Electric Motor Control with Regenerative Braking

Cody Doremus & Keegan Roach

Advisor: Mr. Gutschlag

Bradley Electrical Engineering Senior Design Project

Presentation Outline

- Project Goals
- Project Background
- Regenerative Breaking Overview
- Research
- Intermediate Goals
- Schedule

Project Goals

- Design and implement a test bench to determine the efficiency of regenerative braking
- (Optional) Design a Drive for a Synchronous AC motor

Background Information

- Spin off of current Bradley Mechanical Engineering electric vehicle project

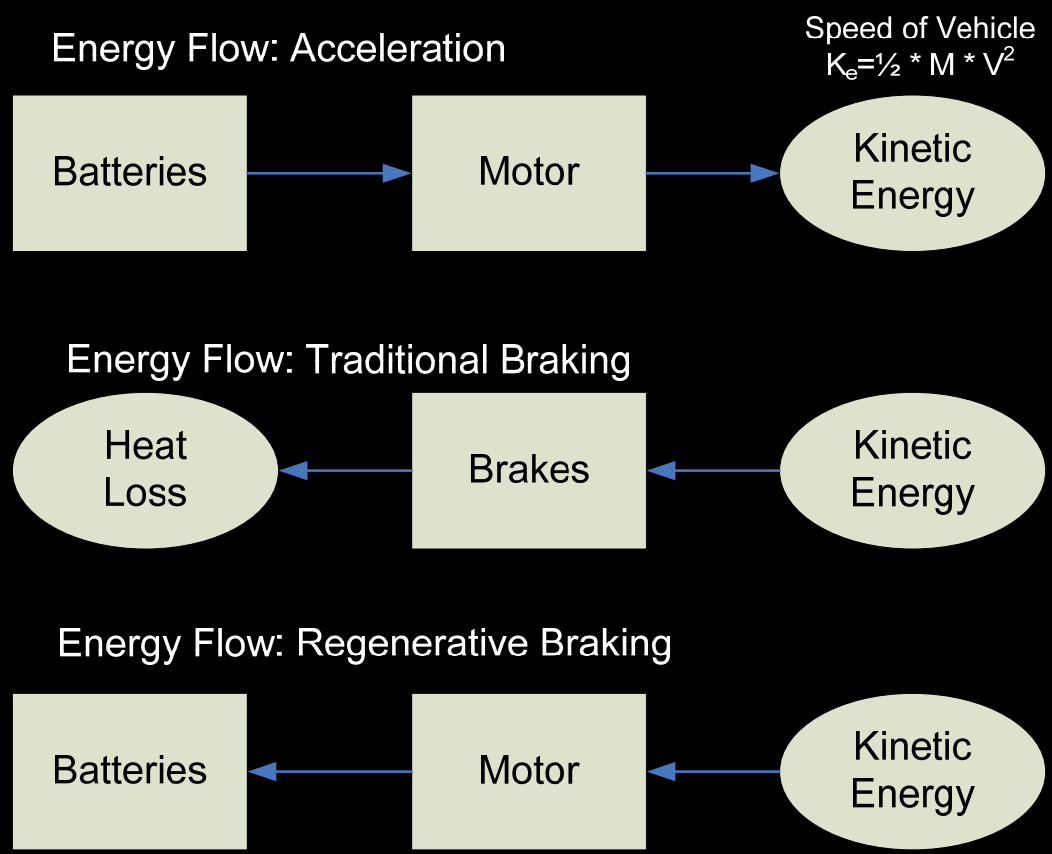
Technology Comparison

- Electric Vehicles today:
  - Zenn (Feel Good Cars):
    - $11,000-$14,000
    - 25 mph max
    - 25 mile range
    - 1705 lbs
  - EV1
    - $34,000
    - 80 mph max
    - 75 – 130 mile range
    - 2900 lbs
- Bradley Mechanical Engineering Ultra Light Concept Vehicle Desired Specifications
  - <$5000
  - 45 mph max
  - 100 mile range
  - <600 lbs.

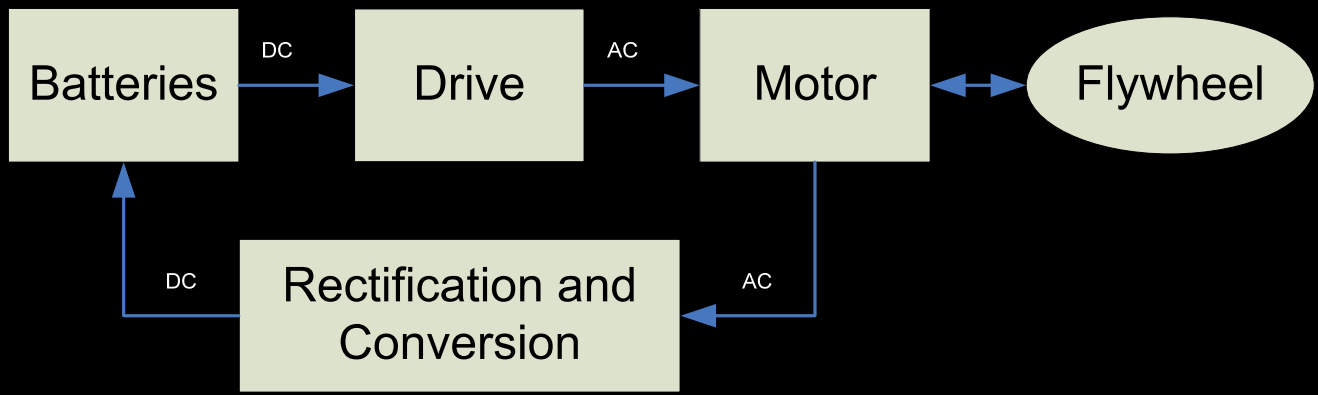
Regenerative Breaking - Overview

- Regenerative braking is used to improve the efficiency (fuel economy) of:
  - Electric Vehicles
  - Hybrid Vehicles
  - Industrial Applications
- Lowers operation costs

Regenerative Breaking - Overview



Regenerative Braking - Overview



Research

- Motors
- Drives
- Energy Storage
- Power Conversion
- Existing Products

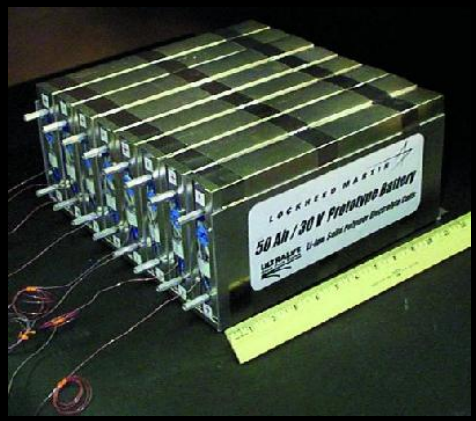
Motors

- DC Motors (Brushed)
- AC Wound Rotor Motors (Commutated)
- AC Induction Motors
- Synchronous AC Motors - Aka Brushless DC
- Wheel Motors

Drives

- AC Servo Drives
  - Torque Control
  - Velocity Control
  - Position Control
  - Integrated Electronics
    - 3-Phase AC rectifier
    - Multiple feedback options
    - Very elaborate control systems

Energy Storage



- Lithium Ion Batteries
  - Best Energy Density
  - Highest Cost
- Nimh Batteries
- Nicad Batteries
- Lead Acid Batteries
  - Lowest Energy Density
  - Lowest Cost
- Ultracapacitors

Power Conversion

- DC/DC Converters
- Inverters
- Rectifiers
- Transformers

Existing Products: Toyota Prius

- NiMh Batteries
- Synchronous AC Motor

Existing Products: Honda Accord

- NiMh Batteries
- Synchronous AC Motor

Intermediate Goals

1. Construct Test Bench
2. Develop Simulation Models
3. Design & Implement Regeneration
4. Collect Experimental Data
5. Compare Experimental Results with Simulations
6. Design a Simpler Controller (optional)
7. Repeat Experiment for Simpler controller (optional)

Schedule

X-Mas	Test Bench Construction
Week 1	Test Bench Construction
Week 2	Test Bench Construction
Week 3	Simulation Modeling
Week 4	Simulation Modeling
Week 5	Simulation Modeling
Week 6	Confirm Simulations by testing motor w/ Flywheel
Week 7	Take Regeneration Data
Week 8	Take Regeneration Data
Week 9	Design Controller
Week 10	Design Controller
Week 11	Design Controller
Week 12	Final Presentation

Questions