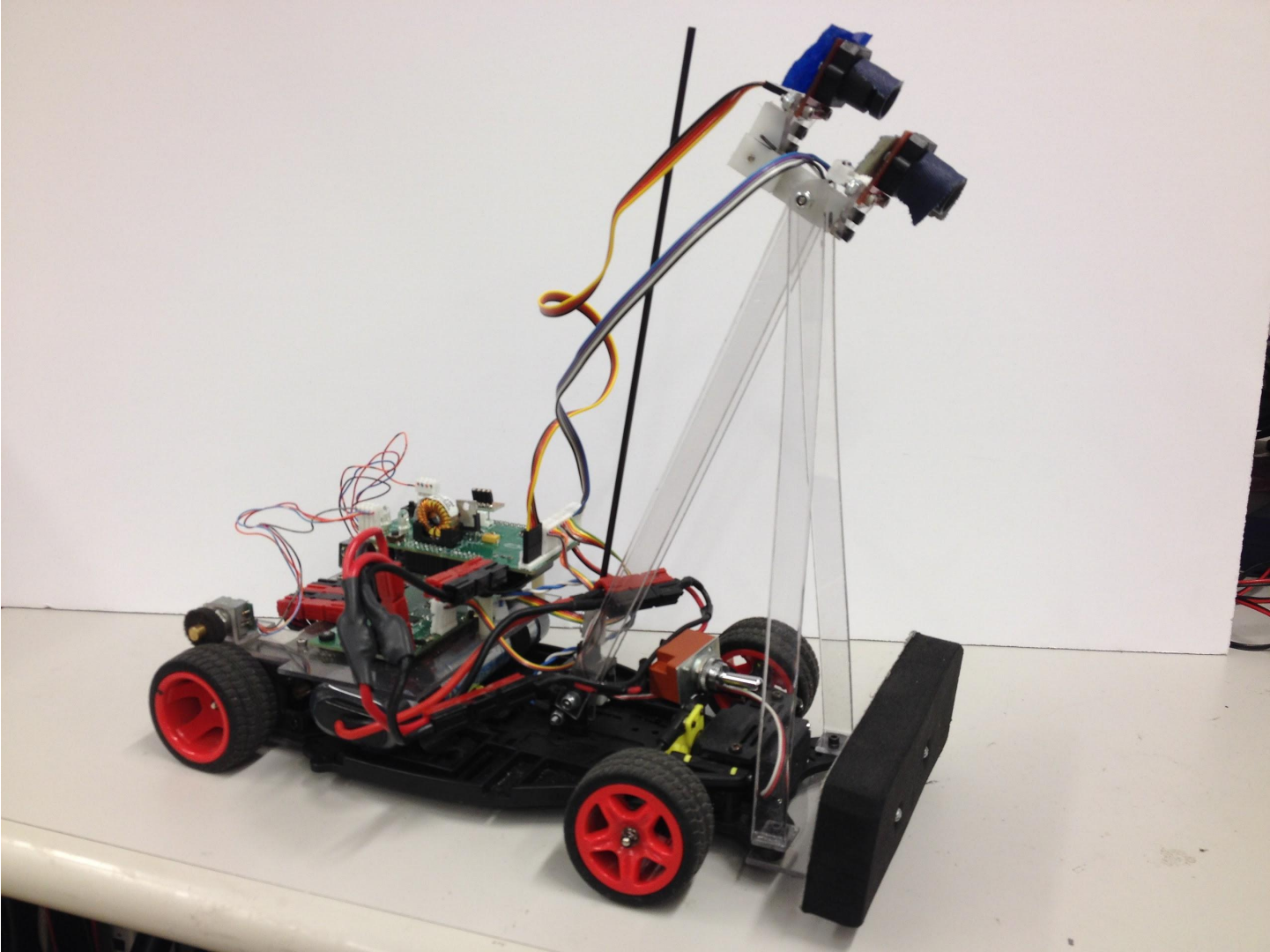


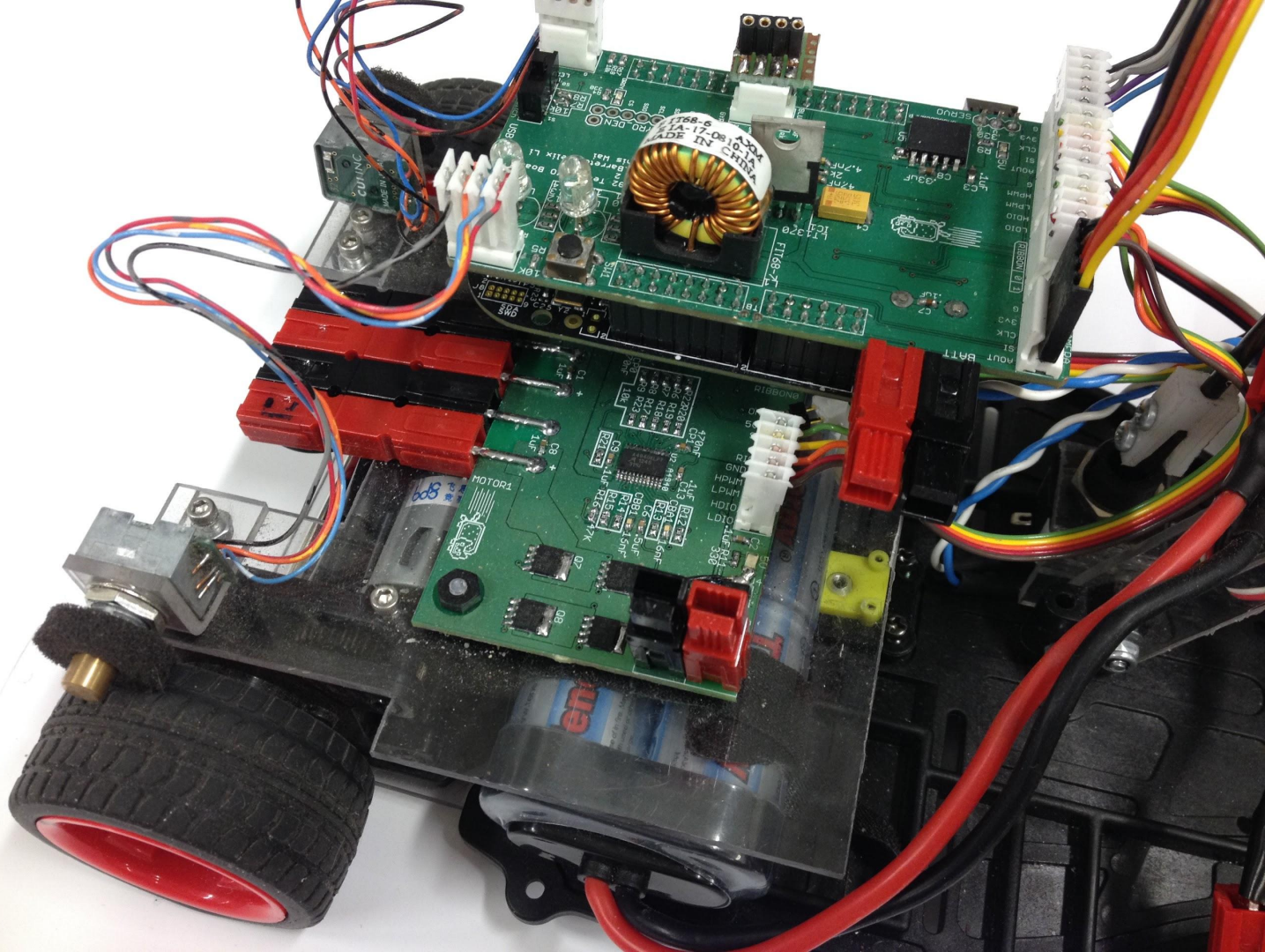
Team 1

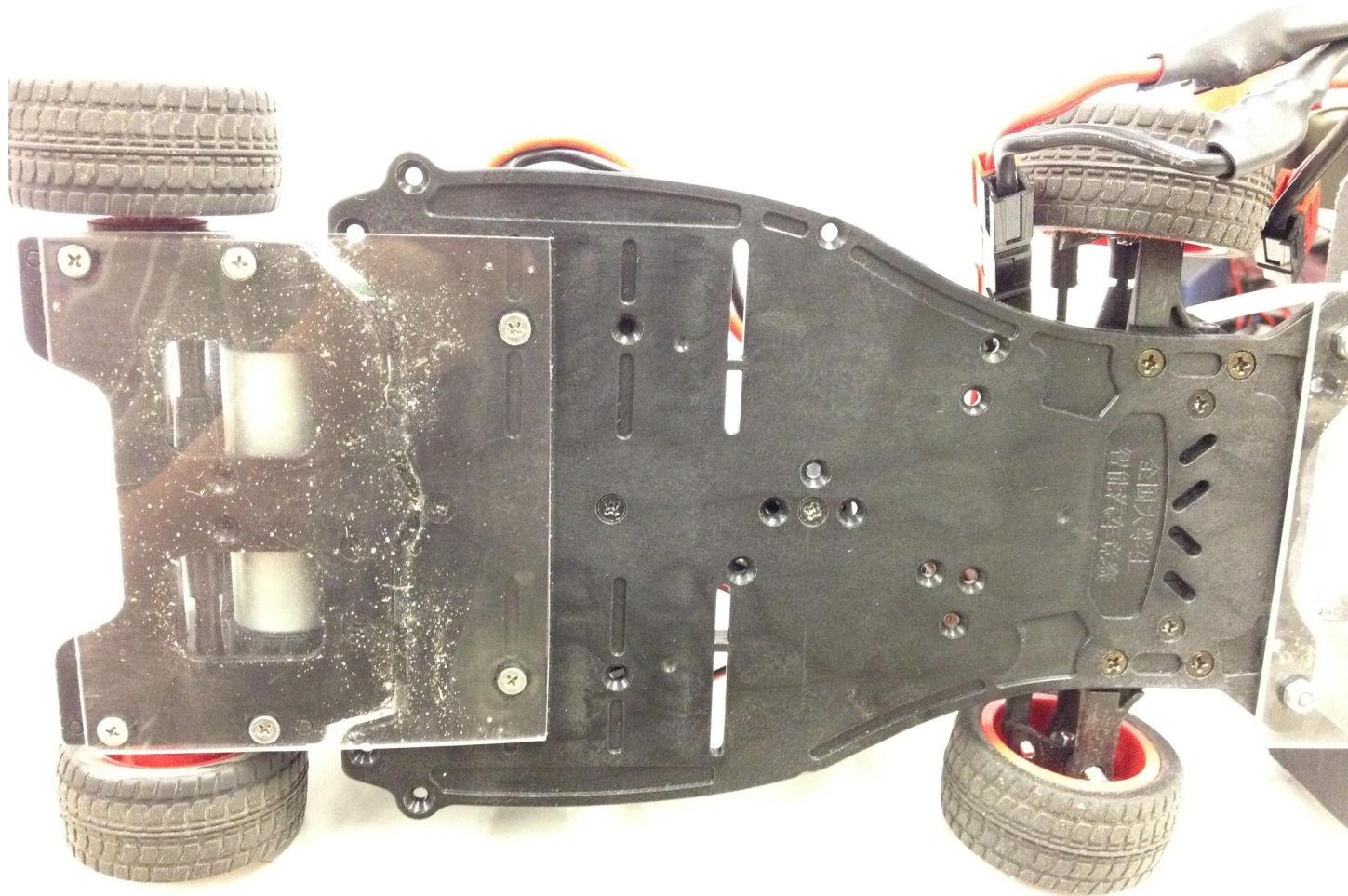
Max Barreto, Felix Li, Dennis Wai

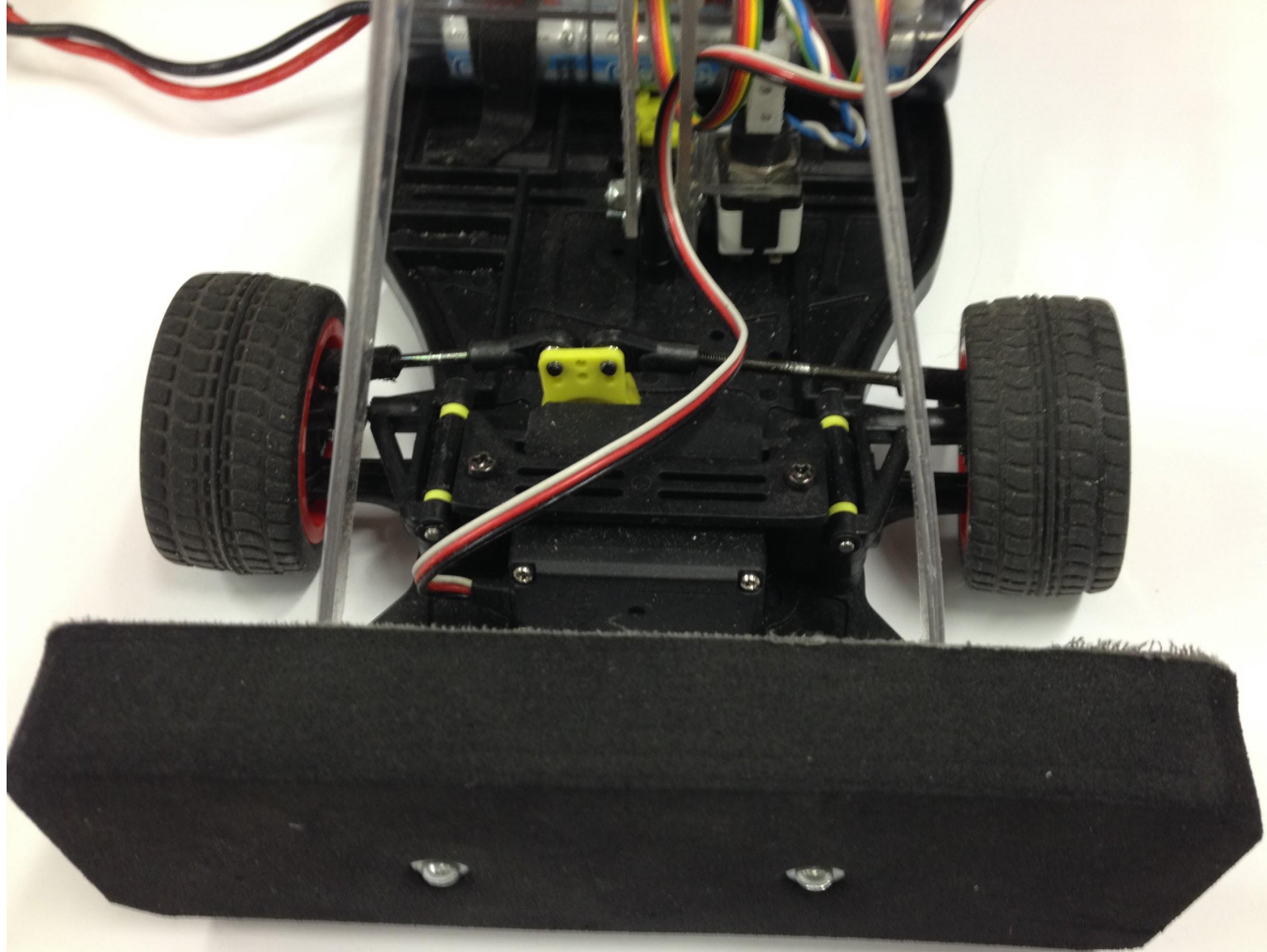
Vehicle Hardware (Mechanical)

- Needed to be reliable, light, and strong
- Polycarbonate is light and strong but quite flexible. Used tricks to fix.
- Removed extraneous parts of base car and replaced them
- Cambered front wheels for better turning

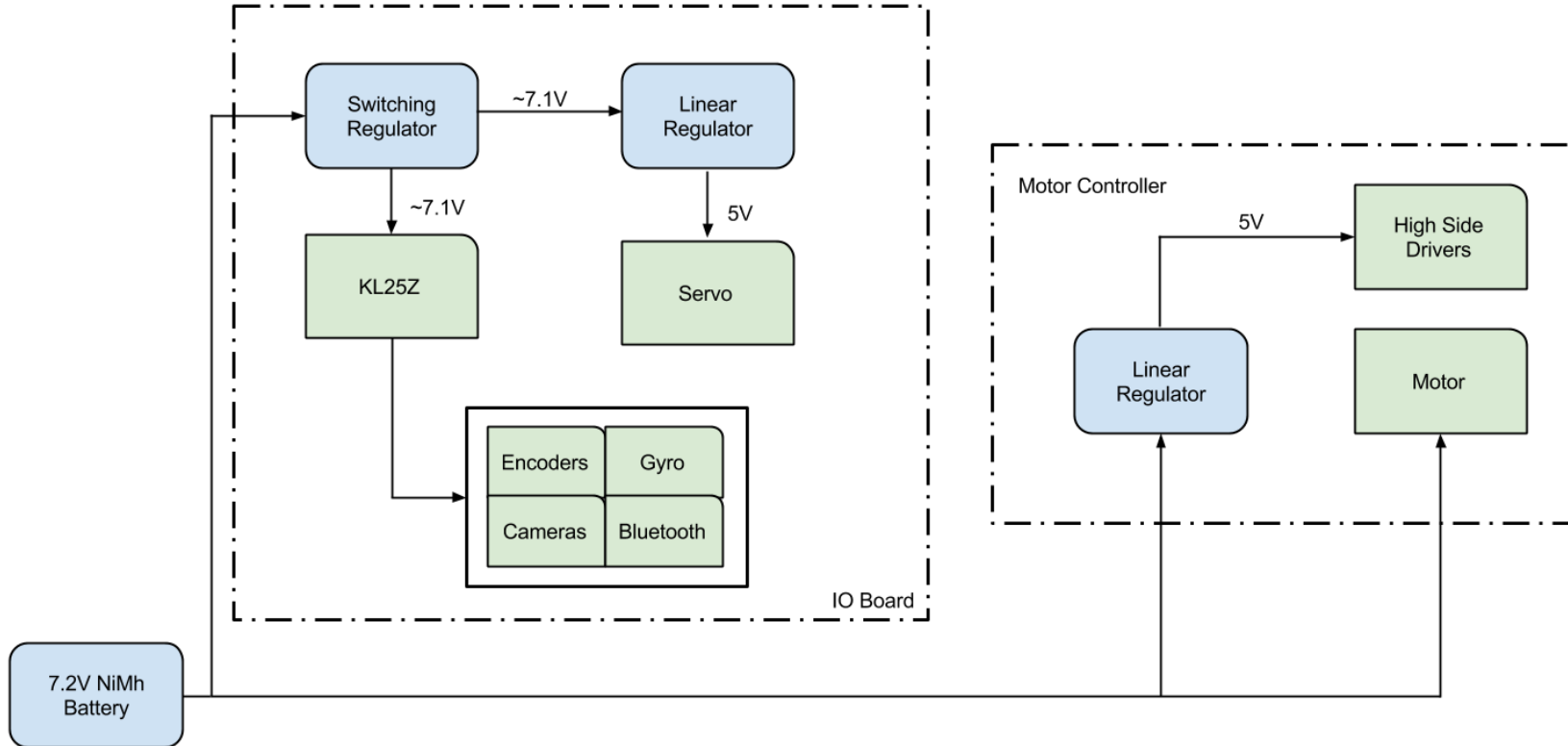




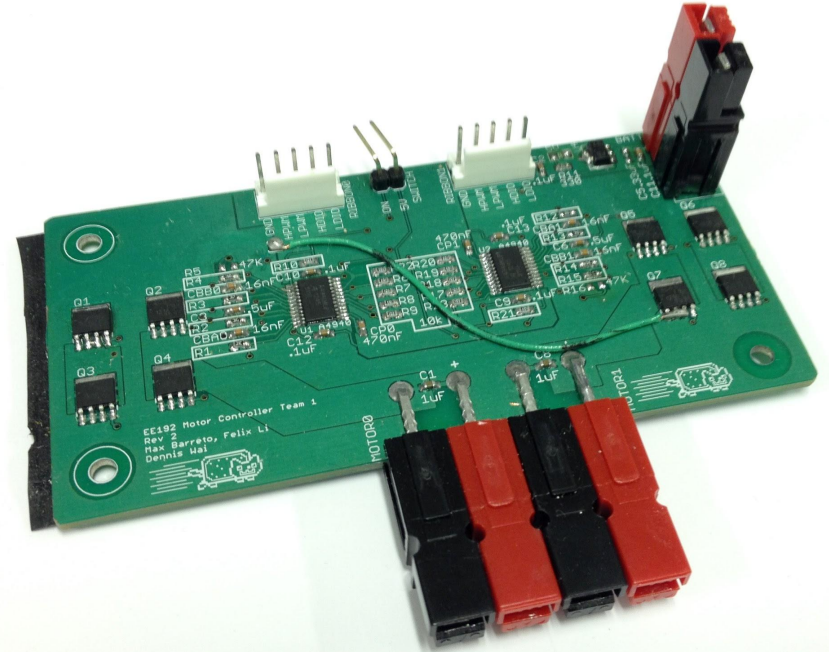
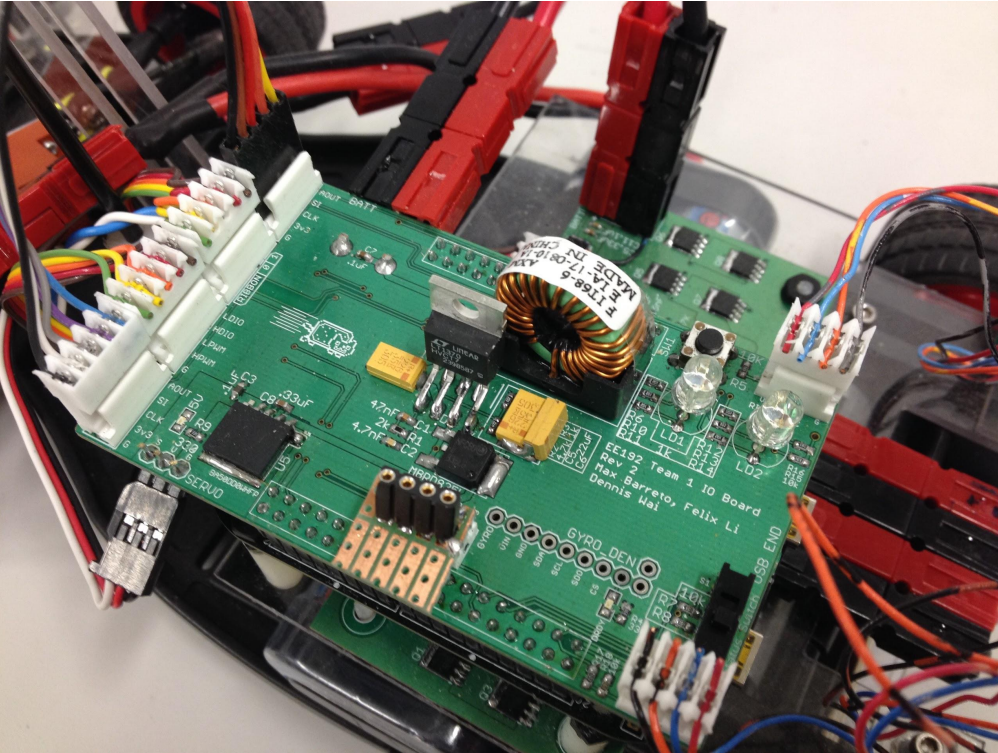




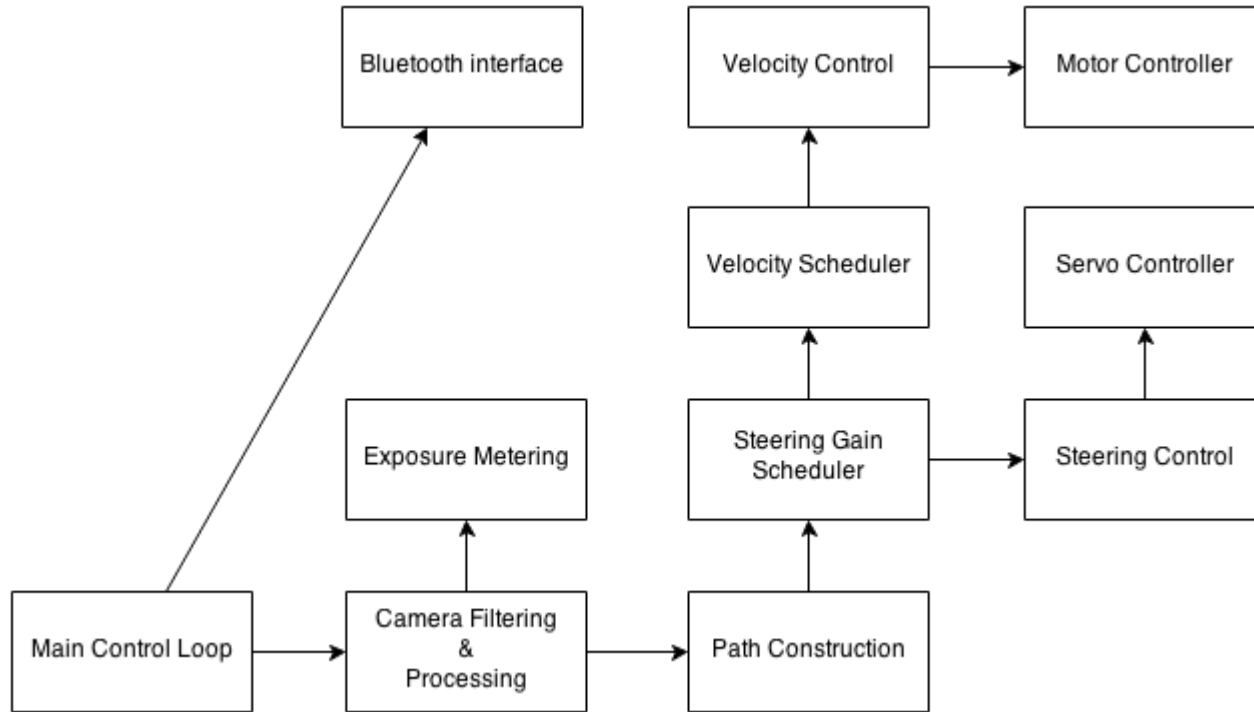
Vehicle Hardware (Electrical)



Vehicle Hardware (Electrical)



Software



Software

- Makes use of a drive/brake H-bridge
- Fast camera reads
- Avoided floating point operations where possible
- Tried to maintain real-time OS
- Object oriented programming eased writing and debugging

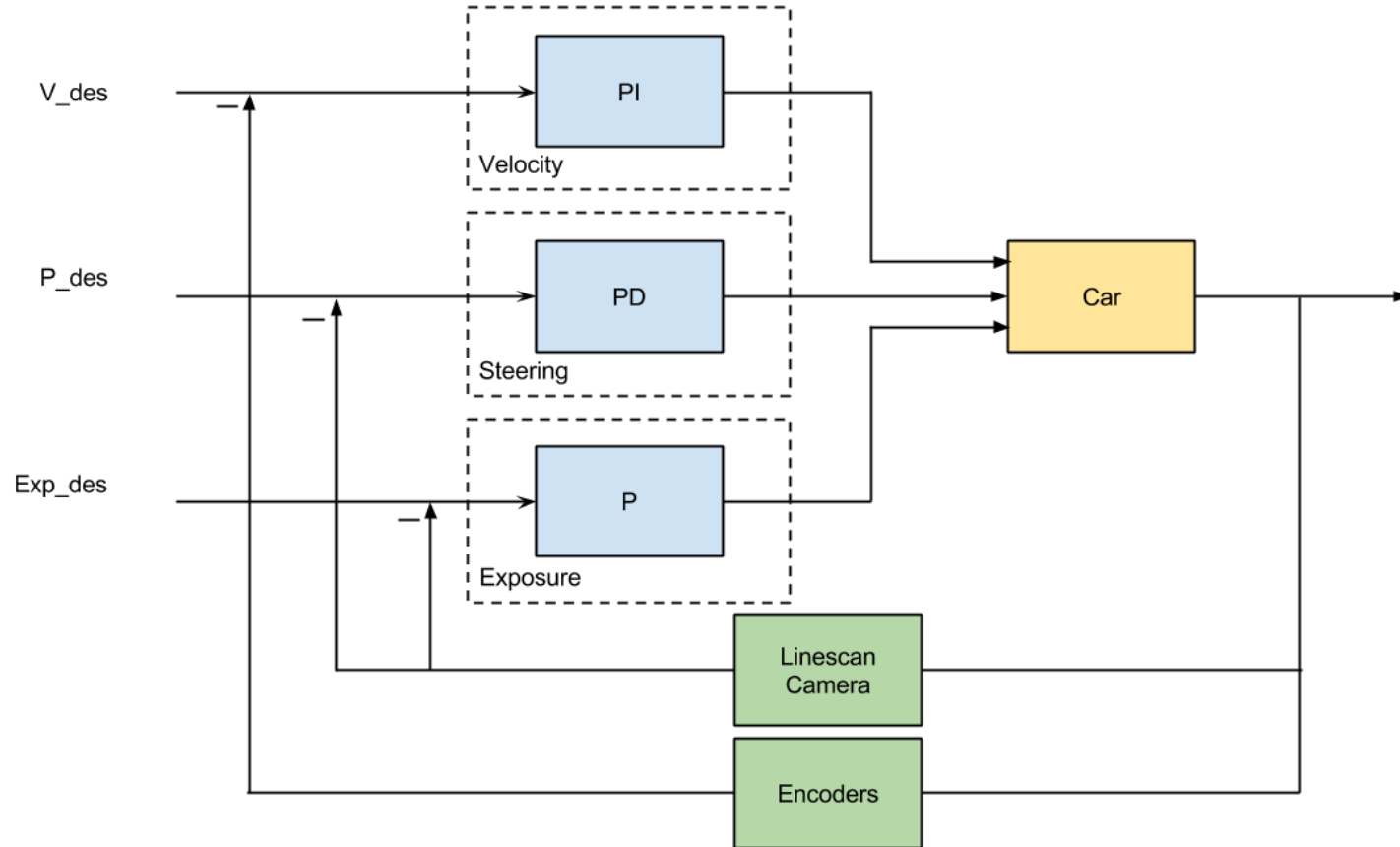
Software

Tried to keep at least 10ms update period

Camera	10ms between data reads and exposure adjustment
Velocity Control	20ms between PID calculations
Servo Update	10ms so each camera reading can be used to adjust our heading

- Line sensing used spatial high pass filter and temporal low pass filter
- Allowed us to filter noise from shaky camera
- Bonus: Can cut through jogs

Controls

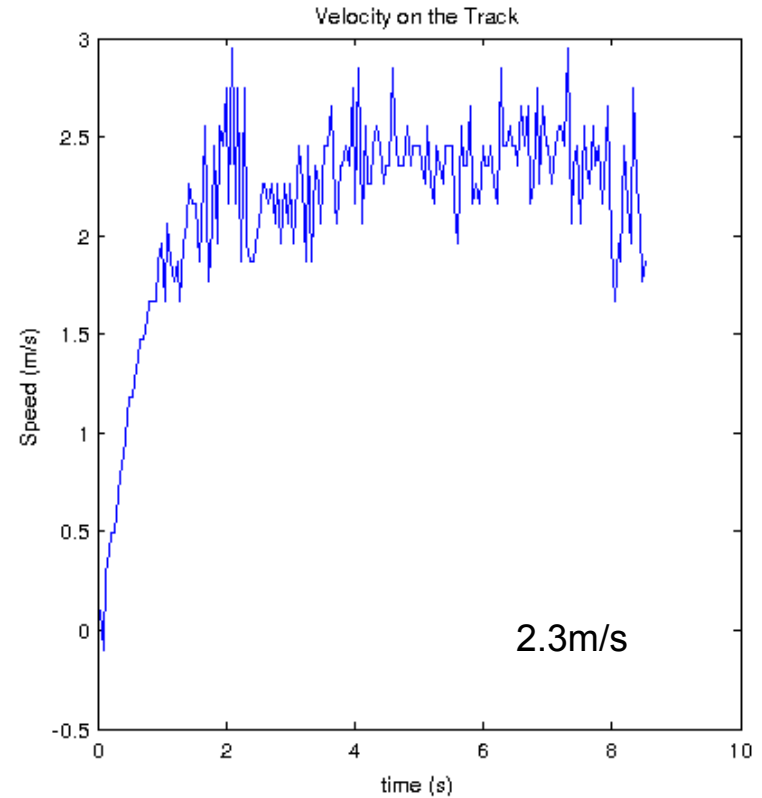
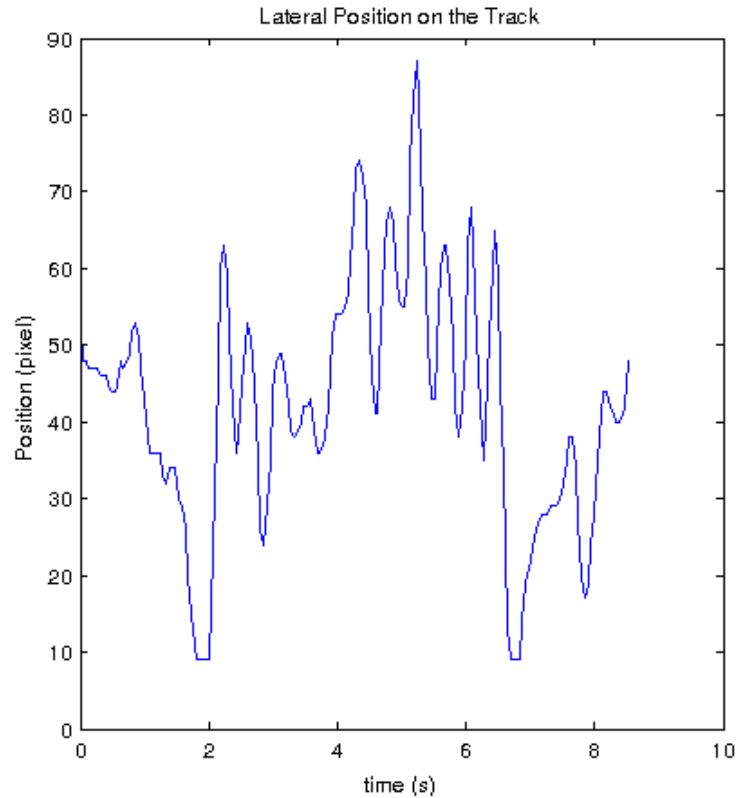


Controls

Gain	Units
$K_{sp} = 6$	servo on time / error pixel
$K_{sd} = 4$	servo on time / rate of change of error pixel
$K_{vp} = 7$	duty cycle / ticks per second
$K_{vi} = .1$	duty cycle / accum. ticks per second
$K_{ep} = 7$	exposure time / saturation value

- No simulations, all empirical
- Discrete time system leads to instability
- Gain scheduling

How well did it work?



Lessons Learned

- A working car is infinitely more valuable than a potentially working one
- On-the-fly tuning and state feedback are really valuable
- Advice: ASCII o-scope is super useful for camera data
- Well-machined parts are nice, but not needed

Lessons Learned

- Through-hole component saves time in the long run but might restrict features
- Start thinking about Freescale much earlier because the course is set up incongruously right now
- Testing points on hardware
- Unit test, unit test, unit test

Lessons Learned

- If it ain't broke, don't fix it
- Make sure everyone brushes up their git-fu
- It's OK to reduce code flexibility for reliability
- Header files and scope are confusing
- Interrupts are great, but only in moderation
- Tuning PID takes a lot of time
- **DOUBLE CHECK YOUR SPELLING**

Roles and Contributions

- Max: Mech. design and fabrication and controller design
- Felix: Low level drivers and software architecture. Electrical debugging
- Dennis: Electrical design and controls