Bicycle Antilock Brake System

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Objective

Goals:
- Prevent skidding out during rapid braking
- Marketed to bicycle commuters and road cycling hobbyists

Customer Requirements:
- Increased safety / control
- Increased stopping power
- Effective for different conditions
- Low cost / maintenance
- Minimal weight / size
- Robust design

Engineering Metrics:
- Sensing system response time / accuracy
- Actuating system response time / accuracy
- Torque at actuator
- Braking force at rim
- User force required at brake lever
- Failsafe mechanism
- Actuator / sensor system masses

Constraints:
- Fit within bike frame
- Minimize excess weight
- Provide adequate stopping power
- Prevent skidding via staggered braking

Concept Generation

Fully Electric System
- Pro: Speed of actuation, weight
- Con: Reliance on electrics is a safety hazard

Hydraulic System
- Pro: Strongest aggregate braking force
- Con: Requires liquid reservoir

Final Design Teardrop Cam
- Pro: Simplicity and reliability
- Con: Large amount of tension on motor from brake line

Design

Product Operation:
- Hall-effect sensor detects tire lock
- Motor spins cam and actuates brakes

Key Functional + Innovation:
- ABS achieved by eccentric cam
- Geometric-based solution
- One-time “on”/ “off” signal input
- Failsafe design

Tradeoffs + Sacrifice:
- Robustness vs. ergonomics
- Price vs. weight / size

Customer Requirements:
- Robust design w/ failsafe
- Reliable brake control
- Minimal weight / size

Prototype and Testing

Prototype:
- Wooden cam
- Mounted on open case
- Radial bearings on the motor

Testing:
- Sensor and actuation accuracy
- Overall ABS effectiveness
- Controller response time
- Bike stop test (from 15mph)
- Bike controllability via user feedback

Brake cable tension: 55 lb.

Improvements:
- Lighter parts → more marketable product
- Reduce friction on brake cable → longer life

Test Results and Future Work

Design Process Summary:
1. Determined customer needs through market research
2. Generated concepts according to design specifications
3. Selected concepts using AHP
4. Identified subsequent improvements from prototype testing and user feedback

Plans for the Future:
- Proof of concept prototype:
  - Switch steel parts → aluminum
  - Cam with roller bearings
  - Motor w/ proper specs
- Make modifications according to user feedback
- Manufacturing and marketing costs