Bringing ROS to the FIRST Robotics Competition

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Meg Massengill IBM

What we're doing:

- 40 high schoolers
- 10 mentors
- Yearly competition
- Integrating latest tech
- Inspiring others

What we strive to do:

- Win competitions
- Push boundaries
- Fully automate robot

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FIRST®

For Inspiration and Recognition of Science & Technology

FIRST® LEGO® LEAGUE JR.	FIRST® LEGO® LEAGUE	FIRST® TECH CHALLENGE	FIRST® ROBOTICS COMPETITION

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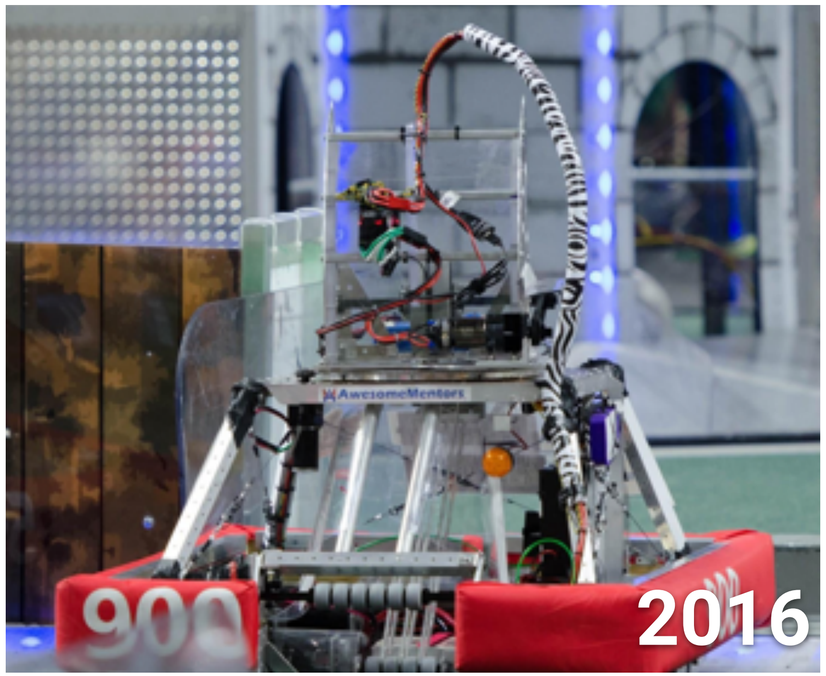
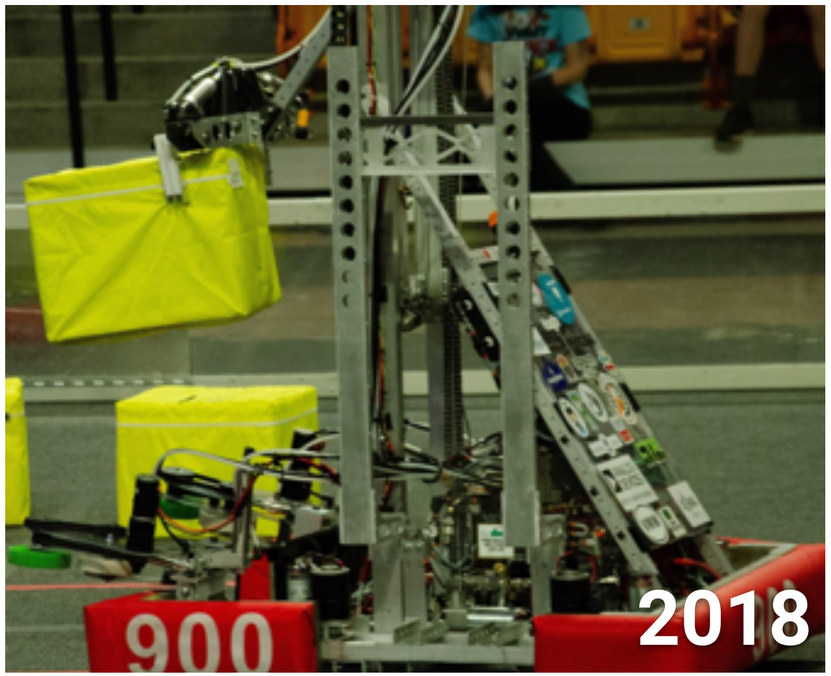
FIRST Robotics Competition (FRC)





FRC Robots

Hardware:

- ~150 lbs
- Size limited
- Parts limited by cost and rules

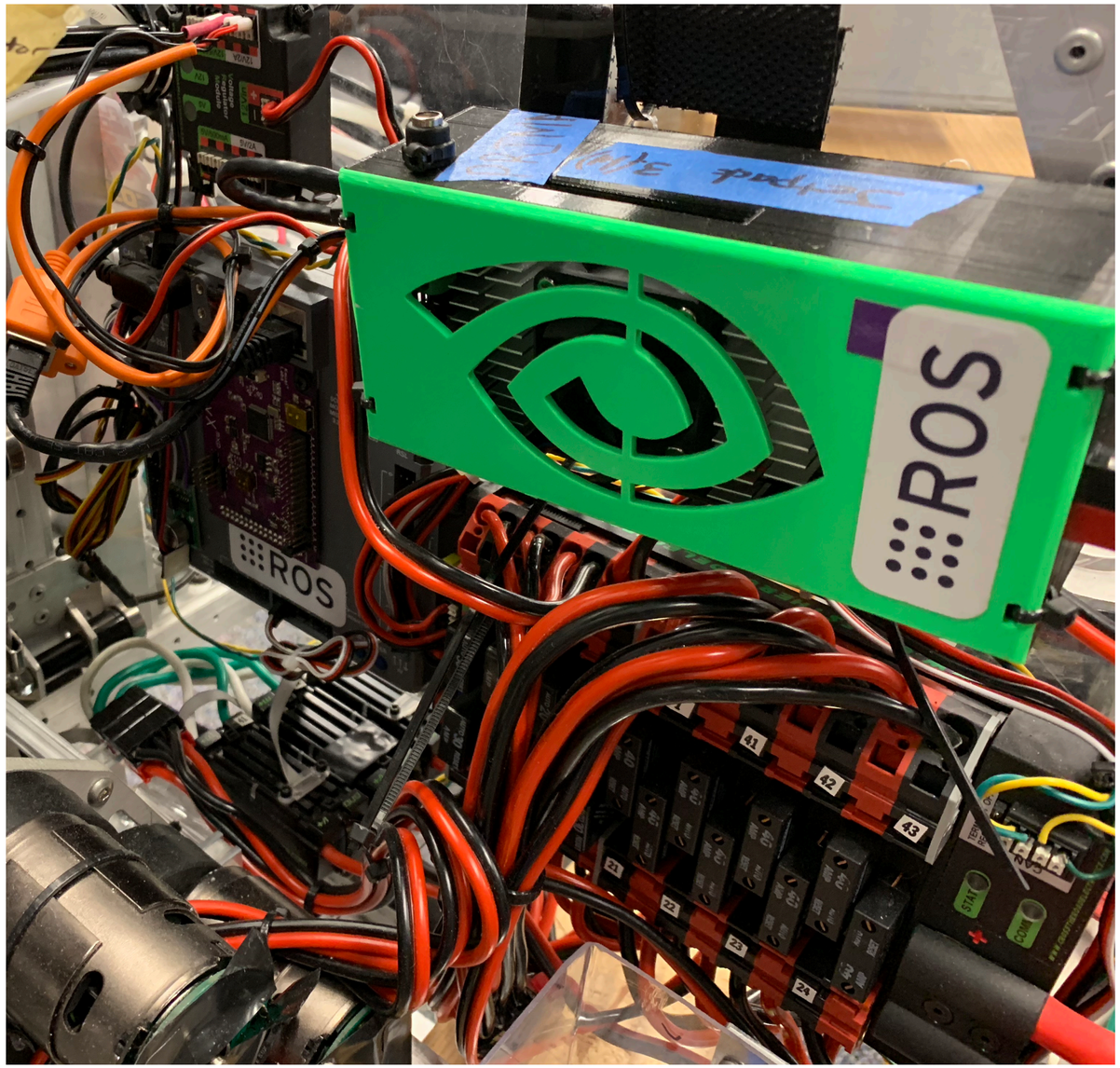
Software:

- NI roboRIO CPU/IO module
- C++, Java, & LabVIEW
- WPIlib HAL

Why ROS?

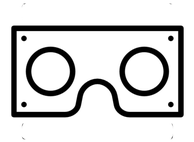
Zebracorn Robots:

- Multiple processors (Jetsons)
- Sensors:
  - ZED stereoscopic camera
  - LIDAR
  - mmWave RADAR
  - Lots of others…
- Data acquisition and analysis
- Dreams of full automation



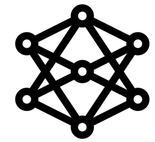
How did we get here?

2012 — Stereoscopic vision



Jetson TK1 and ZeroMQ — 2015

2016 — TX1 running neural networks



Team discovers ROS — Summer 2016

2017 — ROS for LabVIEW

Tufts UNIVERSITY

Initial working ROS build — Summer 2017

2018 — First FRC robot to run full stack

ROS

roboRIO: Hardware & Software

Hardware:

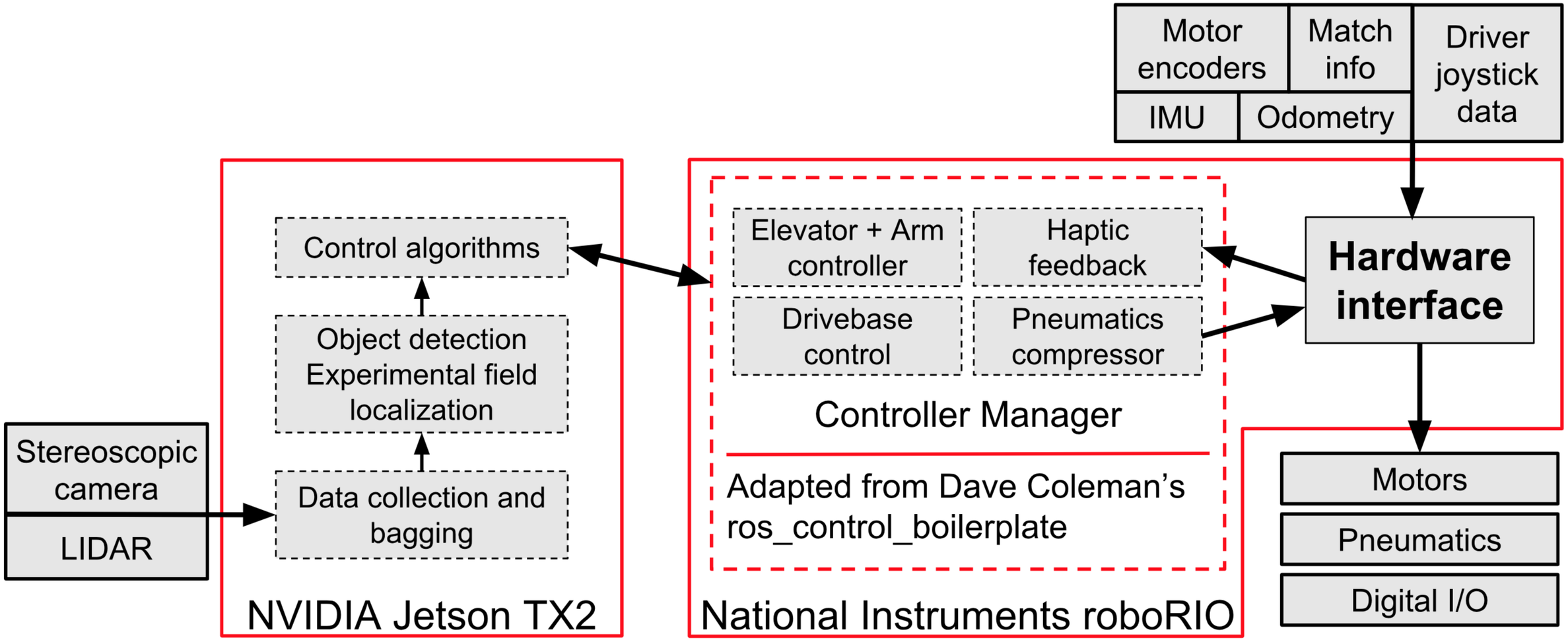
- Dual ARM Cortex-A9 @667Mhz
- 256MB RAM
- 512MB File System
- Analog, Digital I/O, SPI, CAN

Software:

- National Instruments RT Linux
  - No pre-built ROS binaries
- ROS source code
  - Hacked os_detect.py
- Cross-built on x86
  - FRC Specific GCC ARM compiler
- WPIlib provides hardware Interface
  - ROS now a recognized framework!

NATIONAL INSTRUMENTS

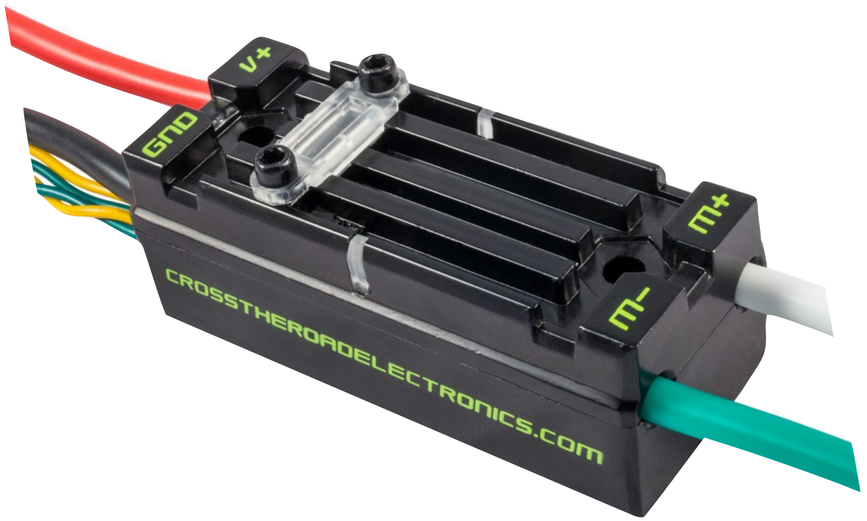
ROS Configuration



Motor Controllers

Cross the Road Electronics - Talon SRX:

- CAN bus motor controller
- 60A, 6-28V
- Highly configurable software

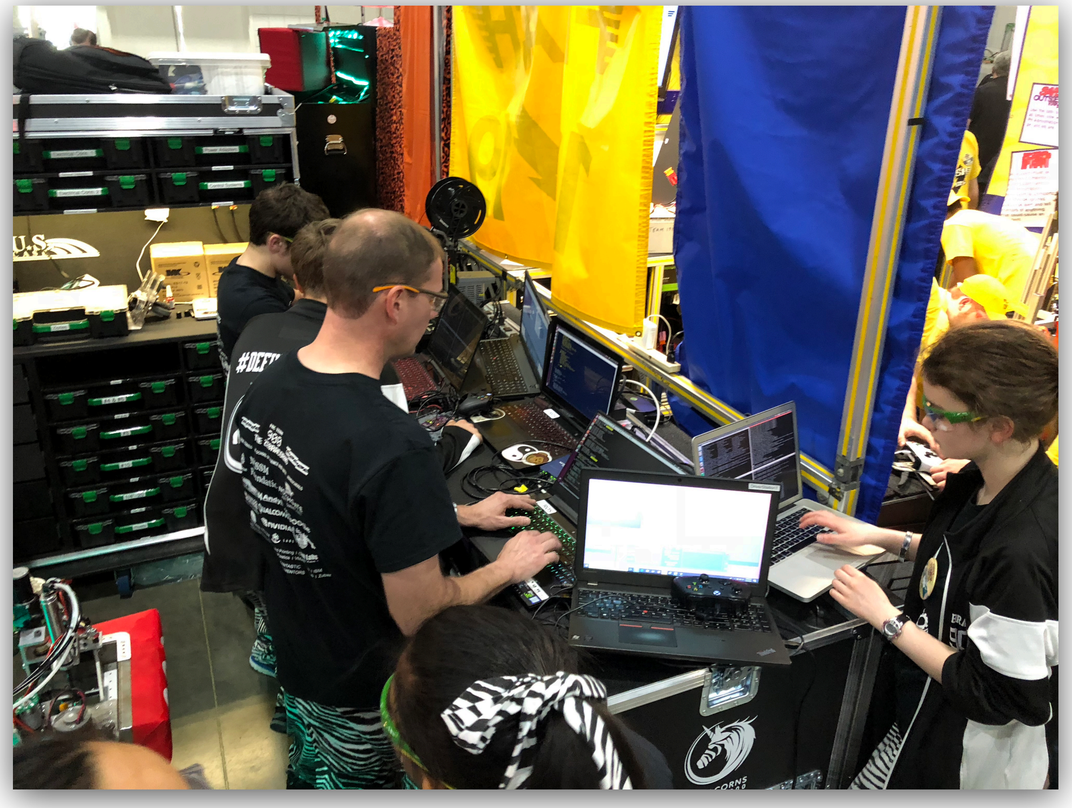


Features:

- PIDF 1KHz rate
  - Position, velocity, & current
- Motion profiling modes
- Encoder/Limit Switch Inputs
- Ramp rates
- Offload control from roboRIO

CTR ELECTRONICS

Our Custom Controller Packages



`talon_interface`

- Array of objects for talon state
- Array of objects for talon command

`talon_state_controller`

- Publishes state data
- Talon hardware → software controllers

`talon_controllers`

- One base talon command controller
- Child classes provide more functionality for different modes
- Designed as a drop-in replacement for standard ROS controllers

Other Controllers

Mechanism controllers:

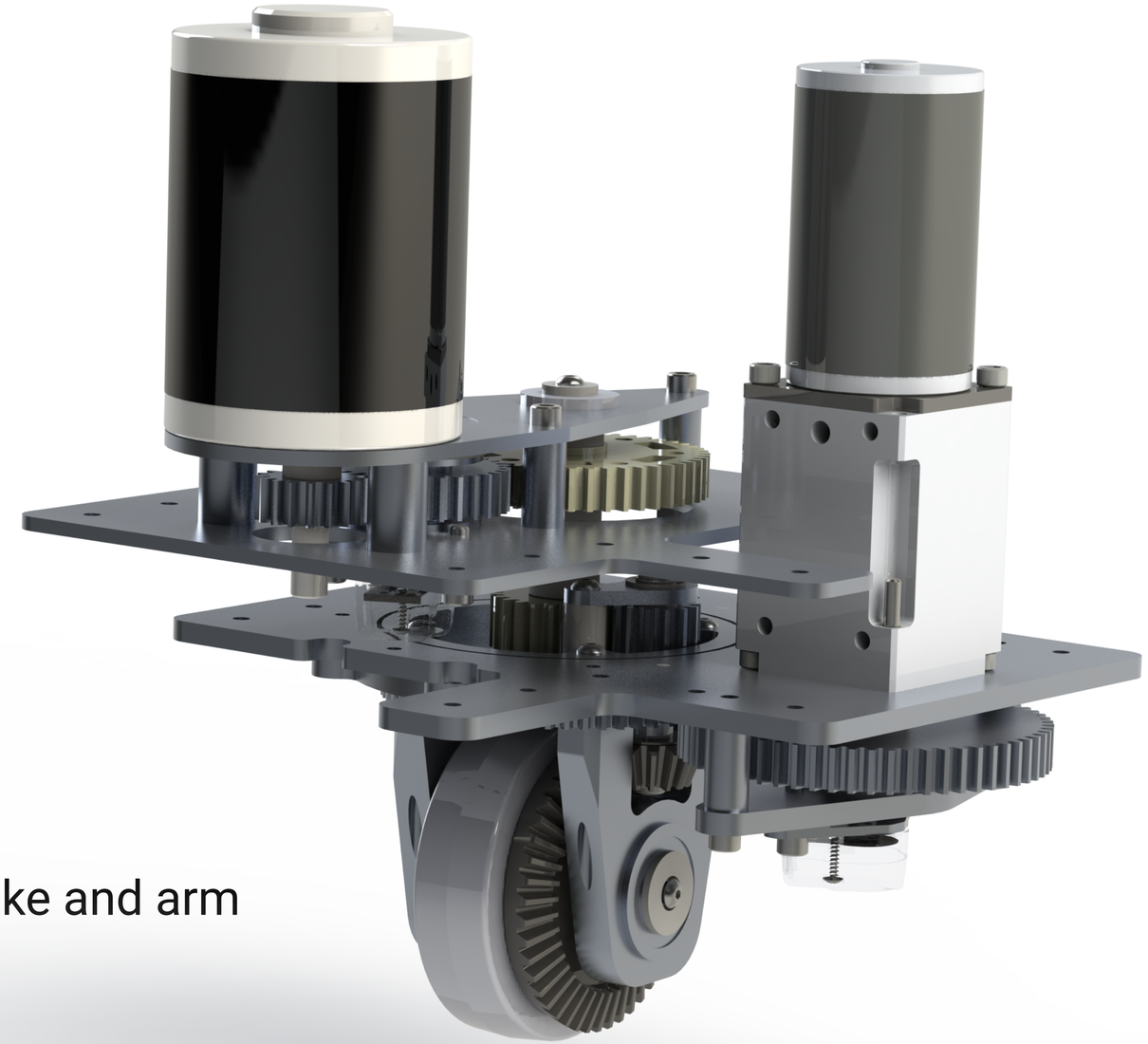
- Integrates multiple talon controllers

Swerve drive controller:

- Motion profiling
- High maneuverability (3 DOF)

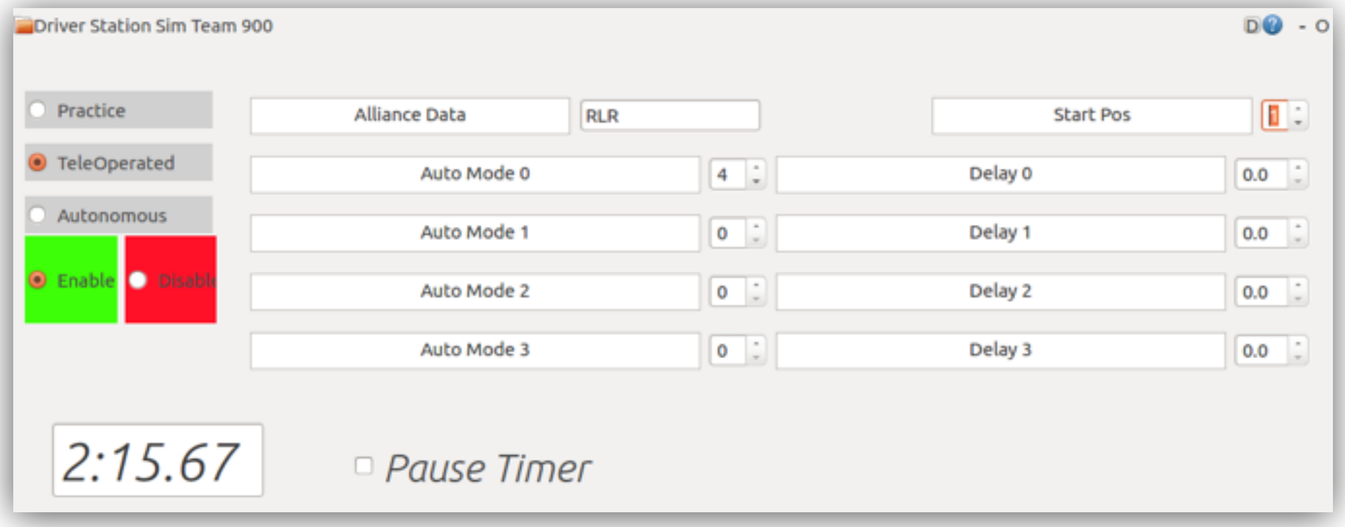
Elevator controller:

- Arm limiting
- Managed intaking and lifting cubes
- Automated transfer of cube between intake and arm

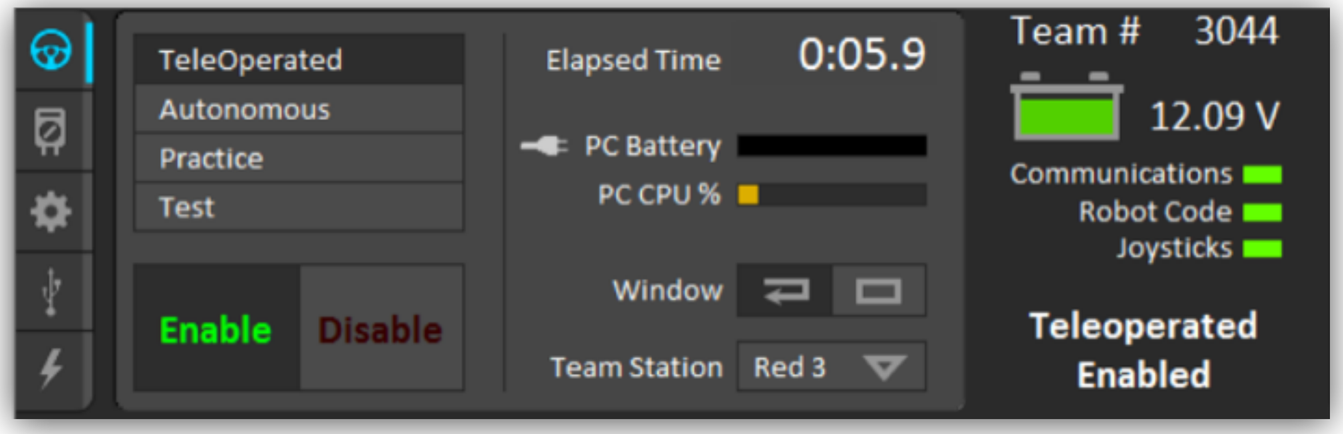


Custom Simulation Interface

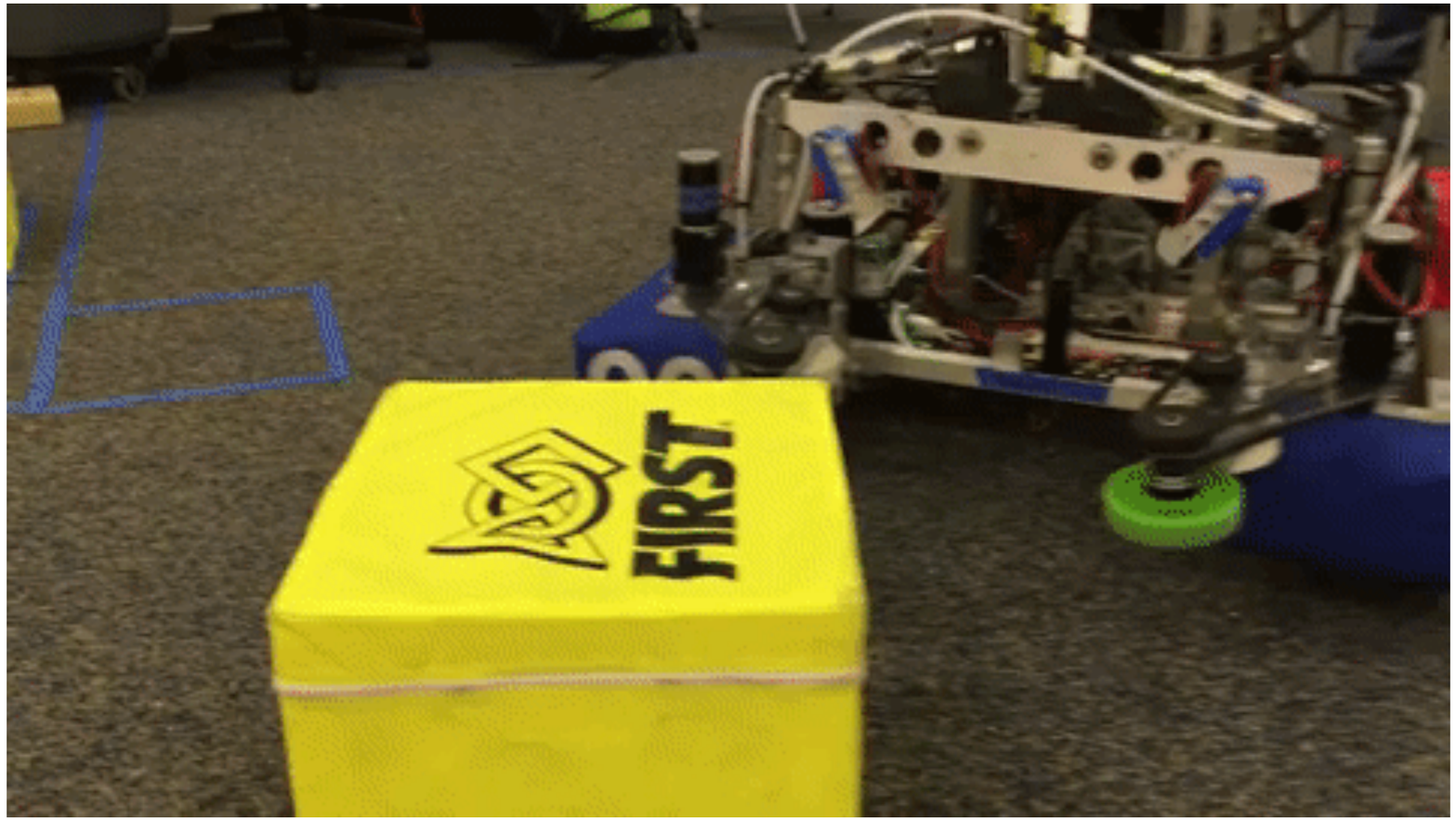
- Run code without a physical robot
- Custom plugin for FRC driver station
- Testing autonomous modes
  - Elevator and arm path verification



Custom Driver Station, Powered by ROS



FRC Driver Station, Powered by NI LabVIEW



Success!

Automated handoff with elevator controller
http://zebracorn.link/rosgif

Plans for the Future

ROS for Mainstream FRC

Robot Localization

Improve Simulation

Fully Autonomous Robot

Get Involved!

Involve your company!
Find a local team or event:
http://firstinspires.org

Help us!
Get in touch with us:
mentors@team900.org
or contribute:
http://github.com/frc900

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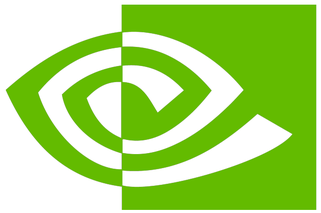

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