Lessons from the Arduino Experience

Mike Butts

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FPGA Fast Start Workshop

Electric Vehicles with Arduinos

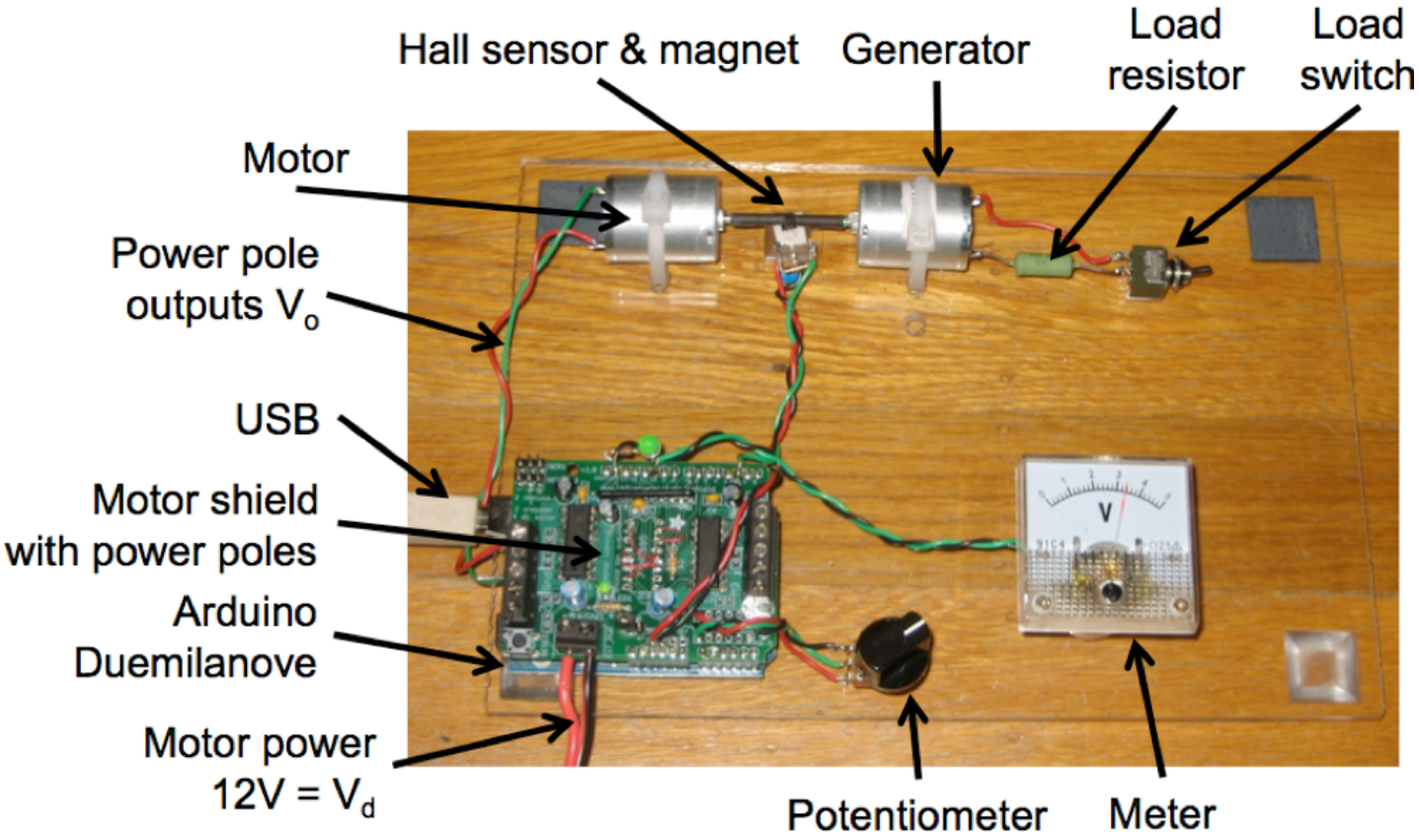
- In 2010, Prof. Dan Hammerstrom and I created a course sequence on Electric Vehicle Technology at Portland State University.

- Since EVs depend on embedded computers, we based labs on Arduinos:
  - Controlling brushless DC motors
  - Charging lithium batteries
  - Keeping battery packs balanced
  - Dashboard instrumentation

- Final exam: Students "rode their own software", running the same motor, battery and instrument code they wrote in the labs.

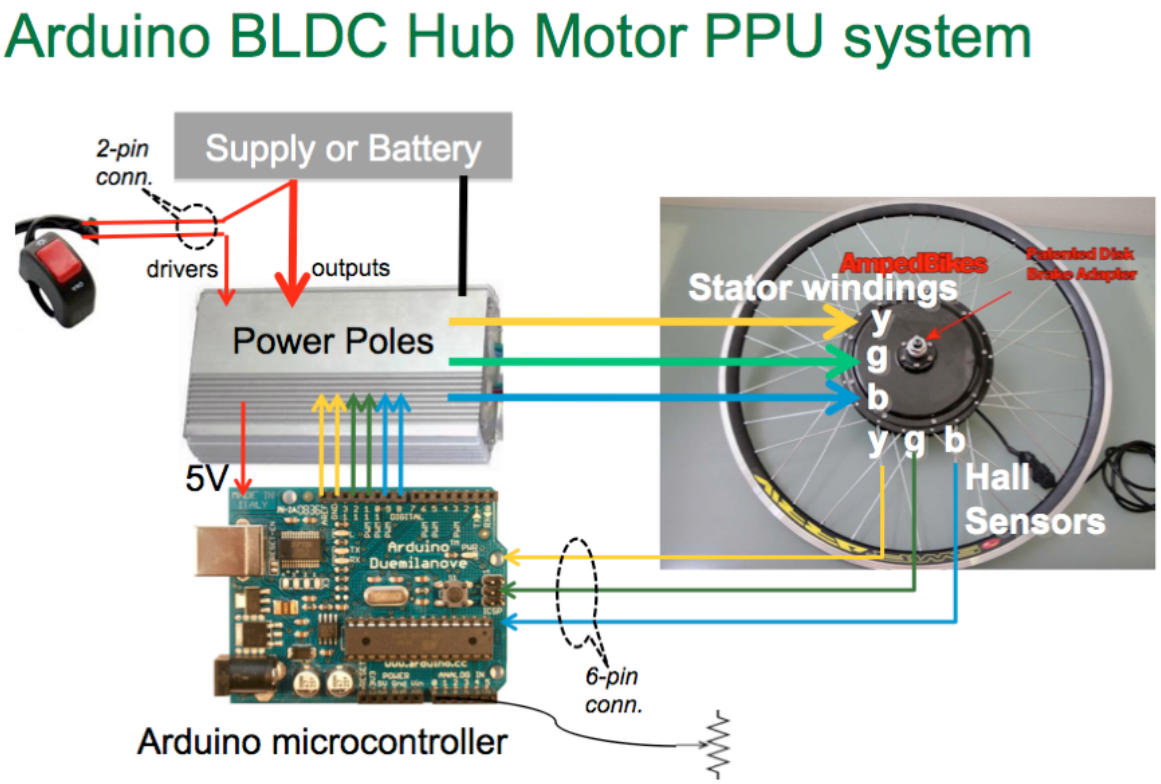
Simple First and Second Labs

- Hands-on, Human-scale, What You See is What You Get
- Very quick edit cycle. Add a feature in a minute.



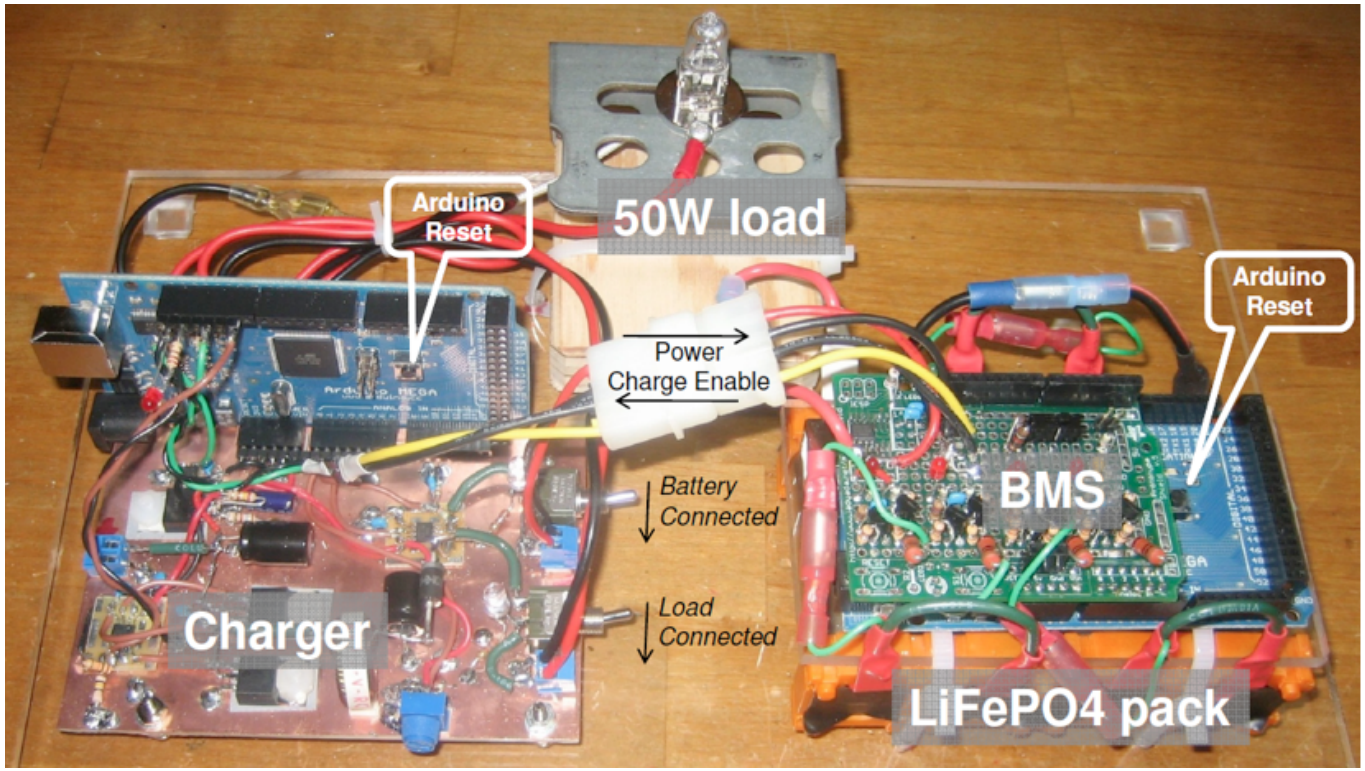
Real Brushless DC Motor Lab

- Arduino interfaced with power electronics



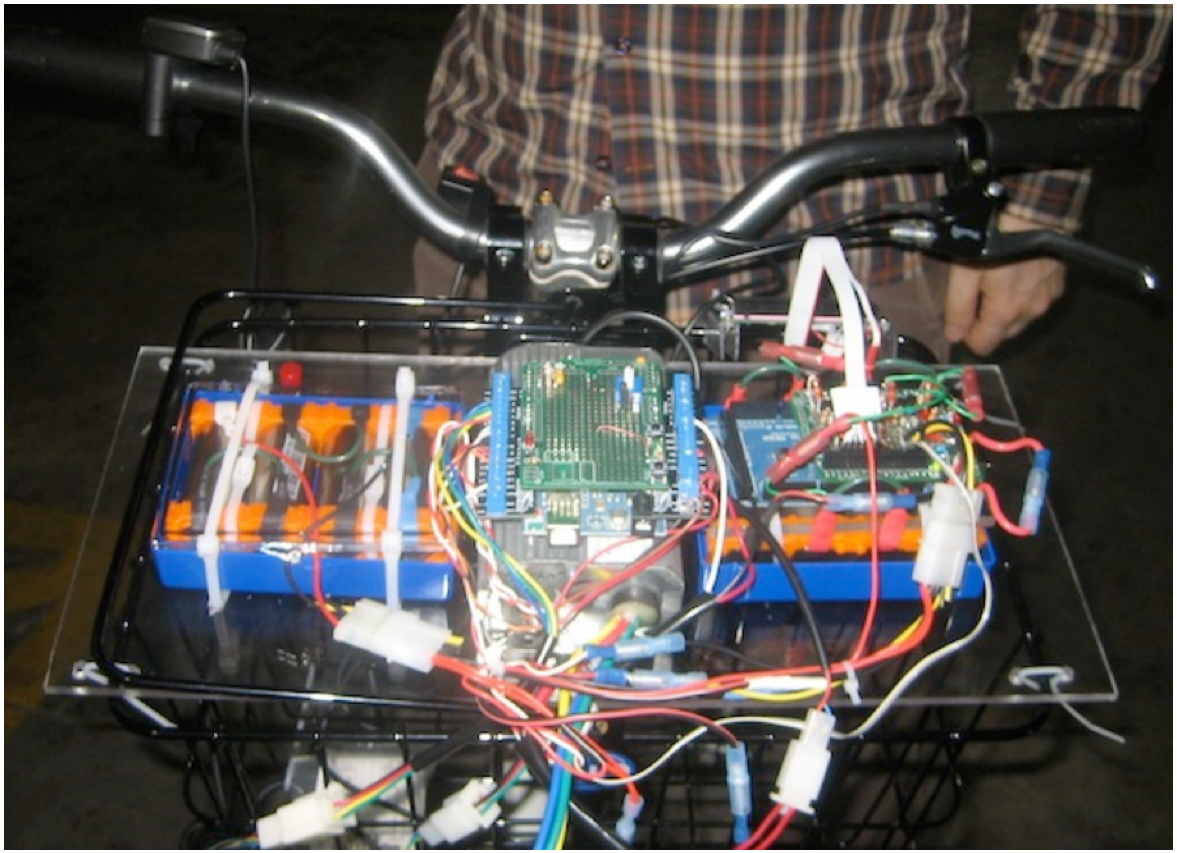
Multi-Arduino Li Battery System

- Arduino Lithium Battery Charger communicates with Arduino Battery Management System.



On the Bike

- Labs are combined on a real electric vehicle the student can ride.



Why Does Arduino Work So Well?

- With Arduino you can make things happen in the real world.

- Hands-on, cheap hardware with free, simple software and great docs.
  - Many students bought their own hardware, cheaper than a textbook.
- Quick and easy to get first results, short satisfying steps from there.
- Lots of “shields” (add-on cards) to interface with sensors and actuators.
- Non-volatile program storage: upload once and run forever.

- Simple C language subset in simple IDE makes most things easy.
- Rich function library to grow into incrementally.
- Arduino’s setup() / loop() program structure is natural for code that actually does things.
- Simple “print”-type debugging on the development PC.

How Can an FPGA be Like Arduino?

- Very simple IDE like Arduino.
- Use a simple subset of Verilog in a setup/run type of structure.
- Rich and easy to use function library.
- Non-volatile program storage: upload once and run forever.
- Simple debugging on the development PC.

- FPGA must operate stand-alone after development. No accelerators!
- Target real-world-interactive projects.
- Easy to interface to rich inputs like video, audio.
- Easy to interface to rich outputs like displays, speakers.
- Integrate an Arduino-like processor for low-speed sensors and actuators.