IPRO 497-324: Power Measurements For Road Bike

Background

- Current systems measure power via:
  - Crankset (strain in crankset)
  - Free hub (strain in rear wheel)
  - Chain (vibration & speed of chain)
  - Opposing force (e.g. gravity, drag, acceleration, wind velocity)
- Strain gauges measure the stretch in the material (strain), which can be related to torque, from which power can be calculated.

Theory

$$Power = T\varpi = \sum_{i=1}^{n} C_i S_i \varpi$$
$$= [Torque][Angular\ Velocity]$$

Problem

- Demand for power measuring device
- Current systems are expensive, and can not be retrofit
- Strain gauges are an inexpensive, practical solution
- Advanced Signal Processing
- Wireless Data Transmission

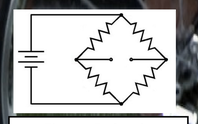

Figure 5: Strain Measurement Circuit

Figure 6: Garmin Device

Objective

- Develop a configuration of strain gauges
- Develop an electronic processing unit for post-processing the strain gauge signals
- Package the system

Results

- Strain readings linear with torque
- Determination of crank angle necessary
- Proposed system is cheaper than competition

Proposed Circuit Estimated Cost
Small Quantity Order (not including manufacturing/production costs)

	Quantity	Cost Each	Total
Microchip 18F2320	1	$8.65	$8.65
74HC154 Decoder	1	$0.96	$0.96
INA122 Amplifier	1	$5.56	$5.56
ADG811 Analog Switch	3	$3.40	$10.20
LP3878 Voltage Regulator	1	$2.50	$2.50
Precision 350 Ohm Resistor	3	$11.52	$34.56
MAX4475 Op-Amp	2	$0.72	$1.44
nRF2401A (ANT+ Chip)	1	$4.75	$4.75
Supporting Components - Resistors/Capacitors		$5.00	$5.00
SRAM S900 Crankset	1	$180.00	$180.00
Strain Guages	1	$442.50	$442.50
Housing	1	$100.00	$100.00
Battery	1	$3.00	$3.00
Total Estimated Cost			$799.12
Quarq System Cost			$1,525.00
Costs will go down due to:	higher quantity orders		
	use of all surface mount components		

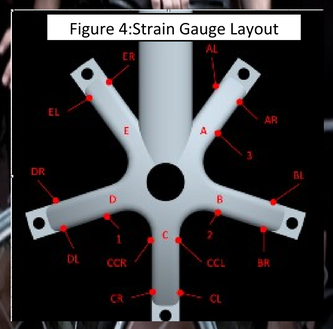

Figure 4:Strain Gauge Layout

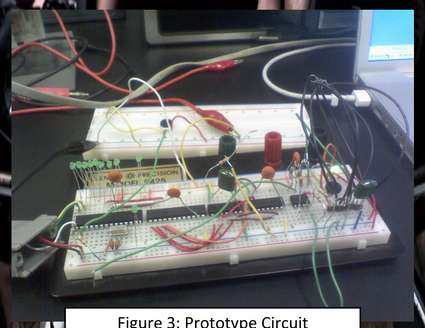

Figure 3: Prototype Circuit

Methodology

- Research Quarq Cinco, Garmin, strain gauges
- Attach strain gauges to spider
- Measure Strain, Torque and Angle
- Analyze strain data
- Relate Strain to voltage
- Learn to program ANT+ system
- Design Prototype Casing for electronics
- Design Circuit to measure voltage

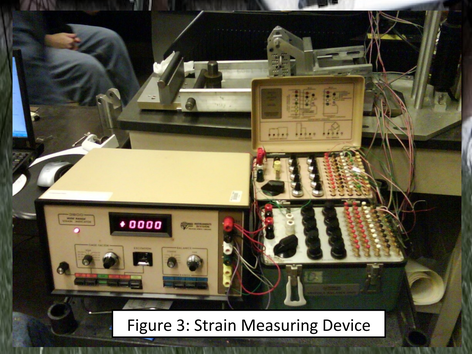

Figure 3: Strain Measuring Device

Future Plans

- RPM measurement
- More strain gauge measurements
- Reverse engineer Quarq spider/casing
- Optimize battery life/cost of end product
- Design electrical housing and spider
- Turn into a cycling product

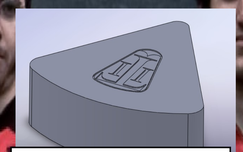

Figure 2: Electrical Housing

Acknowledgments

- Dynastream/Garmin
- Quarq
- Instron
- Micro-Measurements

Figure 1: Instron Machine

Roster

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