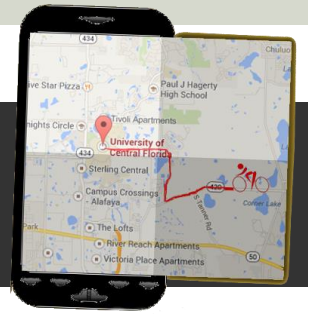
Bike Dash



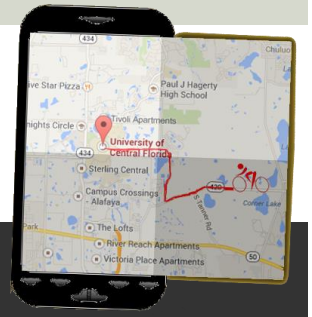
Group 11

Vincent Altavilla

Jose Davila

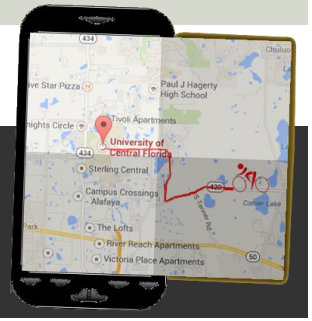
Sponsored by: Duke Energy

What is Bike Dash?



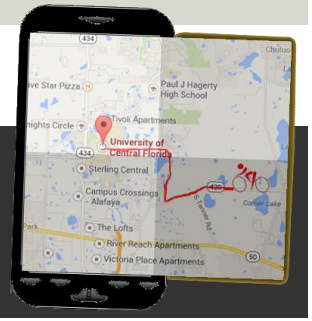
- An all-in-one ride monitoring application
- Consists of:
  - Sensors and Data Acquisition
  - Android application
  - Human power generation
- Target Audience
  - Ages 12+
  - Beginner to Advanced riders

Motivation



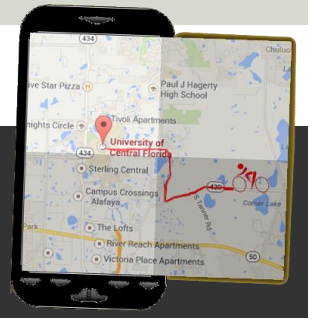
- Make riding easier to track
  - Catalog previous rides
  - Monitor progress during rides
- Visual progress encourages more riding
  - Trends and progress over time
- Challenge friends to ride
  - Post or “share” your ride with a friend
- Crash Detection and Reporting

Objectives



- Durability
  - Dust, water, and shock resistant
- Small Footprint
  - Small form factor
  - Allows for normal operation
- Power Consumption
  - Under 3.0W
  - Rechargeable battery

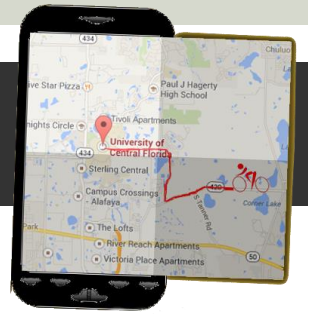
Specifications

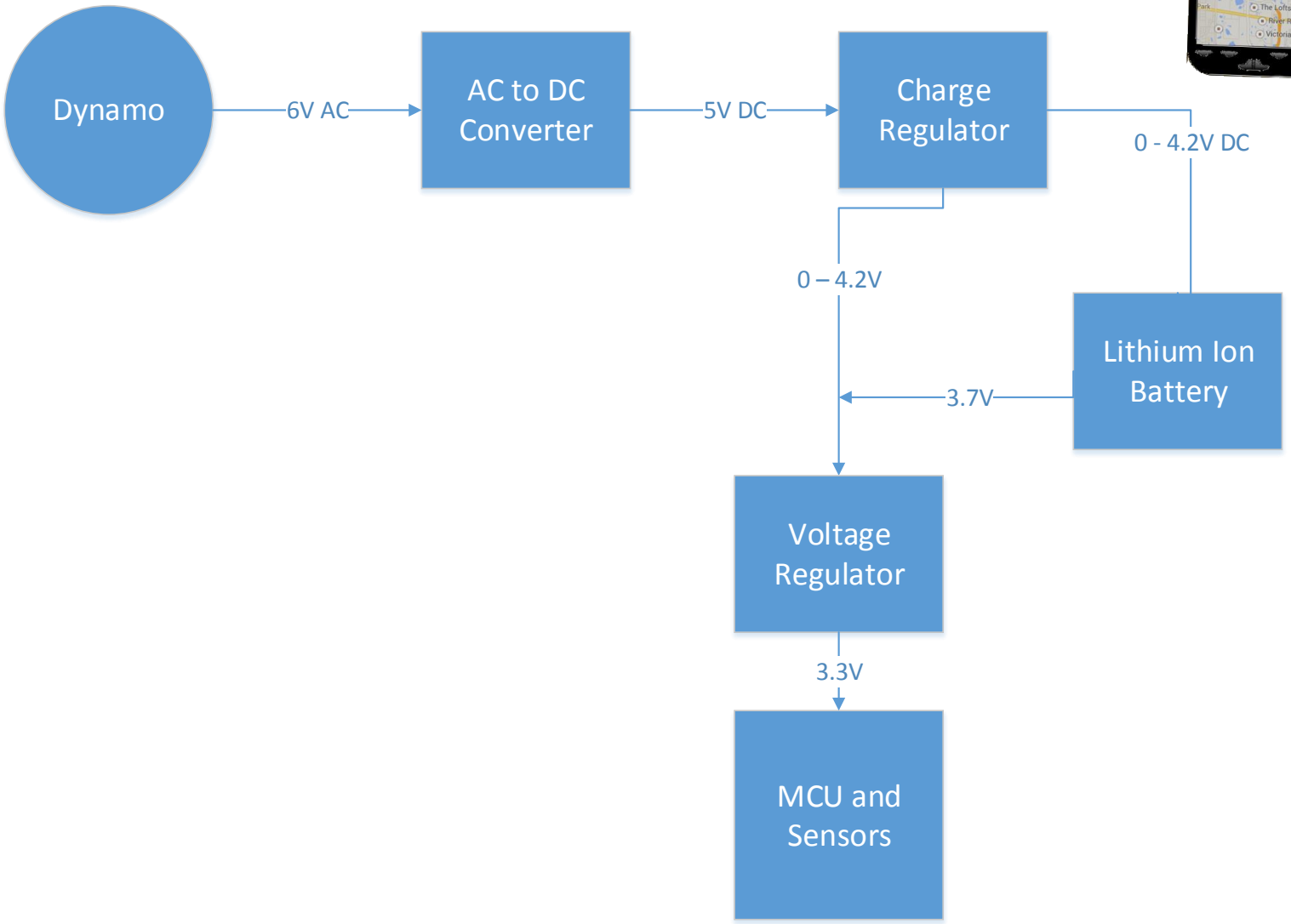


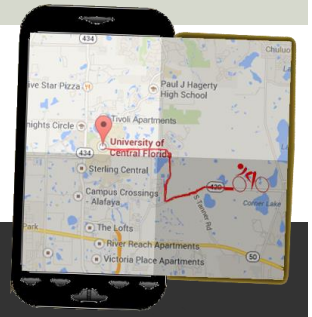
Bike Dash specifications:

System Weight	<2 kg
Power Supplied	3.0 W
Power Drawn	
Operating Temperature	-20°C to 60°C
Dimensions	10cm x 14.5cm x 19cm (l x w x h)

Charging Circuit at a Glance



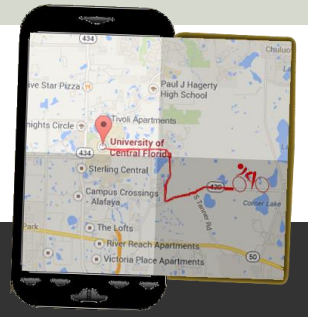




Dynamo

Shimano DH-3N80

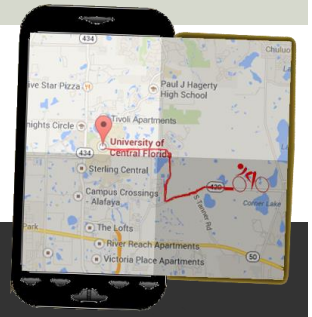
- Front Hub Dynamo
  - Easy to remove wheel
- 3W at 6V (AC)
- Power supply of 3 Watts.
- Versatile
  - DC Jack (ReeCharge)
  - Can fit other devices



AC to DC Conversion

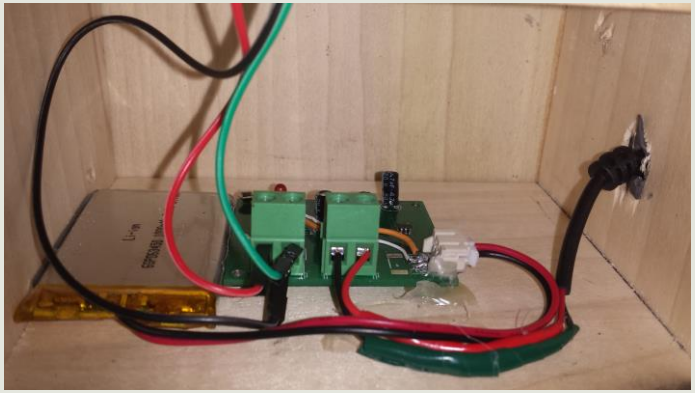
- Input is ~6V AC from dynamo
- Outputs constant 5V DC at full speed (~15 MPH)
- Allows for versatility
  - Any 5V DC device
  - Disable dynamo easily

BioLogic ReeCharge Dynamo Kit

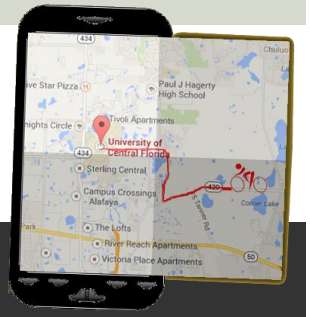


Battery Charging

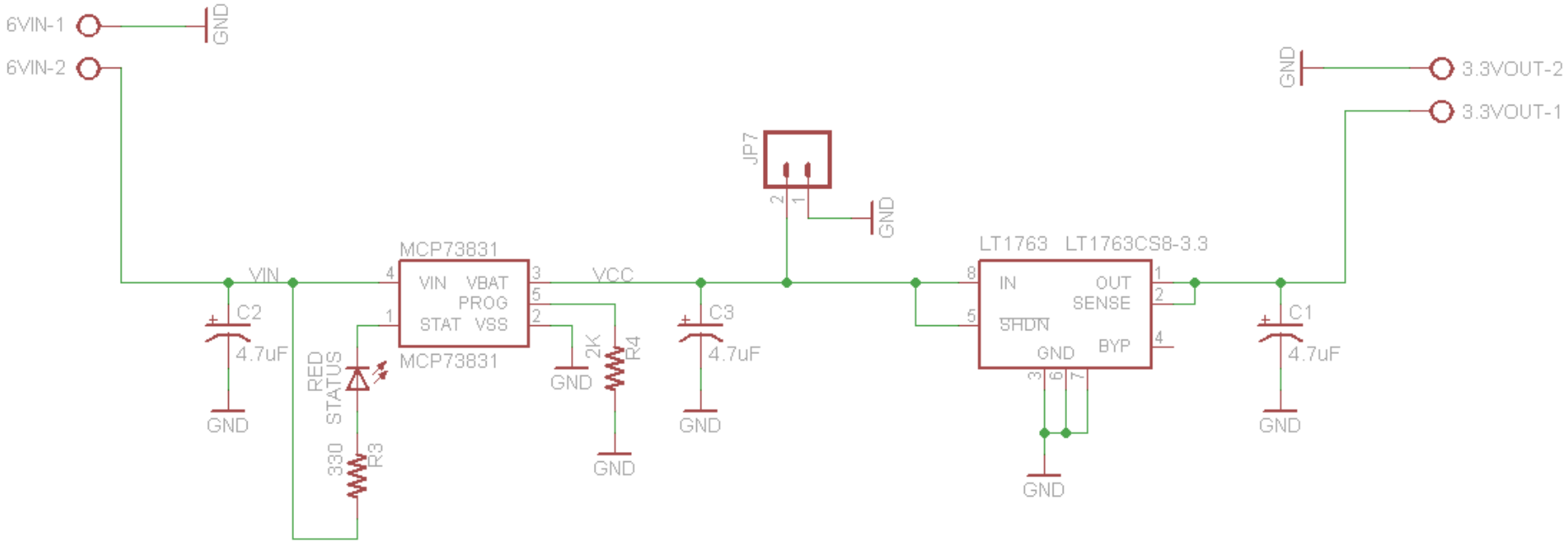
Charging Circuit and the 3.7V Li-Ion

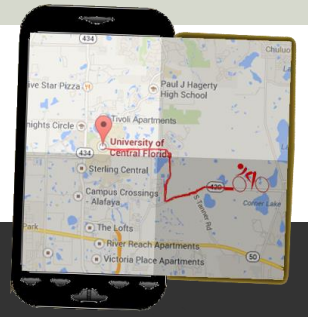


- Input is 5V DC (20V Max)
- Charges at 4.2V
- Trickle charge at full capacity
- Able to charge or run off of battery only
- Output regulated to ~3.3V using LT1763 (LDO)

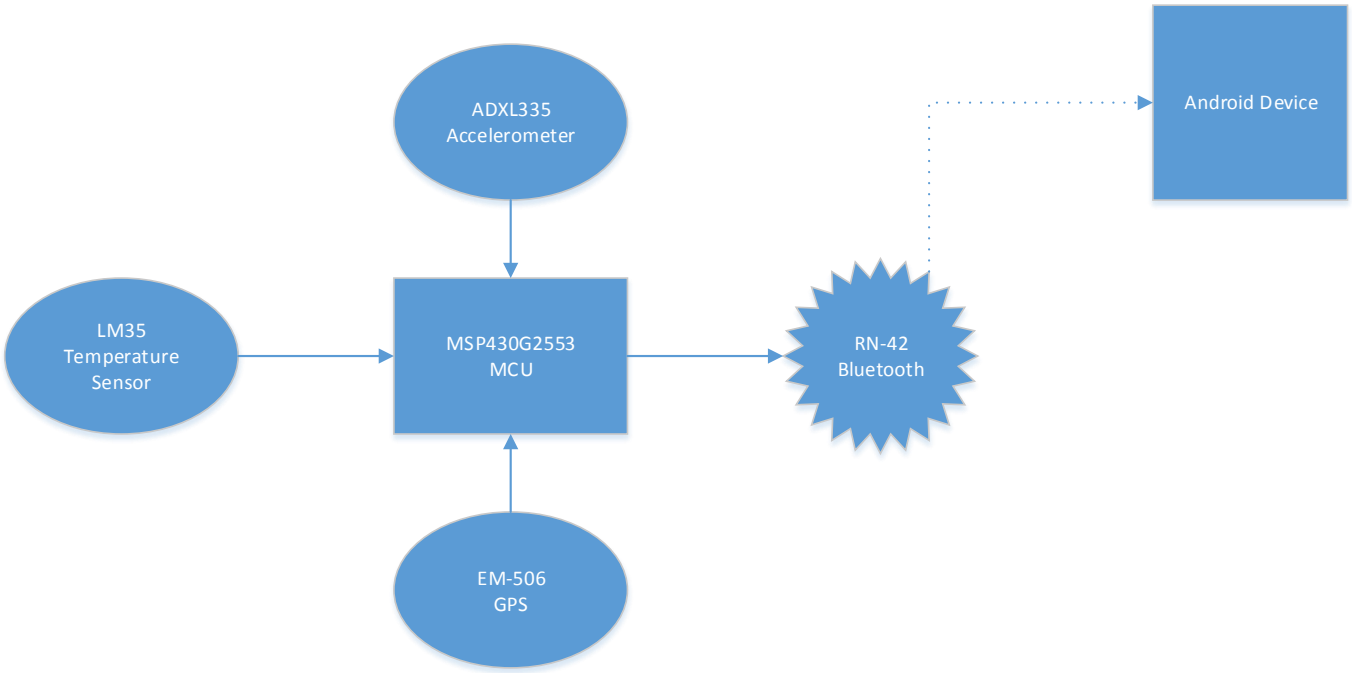


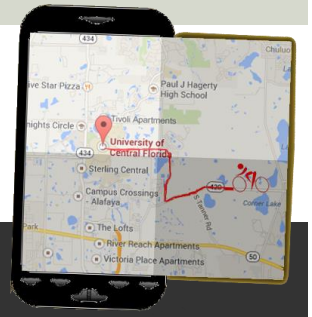
Charging Circuit Schematic





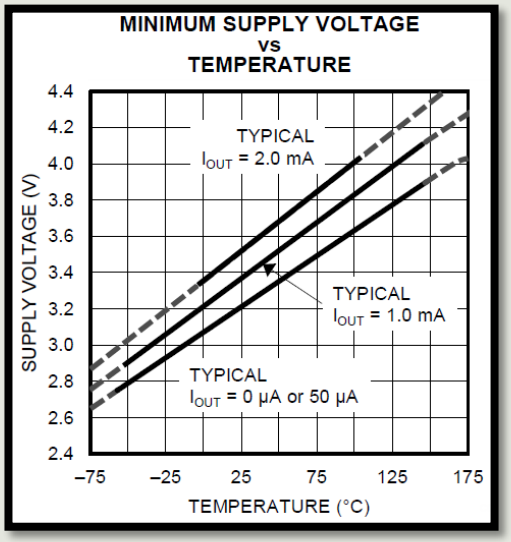
Data Acquisition at a Glance



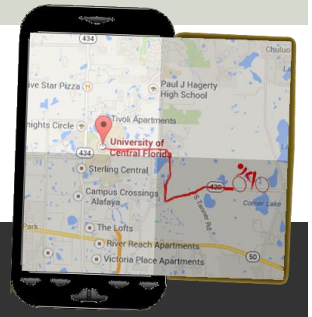


Temperature Sensor

LM35



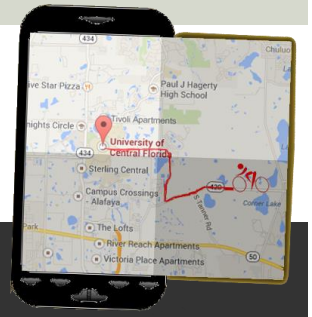
- Broad temperature range
  - -55°C to 150°C
- Precision centigrade temperature sensor
  - Accurate to ± 3°C
- Low voltage design
  - 3.3 V at room temperature (~20°C)



Accelerometer

- Triple axis device
  - Only two used (X and Y)
- Analog input
  - Easier reads
  - Less CPU power
- Crash detection
  - President Hitt
  - Ability to text 911 as of May 15th

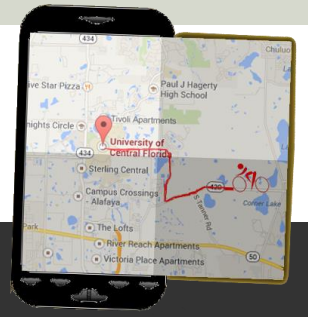
ADXL335



GPS Receiver

EM-506	
Serial Device	UART
Receive pin	RX (MSP430 Pin 3)
Baud rate	4800 bps
Frame Structure	8N1

- 48 channel, UART device
- Outputs NMEA sentences
  - RMC, GGA, GSA, and GSV
  - Speed and location
- Run in Low Power mode
  - Able to use 3.3V source
- Packaged with surface antenna

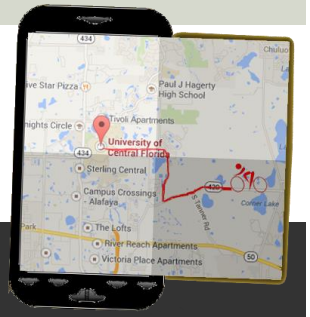


Bluetooth Module

- Passes data to Android device
- Configurable baud rate
  - Up to 115200 baud
  - Configured to 4800 baud
- Low power device
  - 3.3V source
- Device set as slave
  - Waits for data on RX pin
  - Transmits asynchronously

RN-42

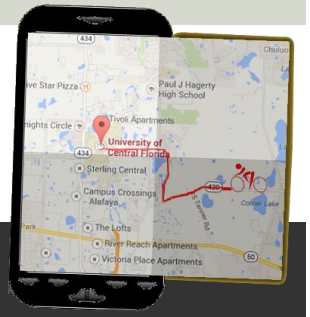
RN-42 Bluetooth	
Operating Voltage	3.3v
UART Baud Rate	4800
Antenna	On-board



Microcontroller

MSP430G2553

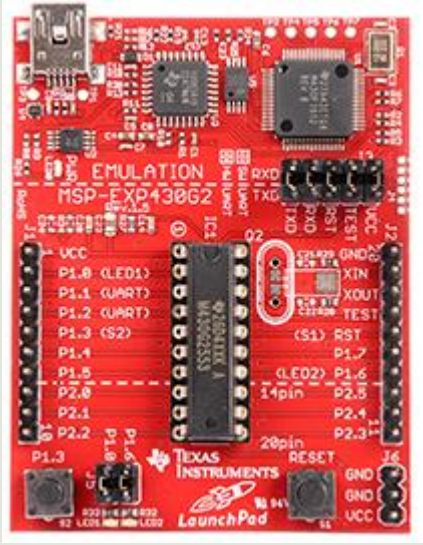
- Low supply-voltage range
  - 1.8 V to 3.6 V
- Power Efficient
  - 16 MHz at 3.3 V
- 16-bit Architecture
  - Other MCUs we 8-bit

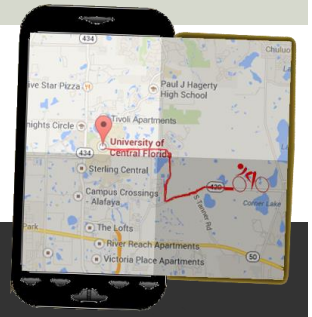


Programming the MSP430

- Originally written in Code Composer Studio
  - Energia for final project
  - Headers included
- Flash and debug using MSP430 Launchpad
- Accept sensor input
  - Accelerometer and Temp are analog sensors
  - GPS uses UART
- Output data through Bluetooth
  - Asynchronous transfer
  - Successive sensor reads

MSP-EXP430G2

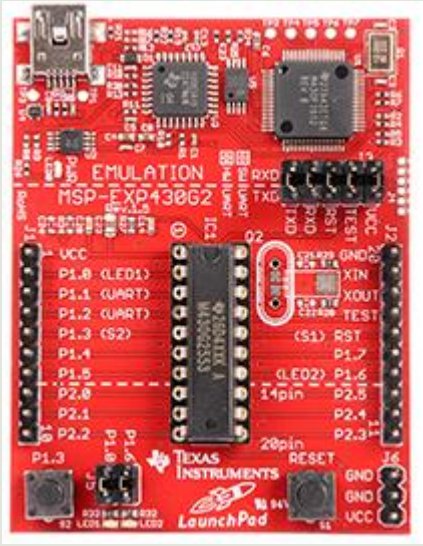


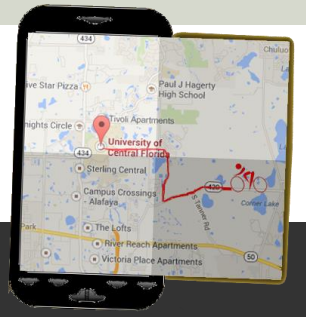


Programming the MSP430 (cont'd)

- GPS sensor requires loop
  - Receive 750 characters
  - Asynchronous
- Data read using infinite loop

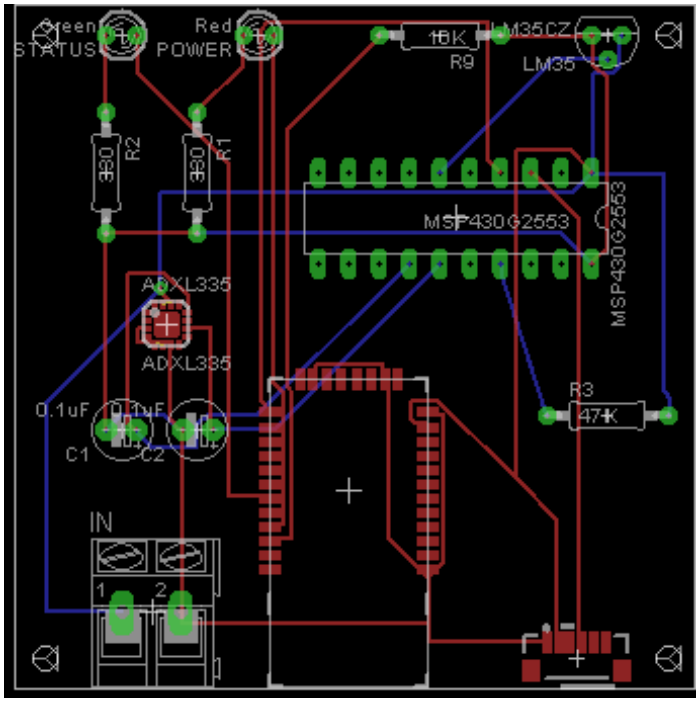
MSP-EXP430G2



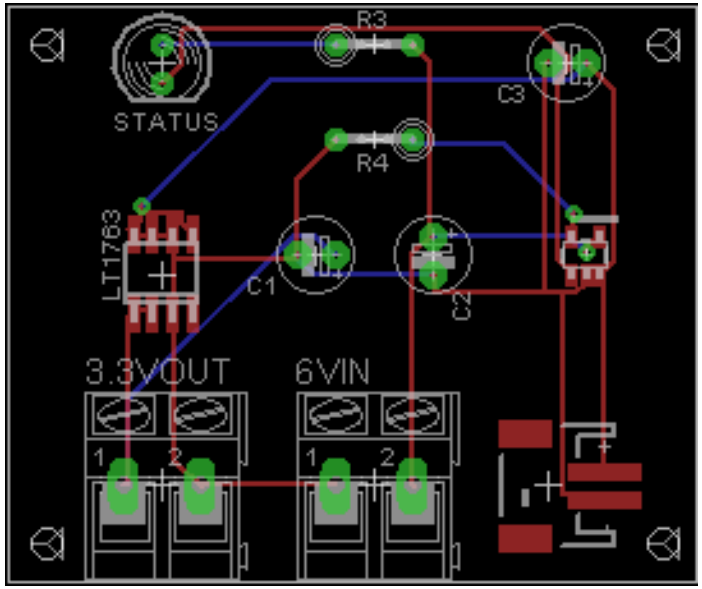


PCB Layout

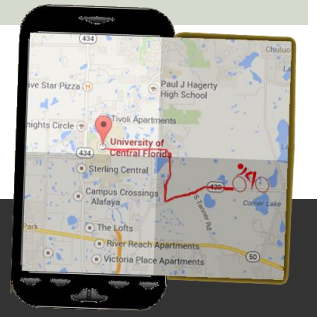
Main Circuit



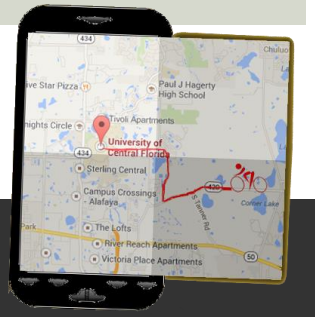
Charging Circuit



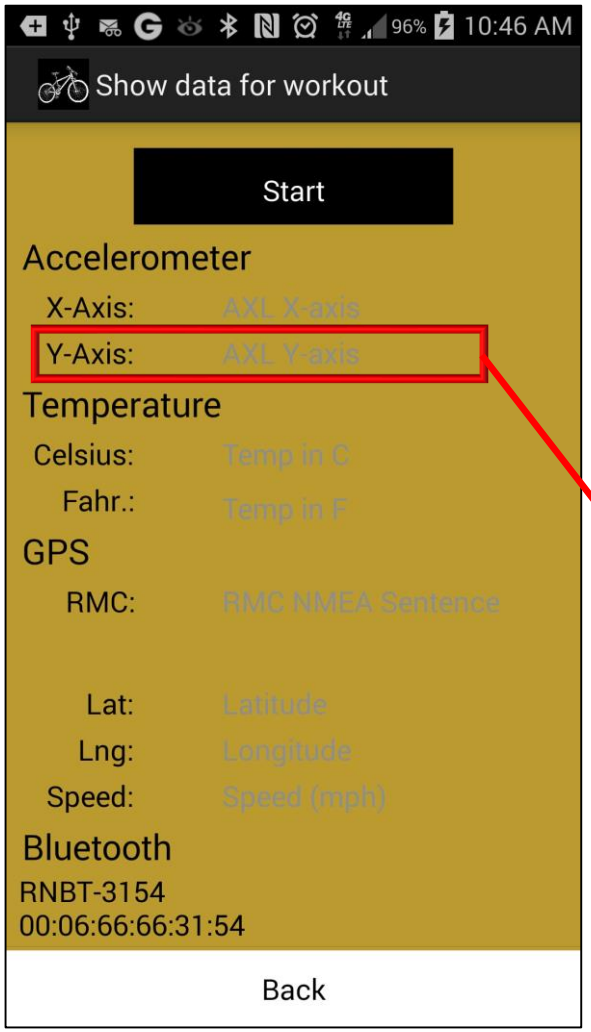
Android Application



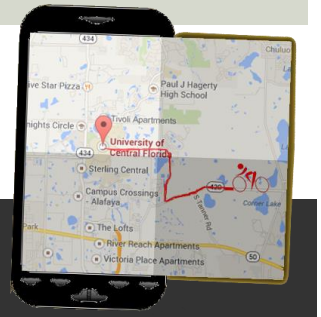
- Used to display workout information to the rider
  - Speed, Duration, Distance, Calories burned, and temperature
- Information will be received via packets broadcasted over Bluetooth network
- Portability: Gingerbread(API 11) through KitKat (API 19) = 81 % of Android devices in the market today
  - Limited by the use of Google Maps v2 API
- Positive user experience
  - Audio and visual feedback
  - Two view options: Map view and Stats view
  - Rich GUI layout



Parsing Data



- Data received via Bluetooth is appended into a StringBuilder until end of data index is received **('~')**
  - **$TEMP73#$ACLX456@$ACLY520%$GPRMC,064951.000,A,2307.1256,N,12016.4438,E,0.03,165.48,260406,3.05,W,A*2C~**
- The data is parsed out using end of data indexes to obtain the desired values. The StringBuilder is clear and the process is repeated
- Accelerometer Data: **$ACLX456@$ACLY520%**
- Monitor Y-axis to determine if the rider has been involved in an accident
  - If Y-axis value: 400 < value > 600
    - The bike is on the floor
    - Check if rider's speed is less than 0.5 mph
    - Show emergency dialog to user to determine the next actions to be taken



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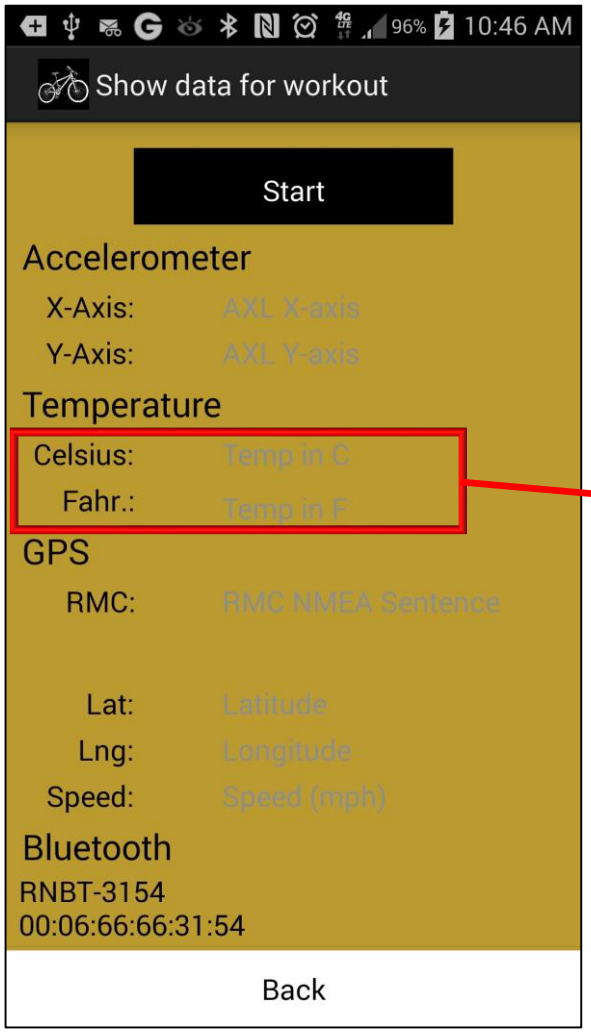
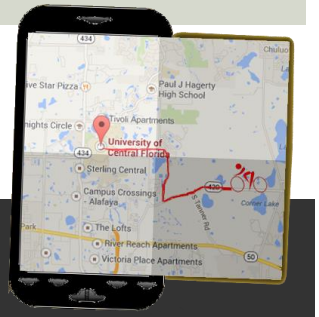


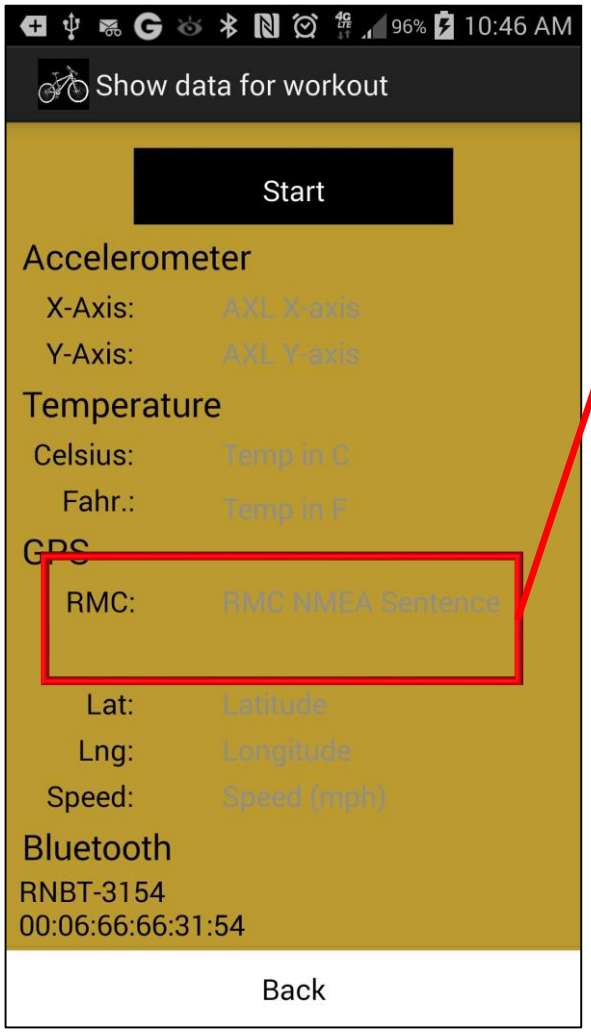
- Temperature Data: **$TEMP73#**
- Formula: Voltage Reading = **value Received**
  Reference Voltage = **3.3 V**
  # of bits = 1024

$$\textbf{Temp (Celsius)} = \frac{\boldsymbol{Voltage\ Reading} * \boldsymbol{Reference\ Voltage} * 100}{\boldsymbol{Number\ of\ bits}}$$

- Temp (Celsius) is then converted to Fahrenheit
- As temperature data comes in it's stored in an array
  - When at least 50 samples are obtain, the samples are averaged
  - Celsius and Fahrenheit temperature are displayed to the user



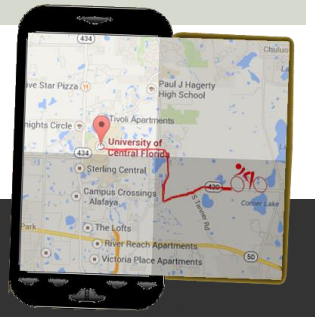
Parsing Data



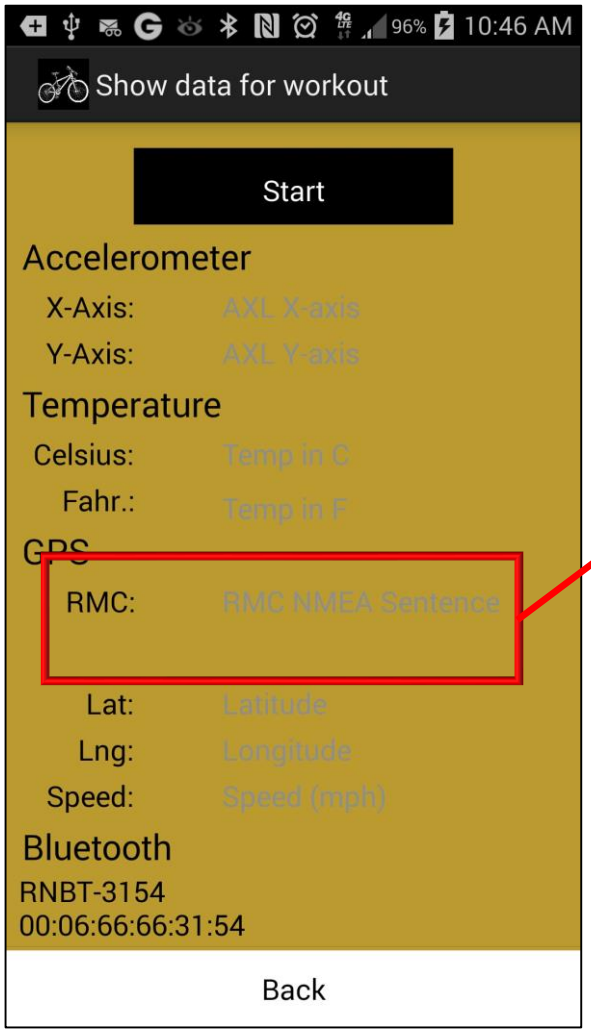
- GPS Data: **$GPRMC,064951.000,A,2307.1256,N, 12016.4438,E,0.03,165.48,260406,3.05,W,,,A*2C~**

- Recommended Minimum Navigation Information (RMC)
  - Longitude, latitude and speed data

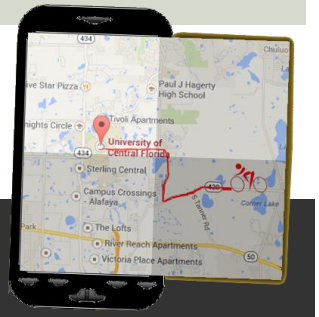
Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Time	064951.000		hhmmss.sss
Status	A		A = data valid or V = data not valid
Latitude	2307.1256		ddmm.mmmm
N/S Indicator	N		N = north or S = south
Longitude	12016.4438		ddmm.mmmm
E/W Indicator	E		E = east or W = west
Speed over Ground	0.03	knots	
Course over Ground	165.48	degrees	True
Date	260406		Ddmmyy
Magnetic Variation	3.05, W	degrees	E = east or W = west
Mode	A		A = Autonomous mode D = Differential mode E = Estimated mode
Checksum	*2C		
<CR> <LF>			End of message termination



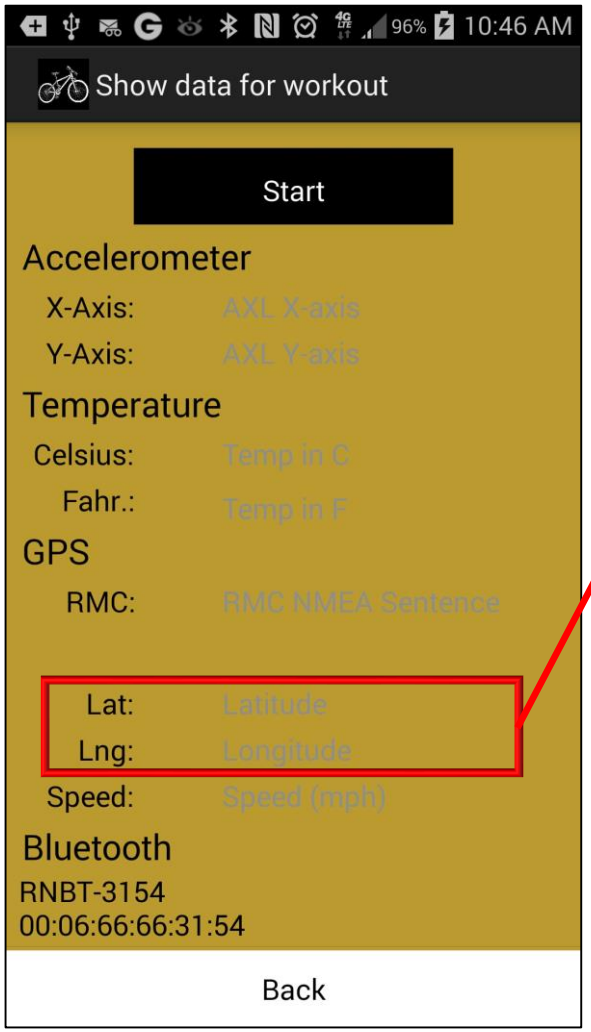
Parsing Data



- Experience some noise from GPS due to Baud Rate mismatch
- **Solution:**
  - Created complicated algorithm that checks for valid GPS RMC sentences:
    - Check status of RMC sentence
      - (A = Valid, V= Not Valid)
    - Contains 70 characters
    - Contains 12 commas
    - Check the length of the String values:
      - Latitude = 9
      - Longitude = 10
      - Speed = 4
- **Drawbacks:**
  - Large amount of data is dumped
  - Occasionally decreases map view refresh rate due to invalid GPS data



Parsing Data



- Latitude Data: **3723.2475**
- Longitude Data: **12158.3416**

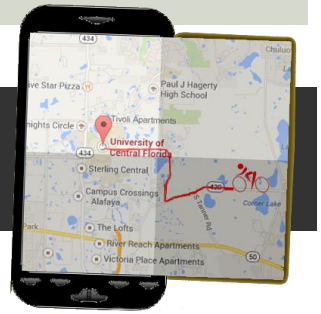
- The latitude & longitude is received in degrees decimal minutes format (**ddmm.mmm**)

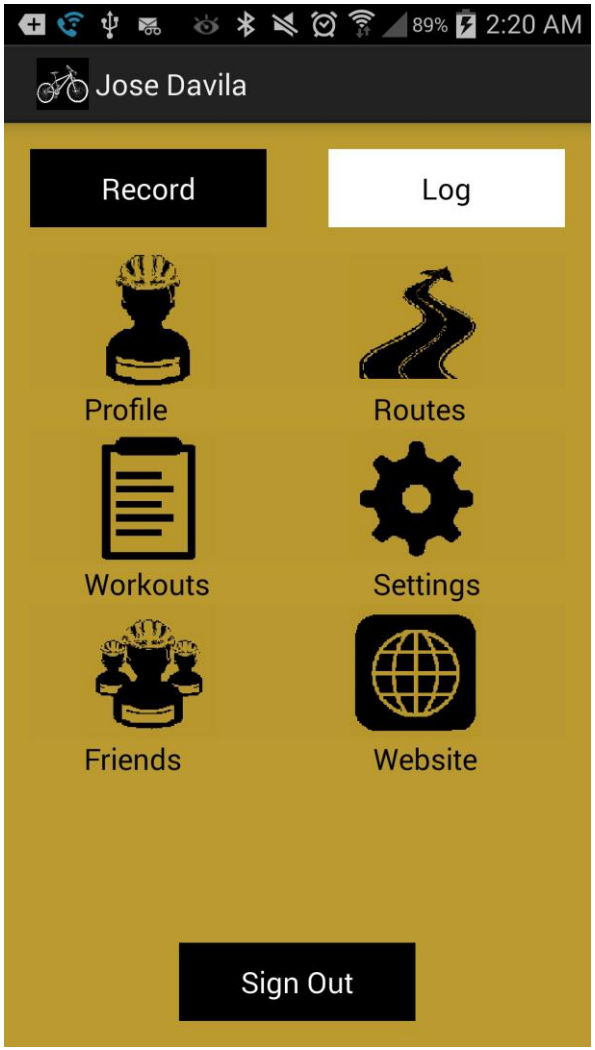
- The map view needs latitude and longitude to be in decimal degrees format to be used with Google Maps

- **Conversion:**
  - **Decimal degrees = dd +** $\frac{mm.mmm}{60}$

- If the N/S indicator = S or W/E indicator = W
  - Multiply the value by (-1) to obtain the correct position

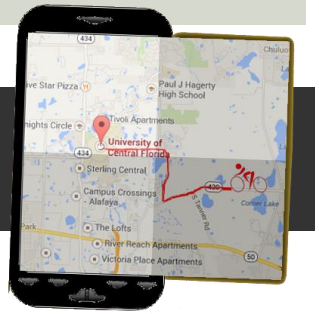
Main Application Layout

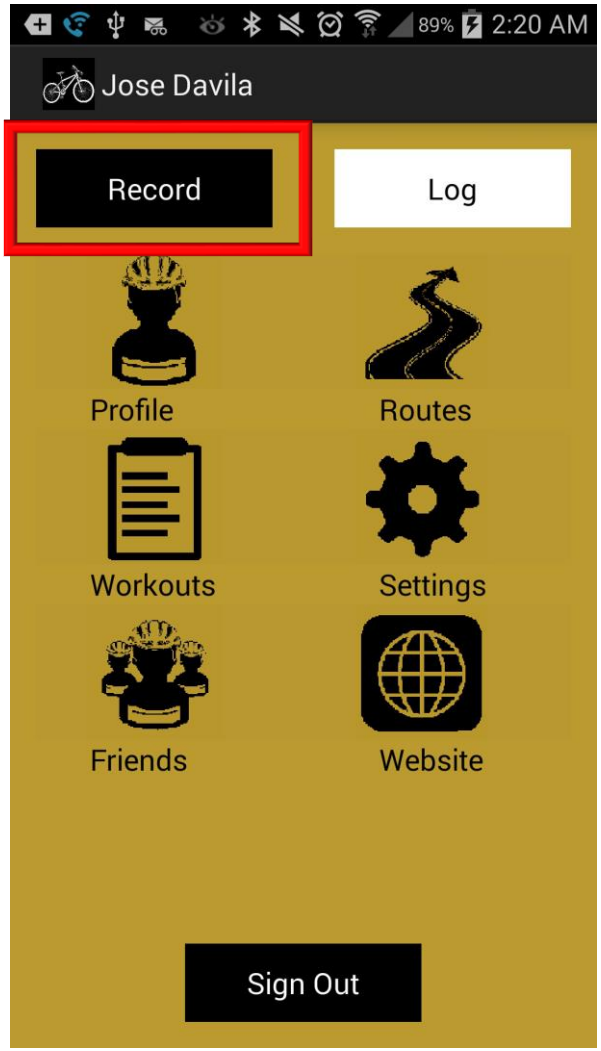




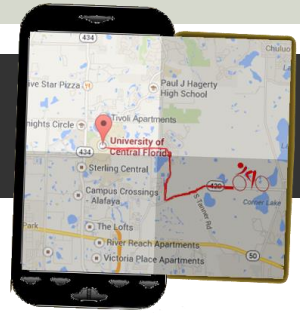
- GUI layout design to be similar to Twitter to improve user learnability and usability
- User will have 8 options:
  - Record new workout
  - Log a workout
  - View User Profile
  - View a list of workouts
  - View a list of routes
  - Change settings

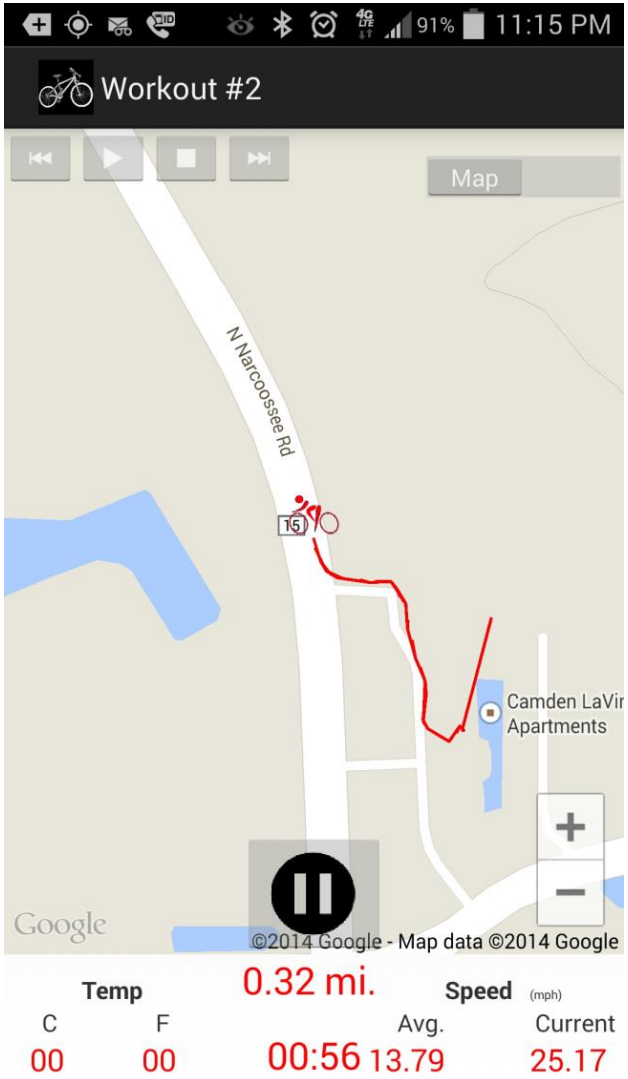
Record


Paul J Hagerty High School
Tivoli Apartments
University of Central Florida
Sterling Central
Campus Crossings Alafaya
The Lofts
River Reach Apartments
Victoria Place Apartments


89% 2:20 AM
Jose Davila
Record
Log
Profile
Routes
Workouts
Settings
Friends
Website
Sign Out

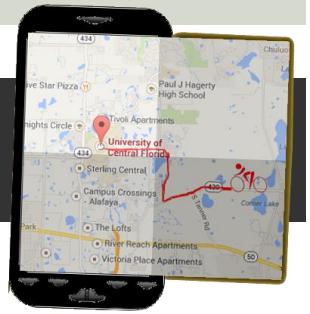
Map View

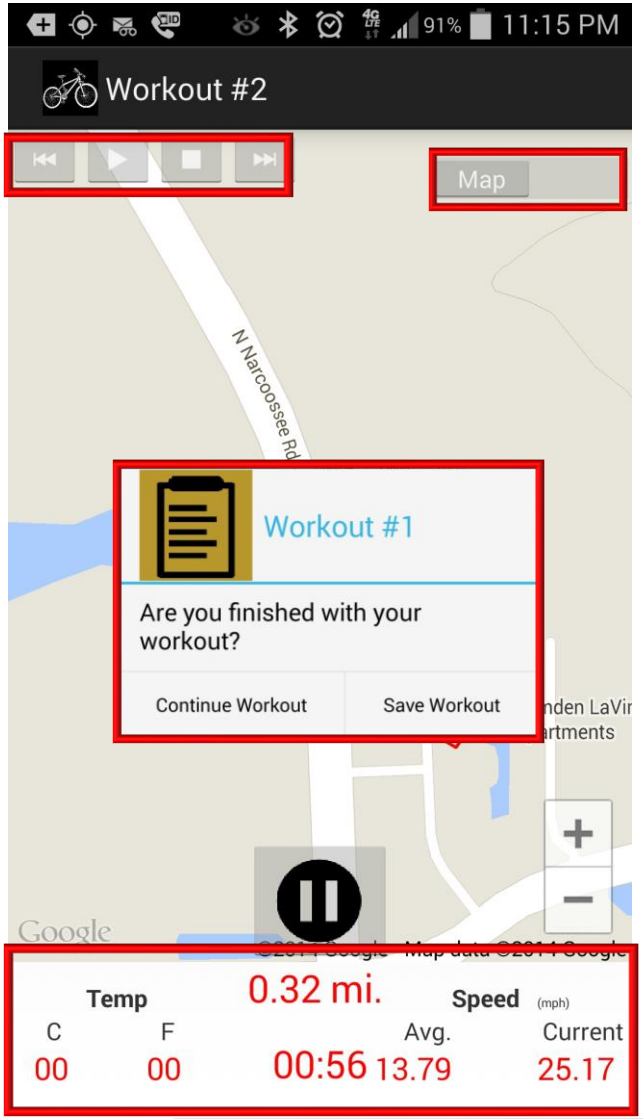




- Uses Google Maps v2 API
  - Supported by Google
  - Registered application in Google Developer Console to receive support from the Google servers
- Has location updates are received from GPS Module
  - The riders current position is displayed (bicycle)
  - The path that the rider has traveled is drawn on the map (red line)
- The rider also has the ability to zoom in and out
  - By using zoom button or touch gestures

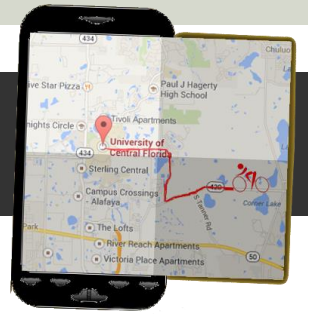
Map View

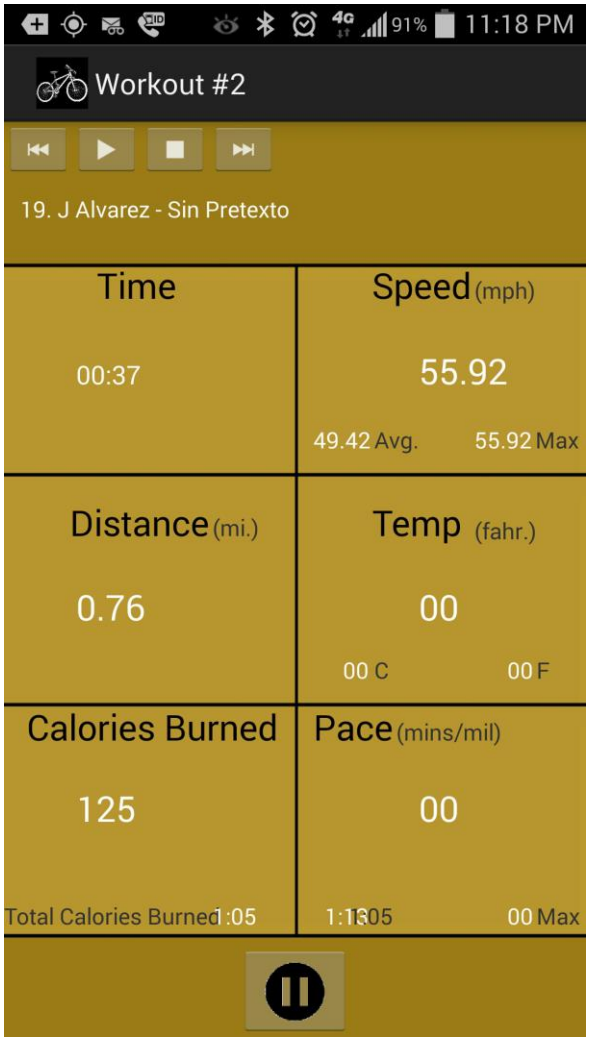




- The most important workout data is also provided in the map view
  - Ambient temperature, distance, duration, average and current speed
- To increase the app's intuition
  - Provided the user with the ability to control their music stored inside phone
  - Statistical view that displays more workout related data
- When the user is done with the workout a set of dialogs are presented in order to decide where to go next
  - Continue or Save Workout
  - Save route (ability to change route name)
  - Challenge Friends (Yes or No?)

Statistical View



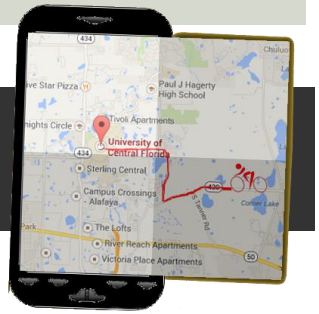


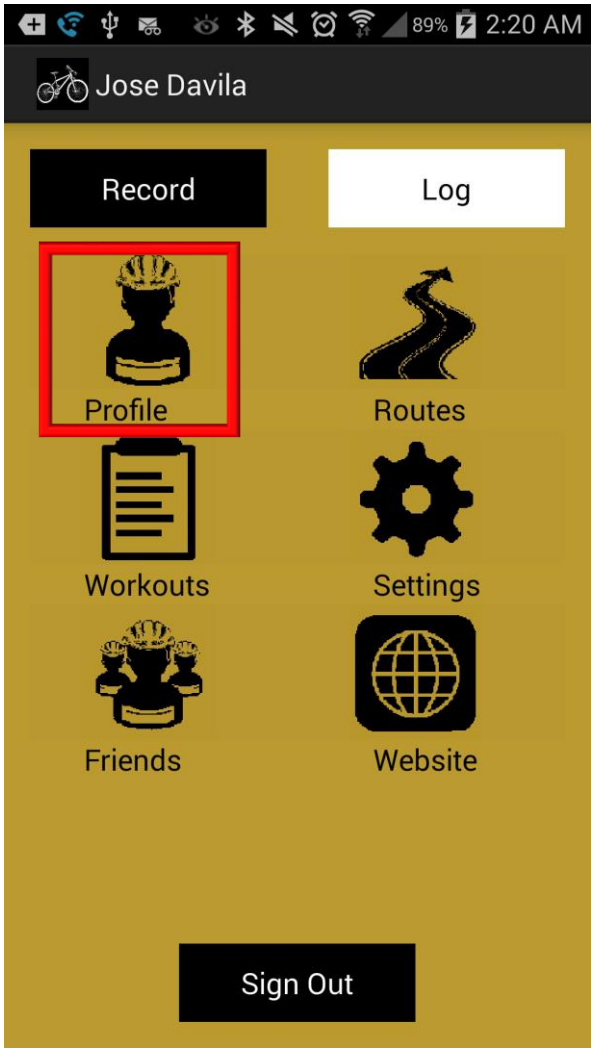
- Second view provided to user
- Displays data related to the workout like map view
  - **Plus:**
    - Maximum speed
    - Calories burned
    - Current, average and maximum pace in minutes per mile
- Pace calculation: $\frac{\boldsymbol{minutes\ in\ an\ hour}}{\boldsymbol{speed\ (mph)}}$
- Calories Burned calculation:
- **Formula:**

Total Cals. = (cal./min/kg) * weight * duration

Speed (mph)	cals./min/kg
< 10	0.12
10-12	0.10
12.1-14	0.14
14.1-16	0.18
> 16	0.21

Profile


Paul J Hagerty High School
Tivoli Apartments
University of Central Florida
Sterling Central
Campus Crossings Alafaya
The Lofts
River Reach Apartments
Victoria Place Apartments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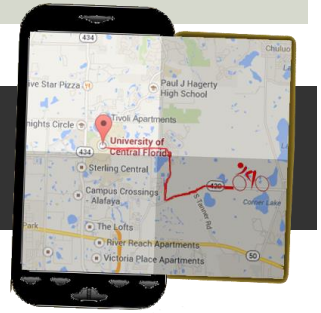
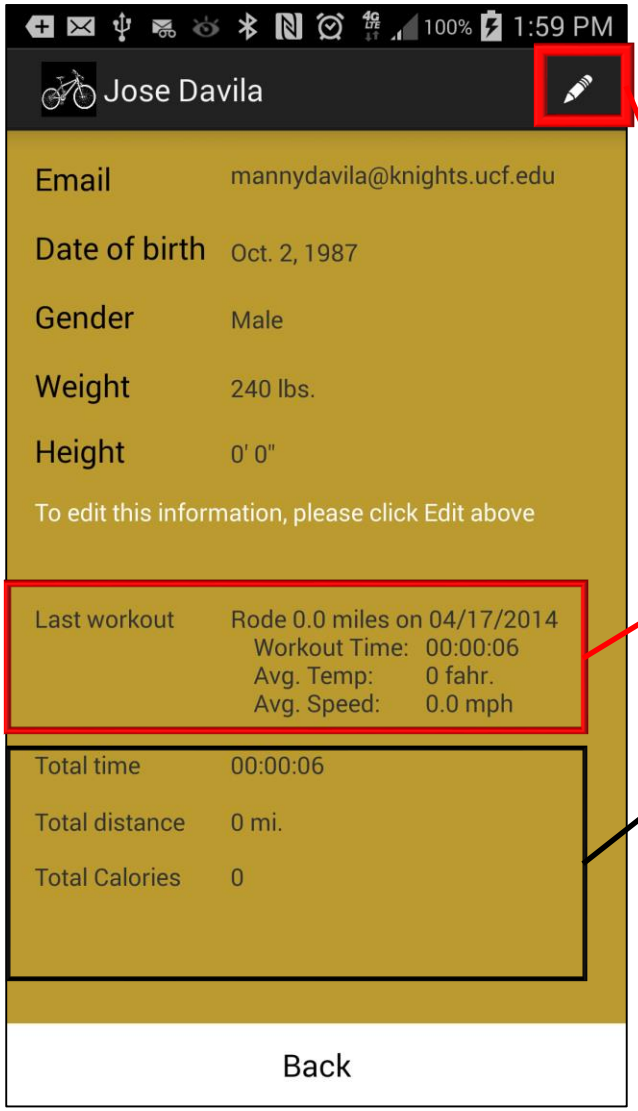
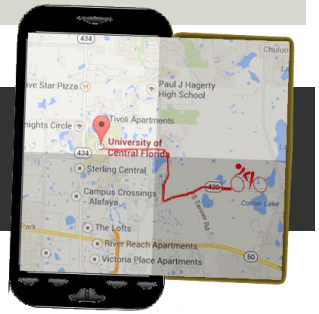
User Profile





- Displays user personal information
  - Email, DOB, Gender, Weight and Height
- Edit button on action bar allows the user to edit their height and weight
- Statistical data of the user's last recorded workout
- Tracks overall total time, distance and calories burned of the rider

Routes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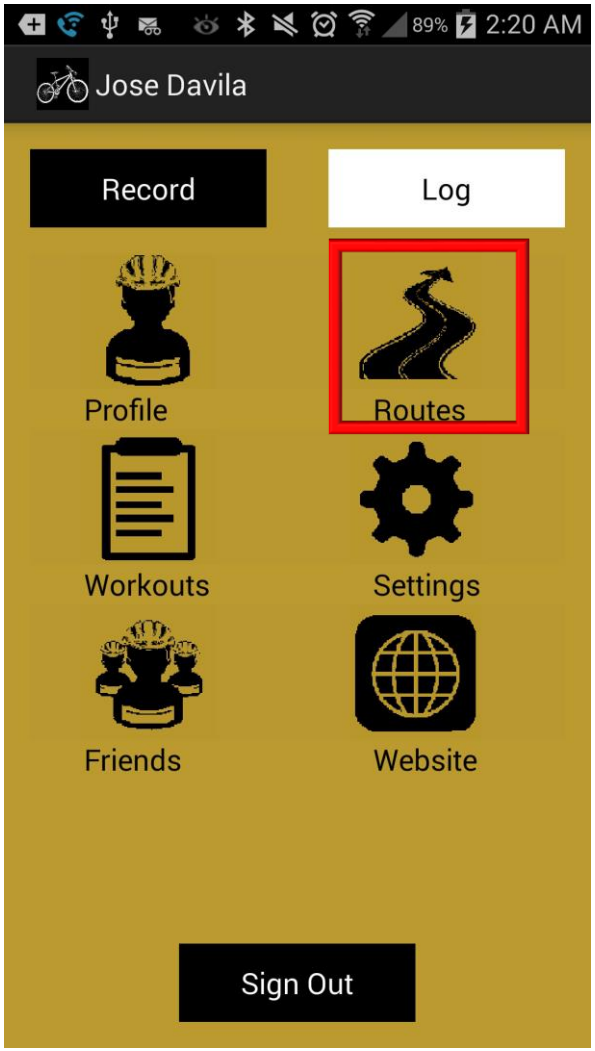
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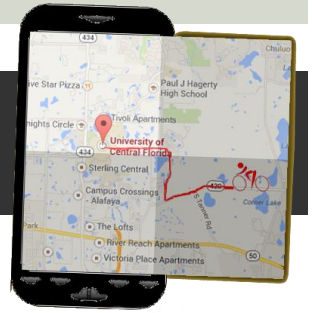
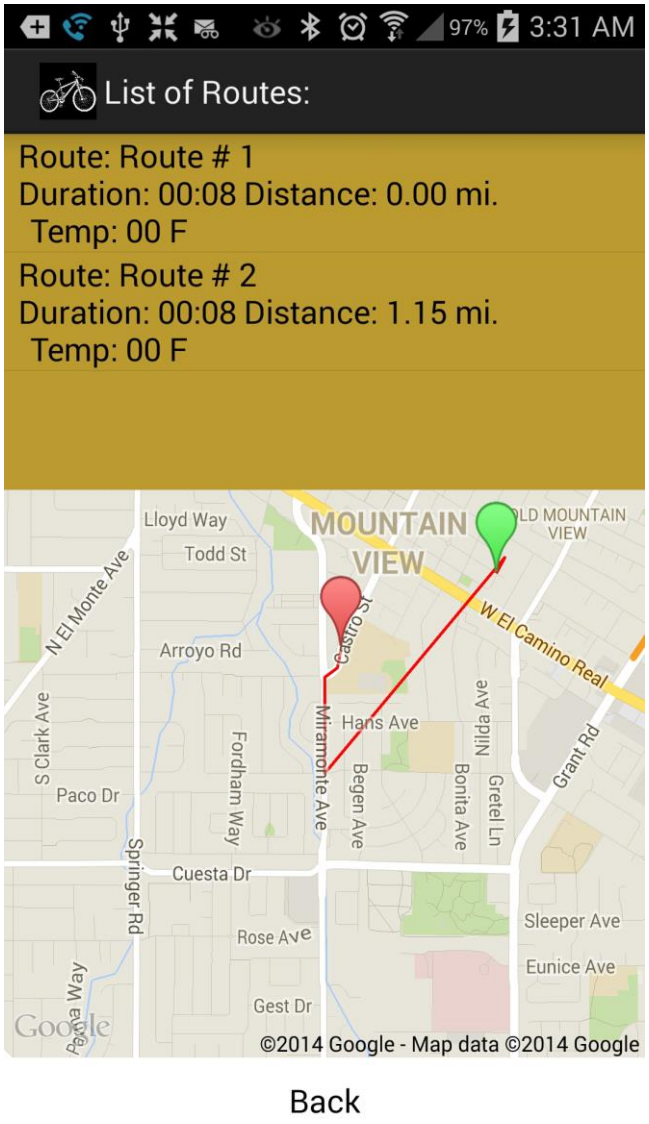
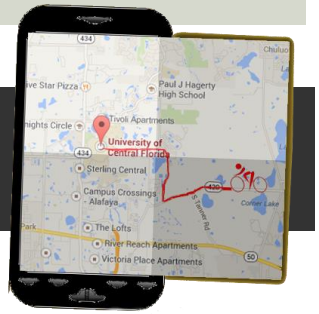
Routes





- Displays user's recorded routes in a list view
- The user will have two options in this activity:
  - Display the selected route
  - Delete the selected route
- If Display is chosen the user route will be display on the map below
  - Green marker = start
  - Red marker = end
  - Red line = path

Friends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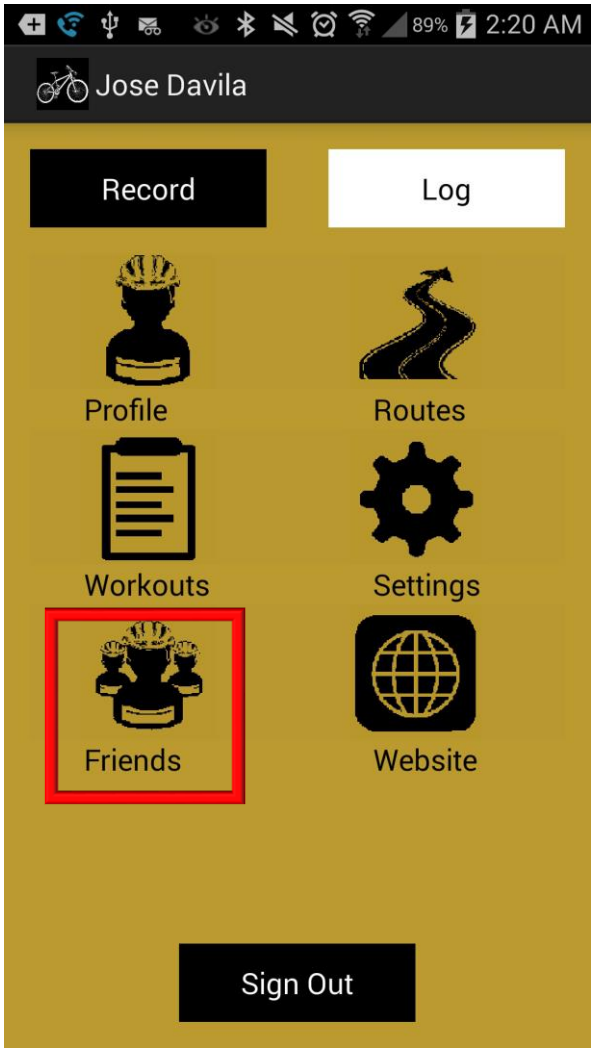
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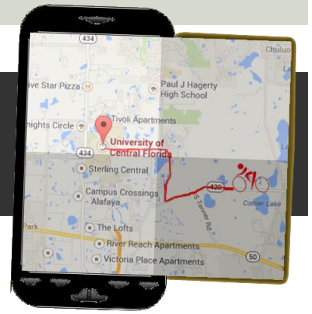
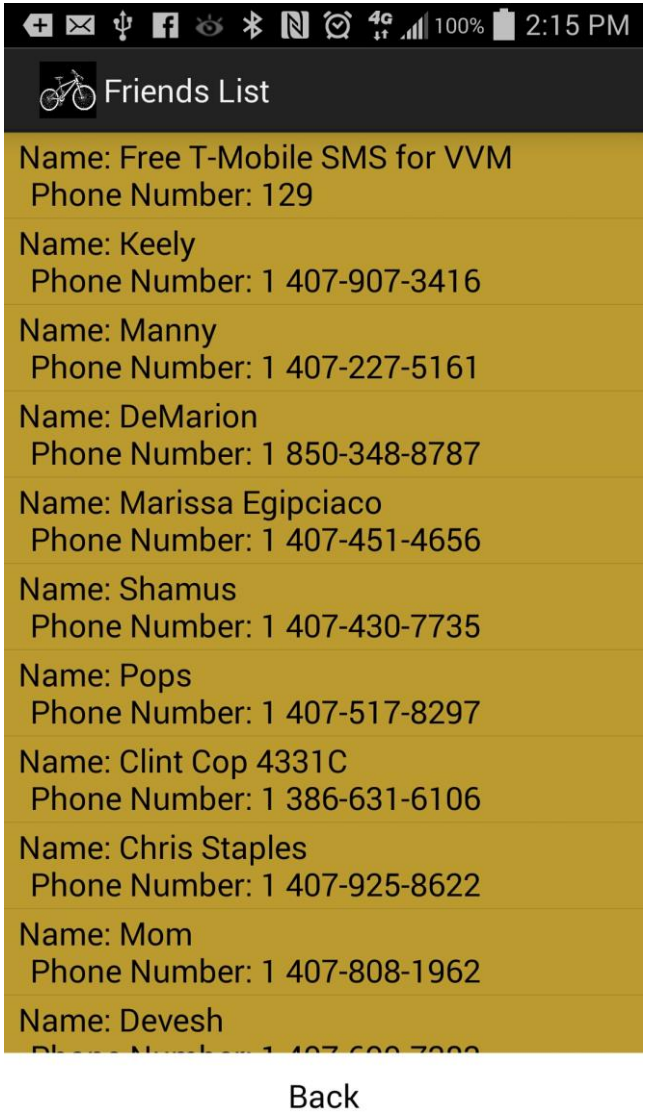
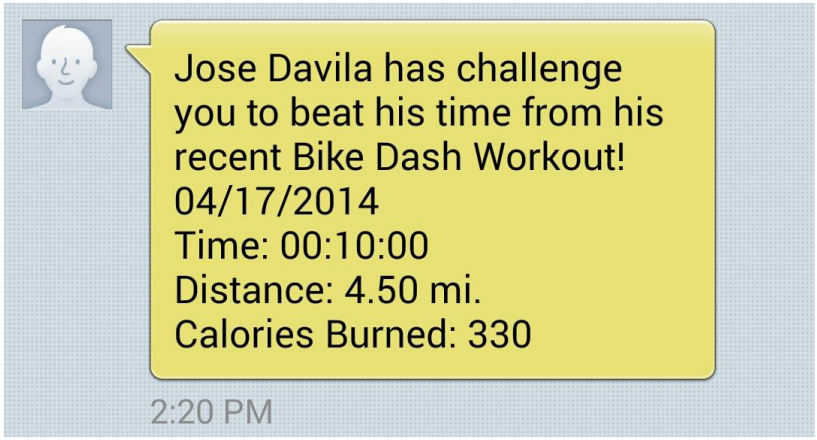
Challenge Friends

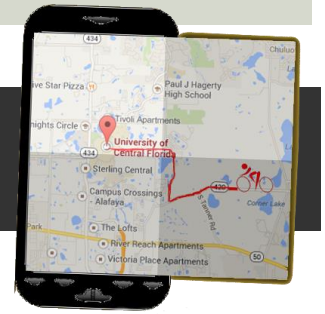




- To motive the riders and their friends
  - Provide the user with the ability to share their workout information
  - User can challenge friends to beat their distance and/or time

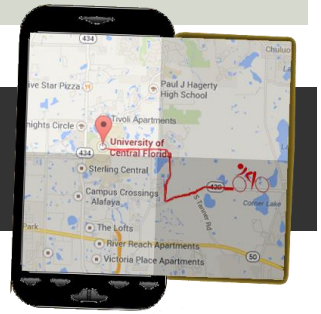


Other Features

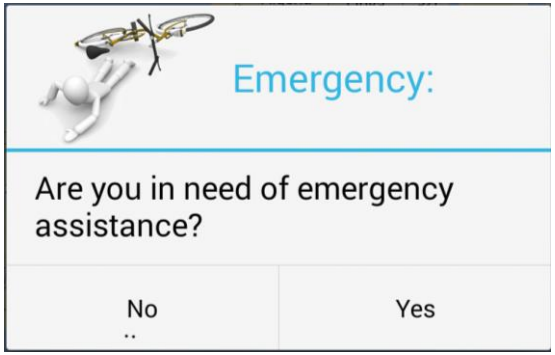


- Provide the user with audio and visual feedback when accomplishment are reached
- Promotes the rider's to ride longer and more often
- Awards are given when:
  - 1st mile is reached
  - 5th mile is reached
  - 10th mile is reached
  - Every multiple of 50, after that
  - When user completes their longest workout in terms of distance

Other Features

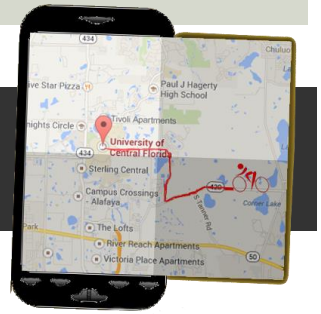


- Crash detection
- If accelerometer value exceeds the thresholds set:
  - If speed < 0.5 mph
    - An emergency alert dialog while show and audio feedback will begin playing
    - Wait 10 seconds
    - Check the values
    - Repeat until user click yes or time limit is reached
    - If its an emergency:
      - An emergency phone call and emergency text messages containing the user's precise location will automatically be sent



- According to 911.gov, emergency text messaging will be available nationwide for all carriers by May 15, 2014

Moving Forward



- Bike Dash version 2: Modified to use without external components

- Implement the ability for the user to select a previously recorded route
  - Then application will provide turn by turn navigation so the user has the ability to challenge their personal best from previous routes

- Redesign structure
  - Lighter materials
  - Smaller housing
- Release Android application to Google Play

- Add heart rate sensor support

Project Budget

Budget = $570.85

Total = $557.16

Surplus = $13.69

PART NUMBER	QTY	UNIT PRICE	EXTENSION
Order 1			
PAN1323ETU	1	71.61	71.61
Est. Shipping	1	3.23	3.23
Order 2			
MSP430G2553	3	2.79	8.37
Shipping	1	2.68	2.68
Order 3			
Scosche BTHM		39.95	39.95
Order 4			
ADXL362	1	14.95	14.95
Order 5			
DH-3N80	1	87.45	87.45
Shipping	1	10.99	10.99
Order 6			
Soldering Iron	1	23.97	23.97
Wire Cutters	1	8.48	8.48
Tax	1	2.11	2.11
	SUB-TOTAL		$273.79

PART NUMBER	QTY	UNIT PRICE	EXTENSION
Order 7			
PIC18F14K22	5	2.48	12.40
LM35DZ	3	1.57	4.71
5V Regulator	5	0.44	2.20
ADXL362	1	9.22	9.22
P14873 BT Mod	1	20.72	20.72
Shipping	1	2.75	2.75
Order 8			
SiRFStarIV GPS	1	14.42	14.42
Shipping	1	6.99	6.99
Order 9			
Resistor Pack	1	9.99	9.99
M/F Jumpers	1	6.99	6.99
M/M Jumpers	1	6.45	6.45
Order 10			
Rim Build	1	186.53	186.53
	SUB-TOTAL		$283.37
	TOTAL		$557.16

Questions and Demo