Pedal-Based Power Meter

Lauren Bailey ▪ Steven Lillig ▪Andrew Mudge ▪ Robert Ramirez

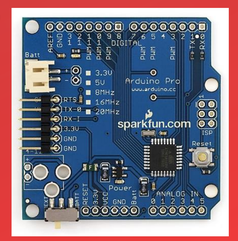
Project Background

Our team of students has an interest in exercise and active lifestyles and chose to utilize this opportunity to create a product used in cycling. We designed, built, and tested a pedal-based power meter that is used in endurance cycling training. The power meter is a beneficial tool used by cyclists to structure and improve training. Combining the data acquired with this tool and a minor knowledge of human physiology provides the cyclist with useful information.

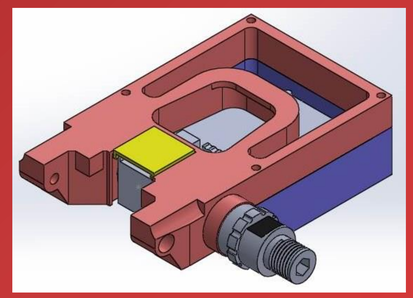
Design Specifications

1. Measure force produced by rider during each pedal stroke
2. Solve power equation, $P(Power) = 2 * \{F_{max} * 9.8 * L\} * (RPM * .1047)$
3. Package electronics on pedal assembly
4. Bluetooth transmission to device for easy rider visibility

The design makes use of many components to meet these specifications. The Flexiforce sensor (seen left) measures the force on the pedal. An Arduino microcontroller (seen right) receives force data and computes the rider's power output. The power is transmitted via Bluetooth Mate to a SmartPhone app.

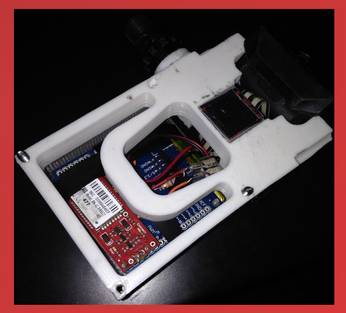


Final Design



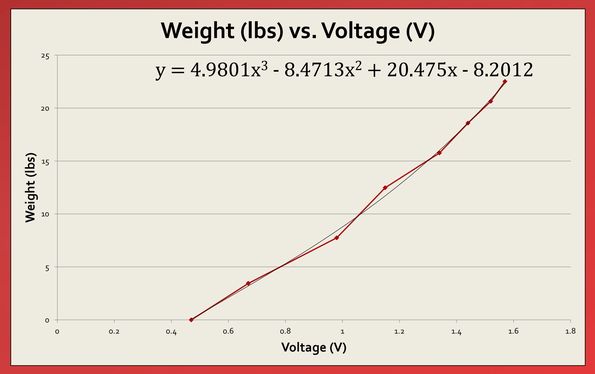
After making minor modifications, the final pedal design was completed (seen right). Our design is compatible with the most common cleat, SPD-SL, and can be fitted onto any bike by simply replacing the standard pedal with our product. The force is read at the spindle location which gives the most accurate data. The pedal body houses all of the electronic components including the Arduino, Bluetooth module, and battery.

After completing the final CAD design, our group had the pedal 3D printed to ensure correct dimensions and fit. The pedal fits onto the bike by screwing it onto the spindle (seen below, left) and allows for the shoe to be clipped into it (seen below, right). The electronic components all fit in the bottom half of the pedal (seen below, middle), safely away from the shoe cleat. The top and bottom halves are secured with 4 screws which allows for easy maintenance and repair.

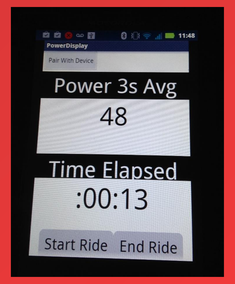


Testing & Results

Multiple static tests were conducted in order to find the relationship between output voltage and force. This figure shows that the relationship between the force applied and the output voltage closely follows the curve of a third order polynomial. This equation is used in the Arduino coding to accurately calculate the rider's output power using the applied force to the pedal. Testing has been conducted with the force sensor in place to account for the dampening present due to the material between the cleat and sensor.



Once the Arduino calculates the rider's power using the force applied and the cadence, the Bluetooth module transmits this data to an Android app (seen right). This allows for the rider to view their real-time power output conveniently on their phone which can be mounted to their bike during a ride. Additionally, this data is logged for later viewing and analysis.



Conclusion & Acknowledgements

This project utilized theories covering design, testing, manufacturing, programming, and SmartPhone app creation. Our group was able to employ engineering theory and practices gained in classes as well as develop new skills required to achieve project goals. The final product met our requirements and proved to teach us principles we can use in the engineering industry. Thanks to Dr. Kee Moon for his consultations, ITSA Bike Shop for part discounts, and to San Diego State University for use of equipment and laboratories.