Mountain Biking Analytics

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Problem Statement

- Team 25's objective was to design and implement a new form of sensor for use in mountain biking data analytics.
- The team has designed a sensor to monitor the angle of the surface, as well as a gear position detection sensor.
- Objective was to collect the data from our sensor and integrate it with other analytics.

Requirements

Number	Requirement	Description	Value or Limit	Requirement Type
1	Ergonomics	Must be able to fit on the bicycle without impeding use	< 1 square meter	Interface
2	Affordability	Must be affordable for the average user	< $500	Functional
3	Feasibility	Be able to develop or utilize existing technology	Priority	Functional
4	Safety	Cannot put user in danger or harm them	Priority	Performance

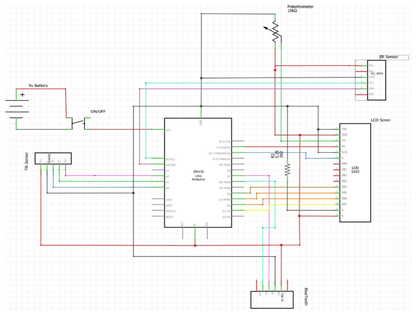
Concepts

- **Concept 1** – By attaching a trimmer potentiometer to the spindle near the handlebar, a rotary motion will allow the rotating screw on the top of the trimmer potentiometer turn to a specific position for each gear.
- **Concept 2** – Involves the measurement of gear selection by monitoring the shifter cable to determine current gear position. An Arduino powered infra-red sensor will record the movement of the shifter cable when the rider shifts from gear to gear.
- **Concept 3** – Involves the measurement of gear selection by monitoring the number of revolutions of the chain to determine current gear position.
- **Concept 4** – Indirectly detect gear position using the RPMs of the crank and wheel and knowing every gear ratio combination possible for the gears on each cassette.

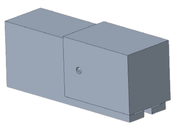
Quantitative Requirements	Concept 1 Trimmer Potentiometer Shifting Sensor	Concept 2 Shifter Cable Sensor	Concept 3 Chain Position Sensor	Concept 4 Inferred gear position
Size < 6in from bike frame (1,0)	1	1	1	1
Weight < 1 lbs. (1,0)	1	1	.9	1
Battery Life ≥ 6 hrs. (1,0)	.9	1	.8	1
Accuracy ≤ 1mm (1,0)	1	.9	1	.9
Cost ≤ $200 (1,0)	1	1	1	1
Time Resolution = 0.10 second (1,0)	1	1	1	.8
Total	5.9	5.9	5.7	5.7
Comments	1 CR2032 3 Volt Lithium Coin Cell Battery Required	This concept easily meets all requirements in this field	N/A	N/A
Comments	On-site calibrations and adjustments nec essary	Bike needs to have only one shifter to work accurately	N/A	Some consumers may not want to do the math involved for this concept
Risks (Likelihood/impact)	Impeding functionality of shifting lever	If sensor moves calibration will be off	Possible to interfere with chain/ge ars if part fails	Could impede motion of rear wheel
Cost	≈$40	≈$30	≈$40	≈$70

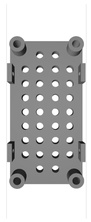
Final Design

- Today, many of the greatest changes in the sports industry is largely thanks to the implementation of data analytics.
- The usage of raw data being transformed into meaningful statistics can be seen in nearly every sport today. When it comes to mountain biking, there isn't much data analytics with relation to gear position.
- Therefore, the team has taken up the task of developing an integrated system of sensors in hopes of being able to improving the rider's skill, mainly through recording and analyzing factors that dictate how a rider performs.
- This will be done by recording what gear the rider is in, the incline or decline of a surface, the rider's velocity, and more.
- These factors, along with data collected from the Wahoo biking computer, can be analyzed to improve the rider's performance.
- In addition to this data, a live display of angle and gear position is displayed on an LCD display screen.



3D Housing Models for In-House Developed Sensors:

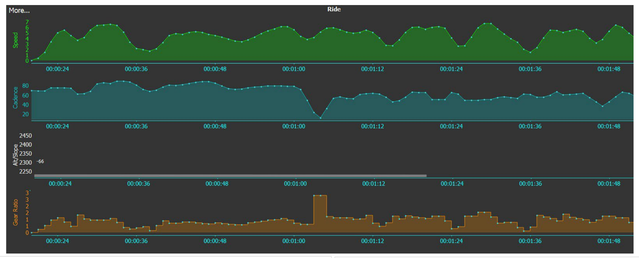


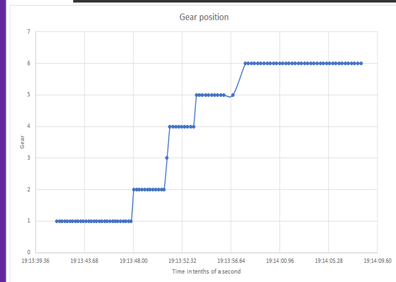


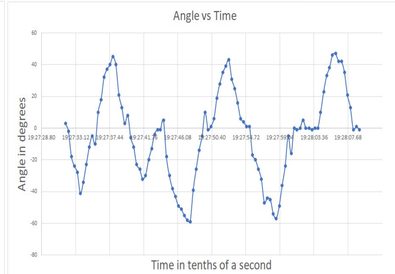
Commercially Available Sensors:

Results

The team used a combination of Microsoft Excel and Golden Cheetah software to view data gathered from the Arduino into graphs that can be seen below.







Summary

- Overall, the team's objectives pertaining to this project have been met in a satisfactory manner.
- All data gathered reflects accurate and valid measurements of a litany of analytics, including but not limited to; gear position, angle of the riding surface, speed, and more.

Team & Acknowledgements

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