelerometer data and marker specifying the begining of the data. This data is then interpreted and the orientation and shape of the hand is guessed. To find the angle an empirically generated look up table is used. The guessed shape of the hand is then compared to the known shapes which have some meaning. It also detects possible error by comparing with GPS data. Determines the pattern of leds to turn on.
c. LED Panel - Displays the turn signal

[3] LED Navigation



a. Bluetooth Module - Receives navigation data as a google api maneuver field from the smart phone
b. PIC - Interprets the google api information. Determines the pattern of leds to turn on.
c. LED Display - Displays the navigation information for the user

[4] Smart Phone

- Provides a platform for google navigation for the bike turn signal and led navigation display.

[5] Car Detecting Radar System

a. 24-GHz radar antenna - Detects automobiles nearby
b. Bluetooth Module - Sends the radar signal to bike turn signal system.

[6] Wireless charging station

- Use inductive charging instead of using a Lithium Ion Battery.

7. Project Management

1. Project Schedule

Week	*Date*	*Goals*	*Notes*
6	2/16 - 2/22	❏ Learn Google Maps API ❏ Start building Android app	

		❑ Create circuits schematic and order 1st batch of parts	
7	2/23 - 3/1	❑ Start building prototypes (gloves, LEDs) ❑ Start design PCB	
8	3/2 - 3/8	❑ Test out gloves flex sensor. ❑ Starts writing gesture recognition software ❑ Finish basic functionalities of the Android app. Start unit testing the Android app.	
9	3/9 - 3/15	❑ Nothing planned specifically	Spring break
10	3/16 - 3/22	❑ Finish and test gesture detection on gloves ❑ Test bluetooth transmission ❑ Test navigation functionality ❑ 2nd order goes out	
11	3/23 - 3/29	❑ Unit testing ❑ Combine subsystems	
12	3/30 - 4/5	❑ Unit testing ❑ Combine subsystems ❑ 3rd order goes out	
13	4/6 - 4/12	❑ Unit testing ❑ Combine subsystems	
14	4/13 - 4/19	❑ System testing	
15	4/20 - 4/27	❑ System testing	

2. Team Member Responsibilities

Project Component	*Primary Responsibility*	*Secondary Responsibility*
Smartphone application	Karen Zeng	Joanne Tse
Glove with flex sensors	Ji Hye Lee	Josh Yu
Front LED display panel	Josh Yu	Ji Hye Lee
Backpack LED display panel	Joanne Tse	Karen Zeng

3. Budget

The latest version of our budget and parts list can be found here: http://goo.gl/kx6F1p

Part Name	**Quantity**	**Unit Price**	**Total Price**
SparkFun BLE Mate 2	2	$29.95	$59.90
Bluetooth SMD Module - BC127	2	$26.95	$53.90
Flex Sensor 2.2"	8	$7.95	$63.60
Flex Sensor 4.5"	2	$12.95	$25.90
RGB LED Panel - 32x32	1	$40.00	$40.00
Circular LED Bargraphs - Green	1	$11.95	$11.95
LilyPad LED Red (5pcs)	2	$3.95	$7.90
LilyPad Arduino 328 Main Board	2	$19.95	$39.90
LilyPad Coin Cell Battery Holder - Switched - 20mm	2	$4.95	$9.90
Powerbank	2	$15.99	$31.98
Fox Head Men's Ranger Glove	1	$26.95	$26.95
Case Logic Backpack	1	32.39	$32.39
Running Total			$404.27

4. Risk Management
    a. Design - If gesture recognition on the gloves is not functional or flex sensors prove to be too delicate for the environment, we may implement buttons on the gloves to light up signals on the backpack instead.
    b. Schedule - If we fall behind schedule, we will need to spend more time the following week on the components of the project that need to be built or tested.
    c. Resources - We will have extra batteries on the side to power the components of our system just in case the batteries we initially use run out of power. We will pay out of pocket or borrow parts from ECE and Robotics labs if we start to go over our budget.

8. Related Work

a. Similar Designs

Zackees Turn Signal Gloves (Exists on market)

The LED lights on the gloves activate with a small metal switch between the thumb and index finger.

Seil Bag (Kickstarter funding unsuccessful)

The SEIL bag provides you with a simple controller that can transmit many basic signals on the LED display as well as custom messages for others who are driving or walking around you. Simply using the detachable wireless controller enables various signals such as directions and emergency indicators.

Hammerhead Bike Navigation Device (about to be launched)

External bike navigation device which uses LED lights to give you the directions. The T-shaped bar-mounted unit receives its GPS data from an app installed on the rider's smartphone.

b. Why our project has an edge

The above products each provide a subset of the functionality that we are hoping to implement in our system. An important aspect of our project is to use gesture detection to send commands to the backpack LED panel, in order to make signalling most intuitive to the biker. We are also planning on incorporating GPS data in determining the backpack signal to show. Therefore overall, our project has more functionality and is more data driven than existing concepts/products.

9. References

Include references consulted. Cite them appropriately and include references to papers, books, URLs, manuals, or other sources

http://www.academia.edu/2646783/Hand_Talk-_Implementation_of_a_Gesture_Recognizing_Glove

https://www.sparkfun.com/pages/wireless_guide

http://odditymall.com/backpack-bike-turn-signals-and-messages

https://www.kickstarter.com/projects/1372886898/seil-bag?ref=nav_search

http://geoawesomeness.com/hammerhead-really-cool-bike-navigation-device/