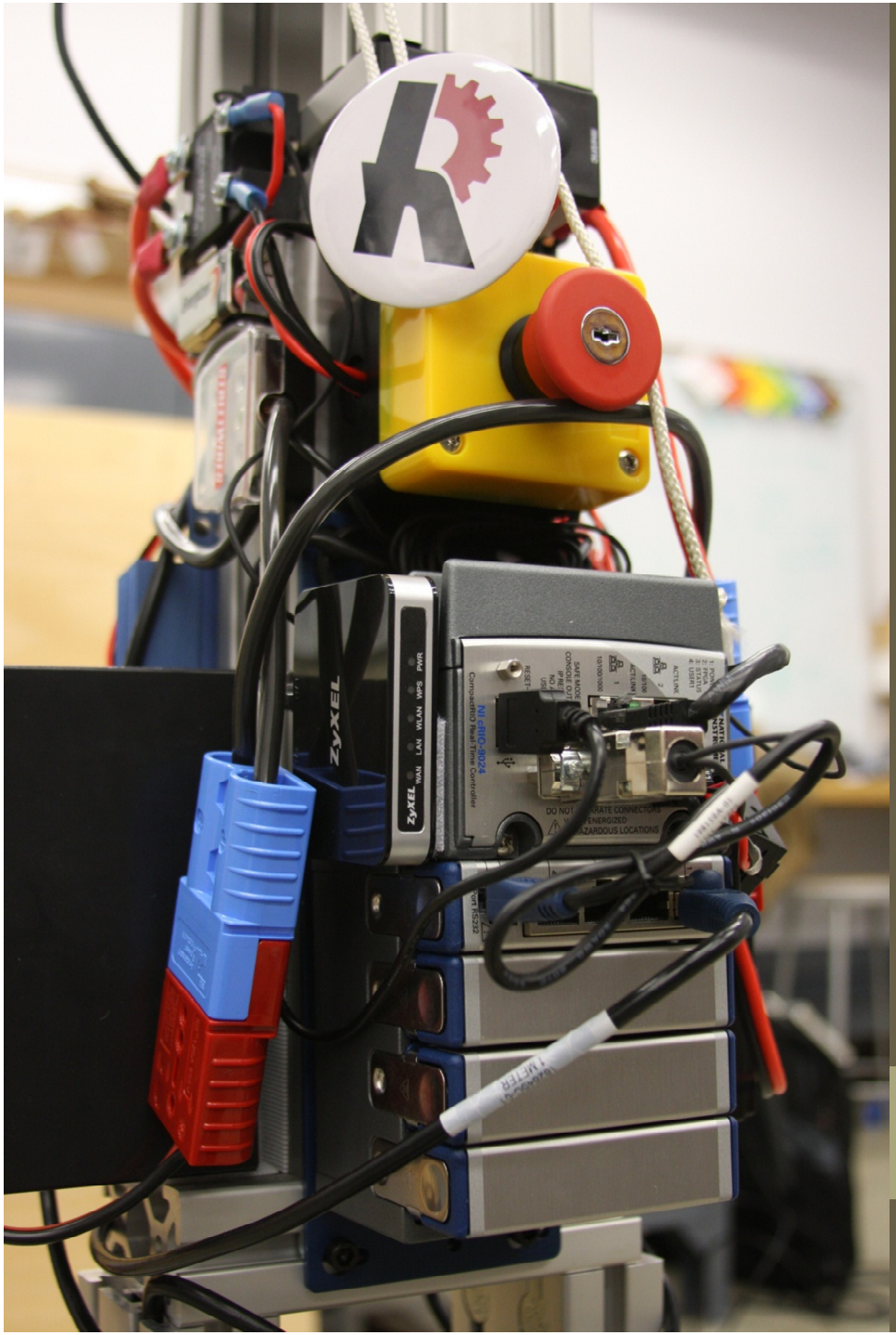
Simple Operation Manual

For Robotic Unicycle Demo

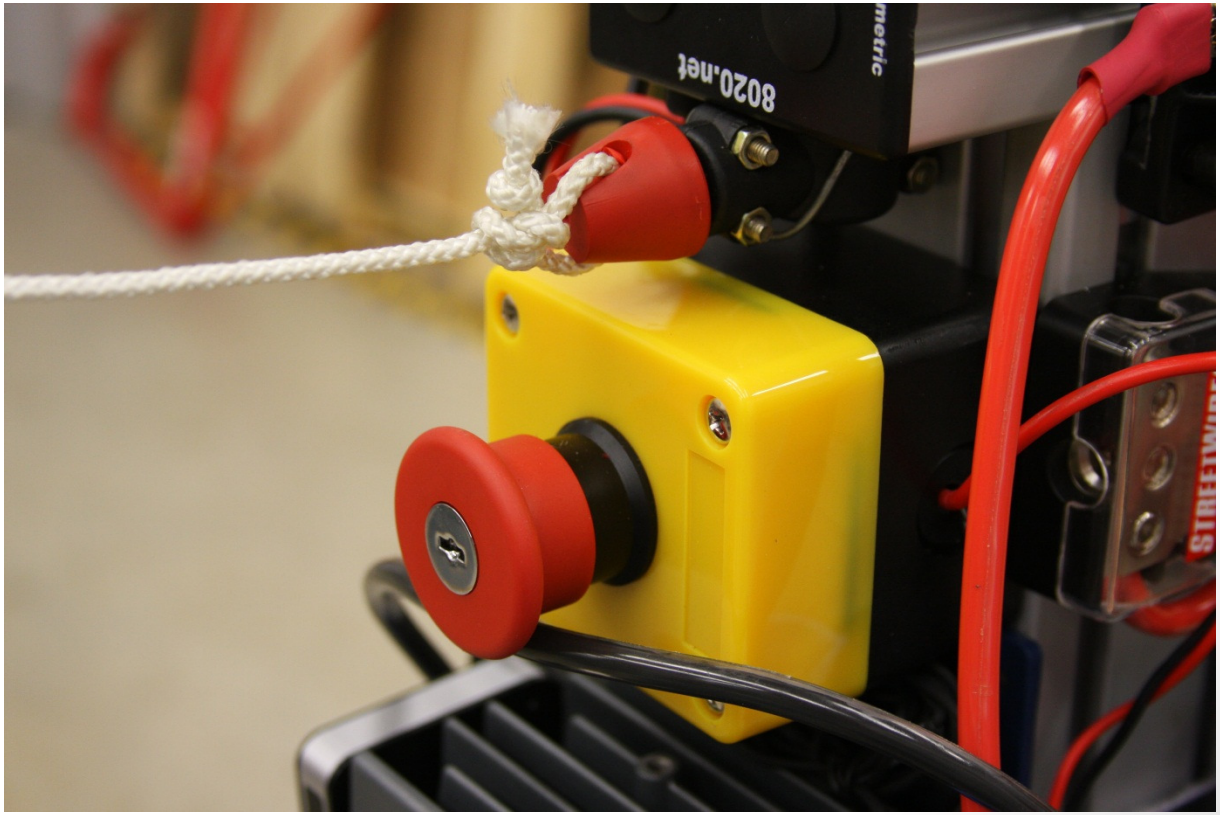
Team G

Index

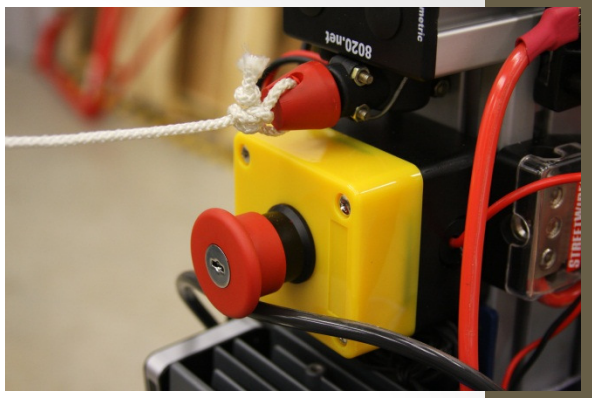


Safety

- Before Operation
  become familiar with the following:
  - Kill Switch
  - Keyed Reset
  - Kill Cord



Safety

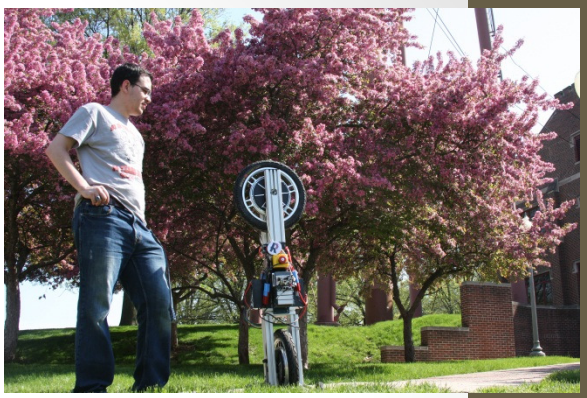


- Both the kill switch and kill cord are in series with the signal reference voltage for the Solid State Relay. This is so that in the even that if either one of the E-stop measures are tripped, current delivered to the motor controller will be stopped immediately.
- The Kill switch has a keyed lock access, preventing the switch from being reset and used without proper authorization.
- The Kill cord has a small rubber cap this is used to depress an internal normally open switch. In the event the robot falls away from the user with the kill switch out of reach, the robot can still be stopped by yanking the cord.
- The kill switch box also happens to have a replicable 5A automotive fuse in the case that the signal reference voltage is accidently shorted.

Quick Start

- How to quickly get your robotic unicycle up and running

Quick Start



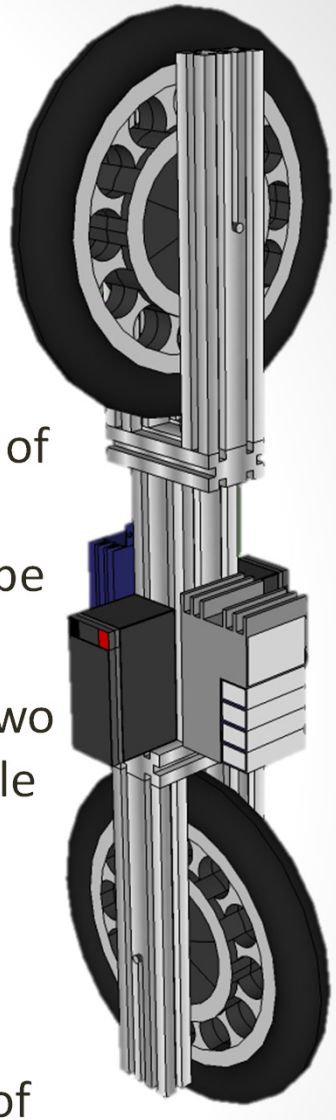
- Check List
  - You have suitable space to demo
  - Hub-motors are secure and spin freely
  - Batteries are fully charged
  - Circuit breaker and E-stops are not tripped
  - Open LabVIEW project Code
  - Connect to UniCyRO WiFi and the cRIO
  - Deploy the Main.vi to the cRIO
  - Have someone spotting the robot
  - Then enable the balance control with front panel UI

Assembly

- Frame
- Motors
- Electronics

Assembly

- Frame
  - For convenient assembly, the robot is constructed out of 80x20 aluminum framing. This “T” slotted aluminum extrusion is used so that mounted components could be easily attached and adjusted.
  - On either end of the center column of the frame are two orthogonal forks that serve as mountings for the bicycle hub motors. For disassembly and shipment these hub motors are also detachable from both the motor controller and the frame. Similar to bicycles, but on a longer dimension, the two forks include channels for which the keyed shafts of the tires to slide in and out of place. Using a large set of pliers, one can either tighten or loosen the threaded shaft of the tiers for assembly.



Assembly

- Motors
  - The motors on the robot are in fact Chinese E bike hub motors used in electrifying bicycles and motorized scooters. Similar to buy tires, the motors use keyed threaded shafts to interconnect with a mounting fixture. Because the forks that tighten around the shaft, it is important that the shaft and spacers are properly lubricated to prevent large amounts of static friction. Static friction buildup can slow response times and dampen control effort reducing the stability of the unicycle.
  - The motors interface with the RoboteQ motor controller poll conductors for three phase power and a DB9 connector for hall sensor feedback. The connectors are color-coded to prevent accidentally swapping channel connections.

Assembly

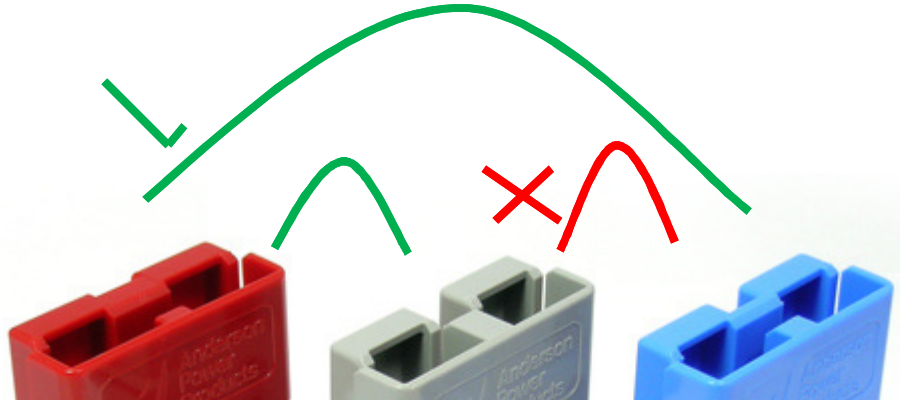
- Electronics
  - Electronics assembly is constructed set of lose wiring and slaked cables. This was intended to allow the components to have a tolerance of adjustability when fine tuning the center of gravity of the entire robot.
  - Providing power are to 12 V 7.5 Ahr sealed lead acid batteries in series to create a combined 24 V supply. This voltage range is suitable for the cRIO and RoboteQ controller operation. In series with the 24 V supply is a 70 A circuit breaker to protect the batteries and electronics accidental short-circuits and excessive current draw.
  - Smaller electronics such as the Inertial Measurement Unit and Wi-Fi router are powered off from an onboard 12 V out DC DC converter and the cRIO's 5 V USB supply respectively.

Assembly

- Electronics
  - National Instruments cRIO
  - The cRIO uses several communication interfaces.
  - The Ethernet port 1 is used to program the real-time platform over the wireless network.
  - And RS-232 to communicate with the IMU and RoboteQ over the internal and external 9870 serial connections respectively.

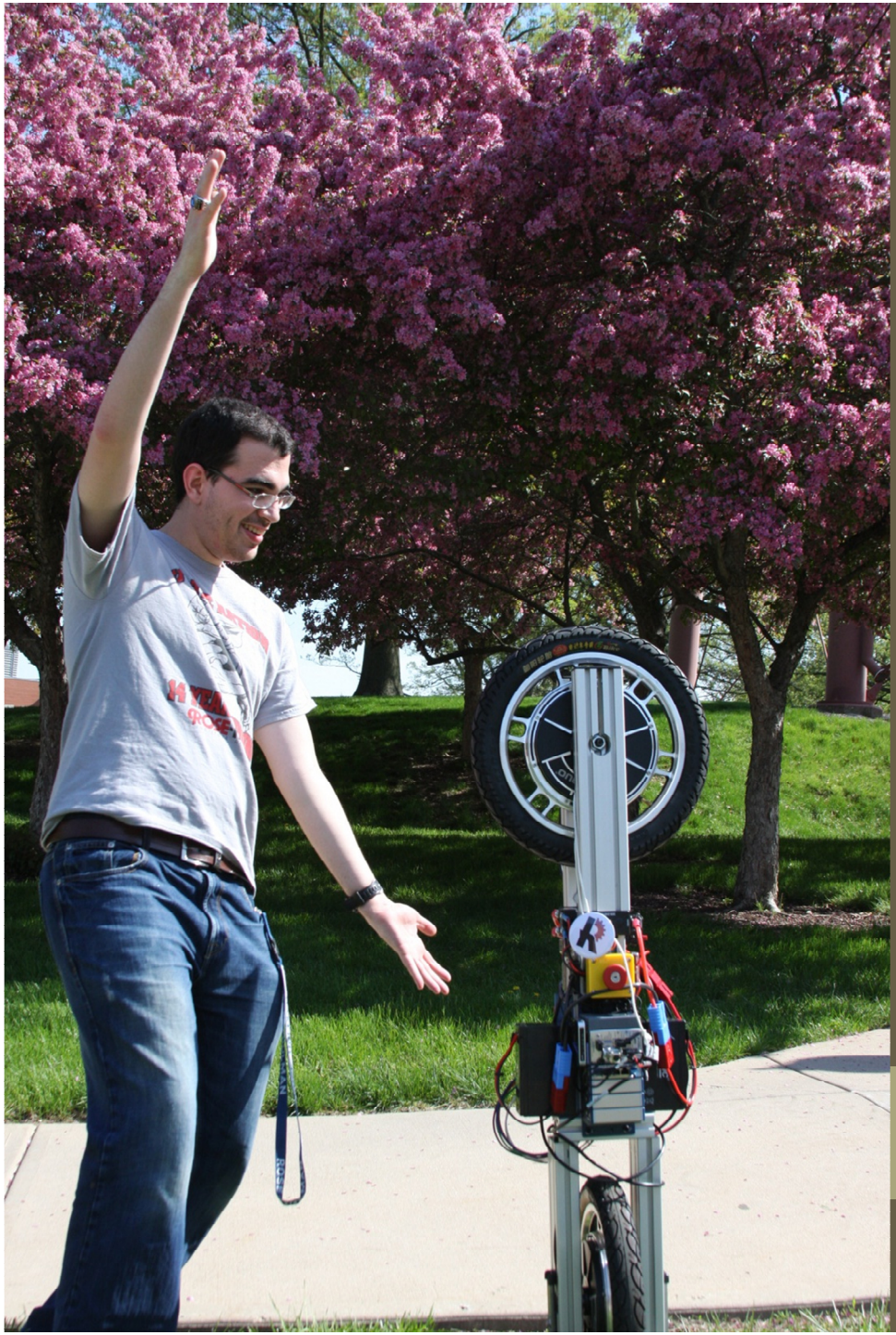
Maintenance

- Charging
- The batteries are supplied with large power red pole connectors. These connectors are color-coded and are limited in there interconnect ability to prevent misuse.
- The red power pole connectors can be connected to either the grey connectors for charging, or the blue connectors for robot operation. Do not try to power the robot with the charger, charger is not designed to supply the required current and may not be meant to be connected in series with itself.

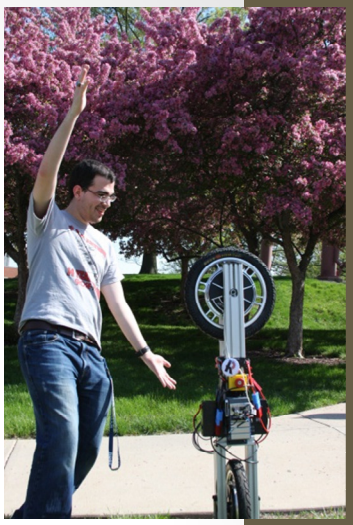


Demoing

- How to demo the robot in detail



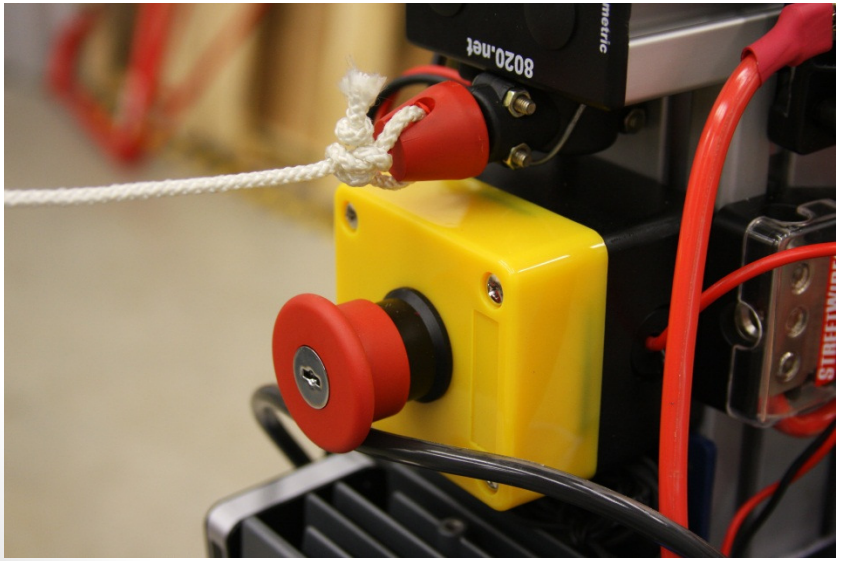
Demoing



- Requisites
- Make sure you have suitable space to demo. The robot require some space to stabilize as well as potential room to fall unobstructed by bystanders.
- Hub-motors are need to be secure and spin freely. If the static friction is too great or the slip between the key shaft and fork will make it difficult or impossible for the controller to adequately actuate its corrective efforts for a steady-state balance.
- Batteries are fully charged. The performance of the power output to the motors as well as expected voltage ranges for other electronics are dependent upon the terminal voltage of the lead acid batteries.
- Circuit breaker and E-stops are not tripped. It is possible to leave the E-stop engaged throughout the start process as a safety measure, just remember to disengage it prior to enabling the main vi controller. With the circuit breaker closed, we will assume that the robot is now under power.

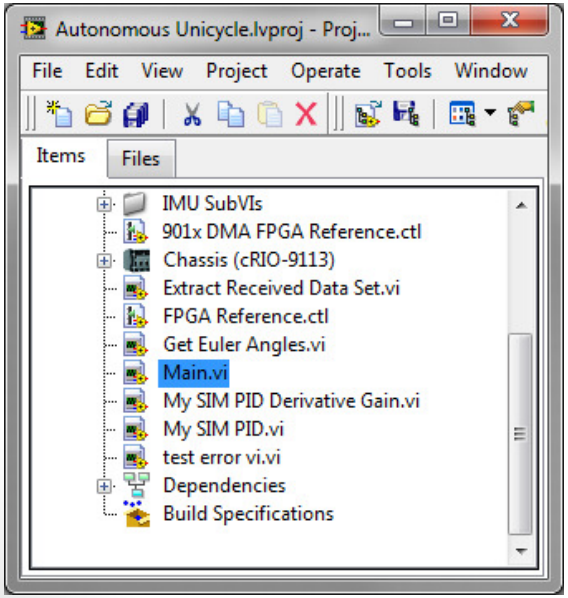
Demoing

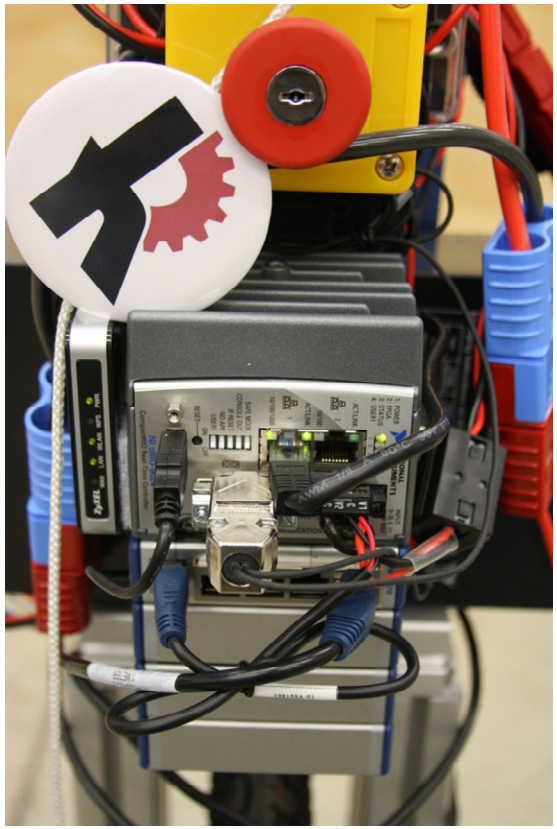
- Power Up
  - Make sure the reset latch for the circuit breaker is engaged or recessed into place.
  - The kill switch button is reset and extended outward.
  - The kill court rubber knob is firmly pushed back into place.

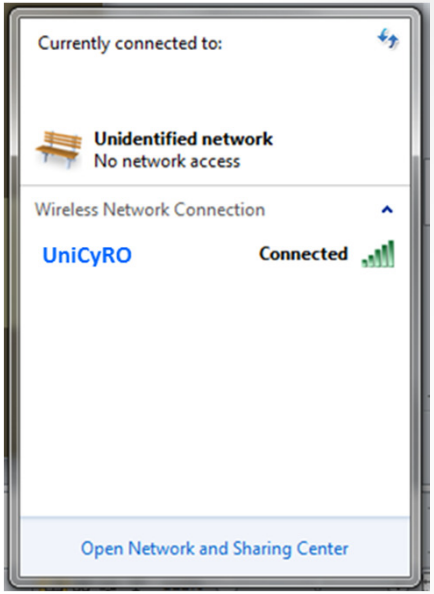


Demoing

- Connecting
- Connect to the Robots WiFi network, “UniCyRO”
  - Password: rhitni13
- Open up the project
- Open the Main.vi

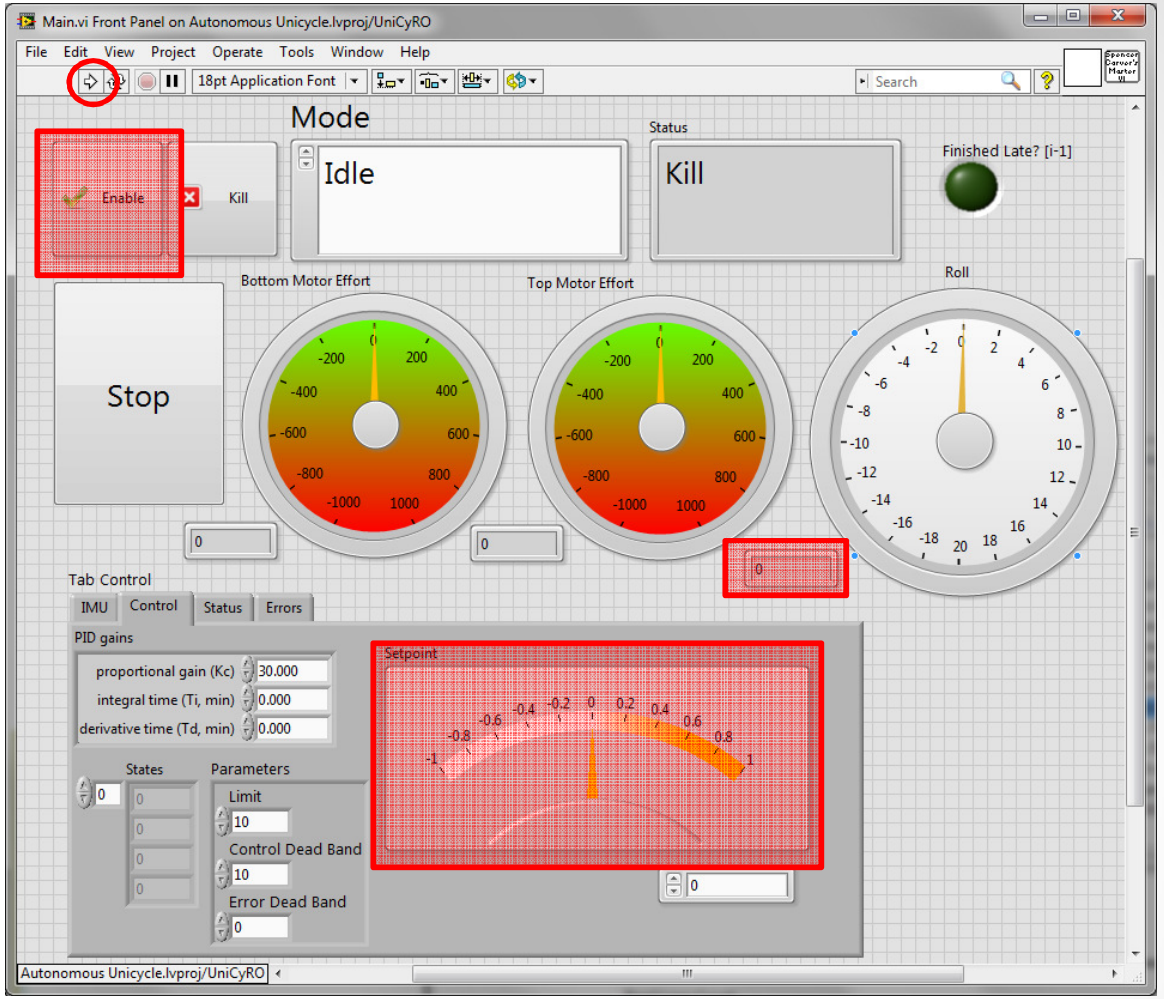


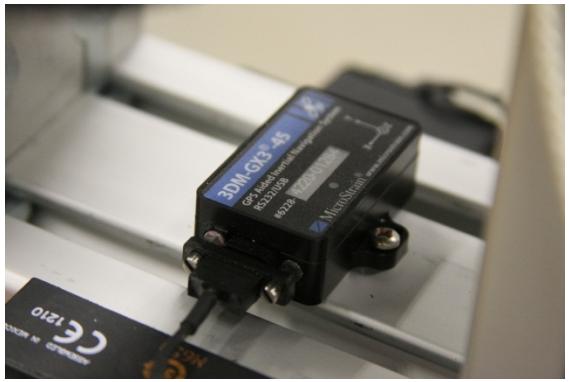


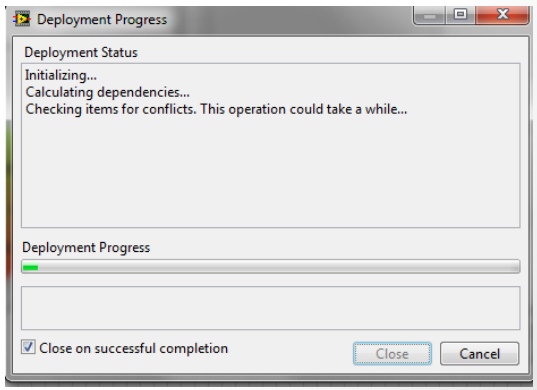


Demoing

- Deploying
  - Hit the run button
  - Wait to connect
- Zero out IMU bias
  - Adjust Setpoint so it match's the upright roll reading
  - Helps to have some spot the robot upright while you calibrate

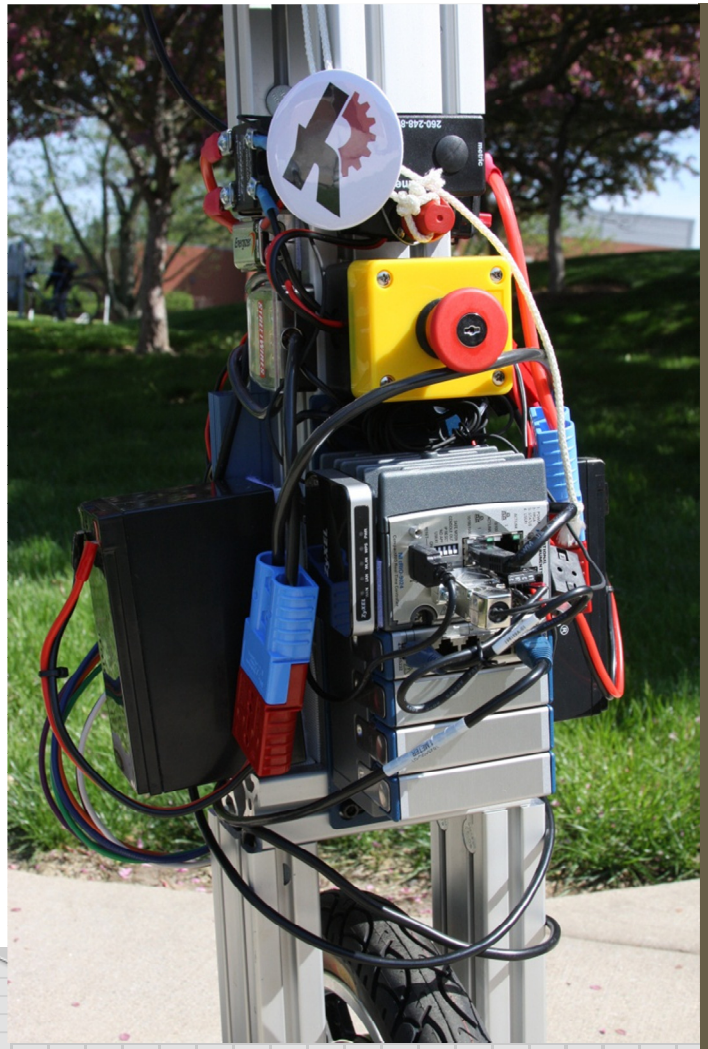


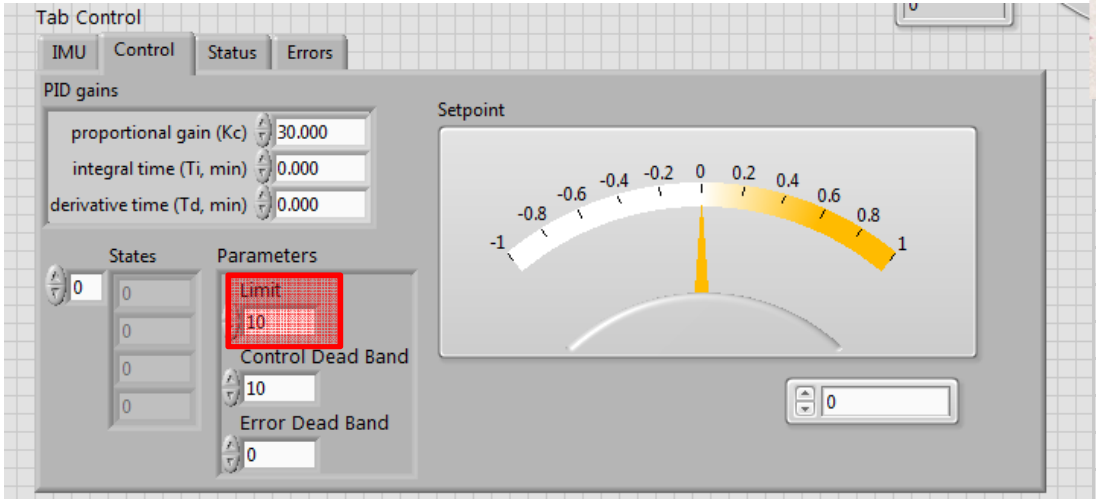


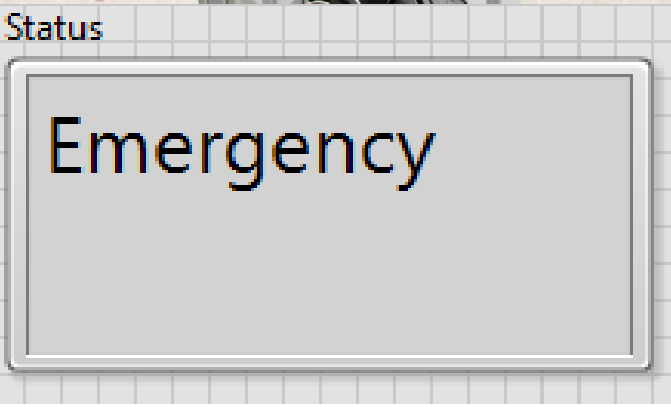


Demoing

- Running
- Be sure to know the behavior of the supporting finite state machine of the controller. Should robot tilt beyond a point of no return, a configurable limit within the front panel, the robot will enter an emergency state. This will lock the controller and motors until tell the enabled button is toggle or cycled.







Notes

- Debugging
  - An device not working
    - Does it have proper voltage supply?
    - What does its status indicator say? (device specific documentation in the repo)
    - Is the E-Stop triggered
    - Is the 9V battery for SSR signal boost dead or backwards?
    - Is the controller or sensor loaded with the right configuration file? (configuration files in the repo)
  - Also
    - Pease be carful with to robot
    - Even if the components used are durable and a the safety fixture is mounted, its best to be safe than sorry. So try your best to watch out for our little robot.