RoboJackets

FIRST - IGVC - BattleBots - RoboCup

Misti

Design Presentation

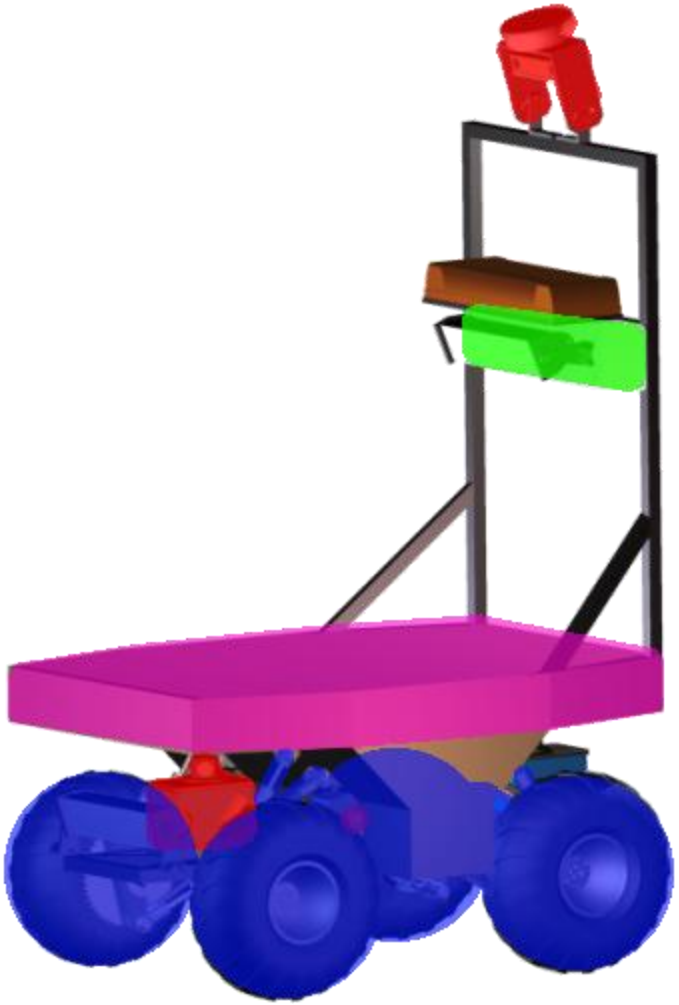
Outline

- Design Features/Innovations
  - Mechanical
  - Electrical
  - Software
- Simulation
- Questions

MECHANICAL

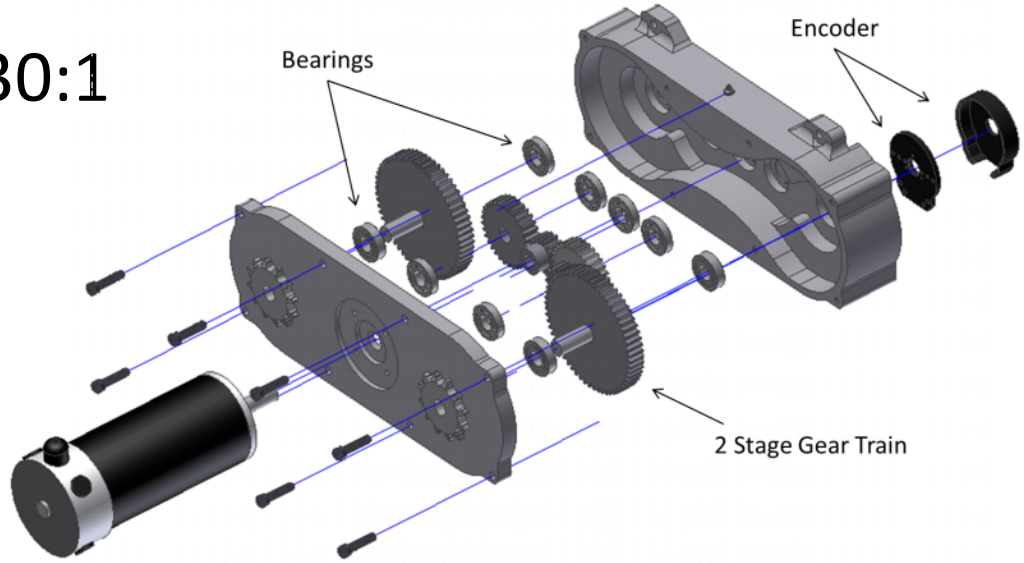
Organization

- Red – Sensors
- Green – Interface
- Blue – Drivetrain
- Pink - Electronics



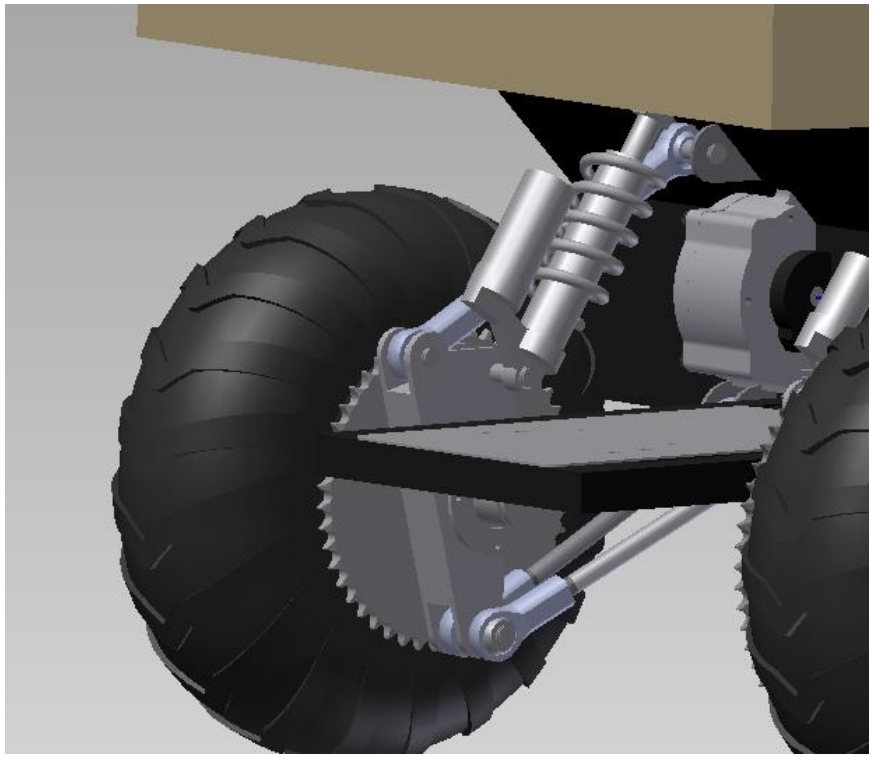
Drivetrain

- 2 x A28-400 Ampflow Motors
  - Combined 9 peak horsepower
  - Redundant motor controllers
- Custom gearboxes
  - Total reduction 30:1



Suspension

- Stabilize sensory input over rough terrain
- Designed to exceed IGVC performance requirements
- 5” wheel travel



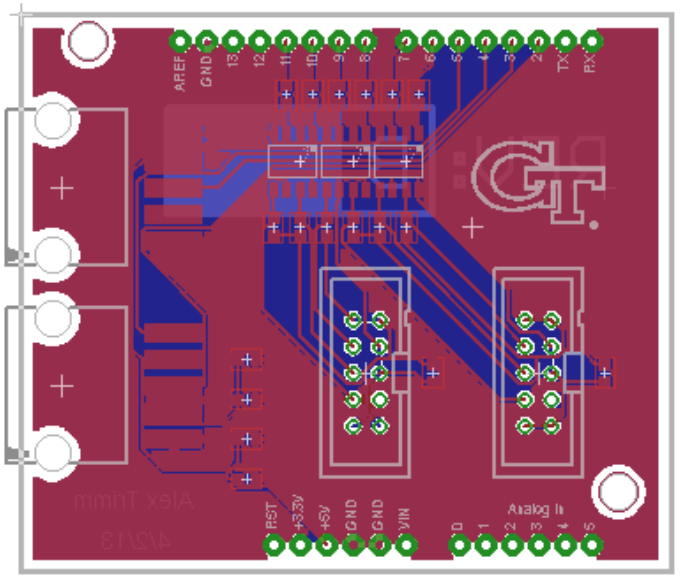
Safety

- Fuses on every voltage rail to isolate shorts
- Multiple remotes for wireless E-stop
- Wired E-stop at operator's forehead level

ELECTRICAL

Computers

- Main Computer
  - Intel i7 processor
  - 6GB RAM
  - USB, Firewire, Serial
- Microcontrollers
  - Arduino for motor control and encoder reading
    - Custom daughter board
    - replaces previous 4 Arduinos on previous robot
  - Second Arduino for ancillary systems (lights, etc).



Sensors

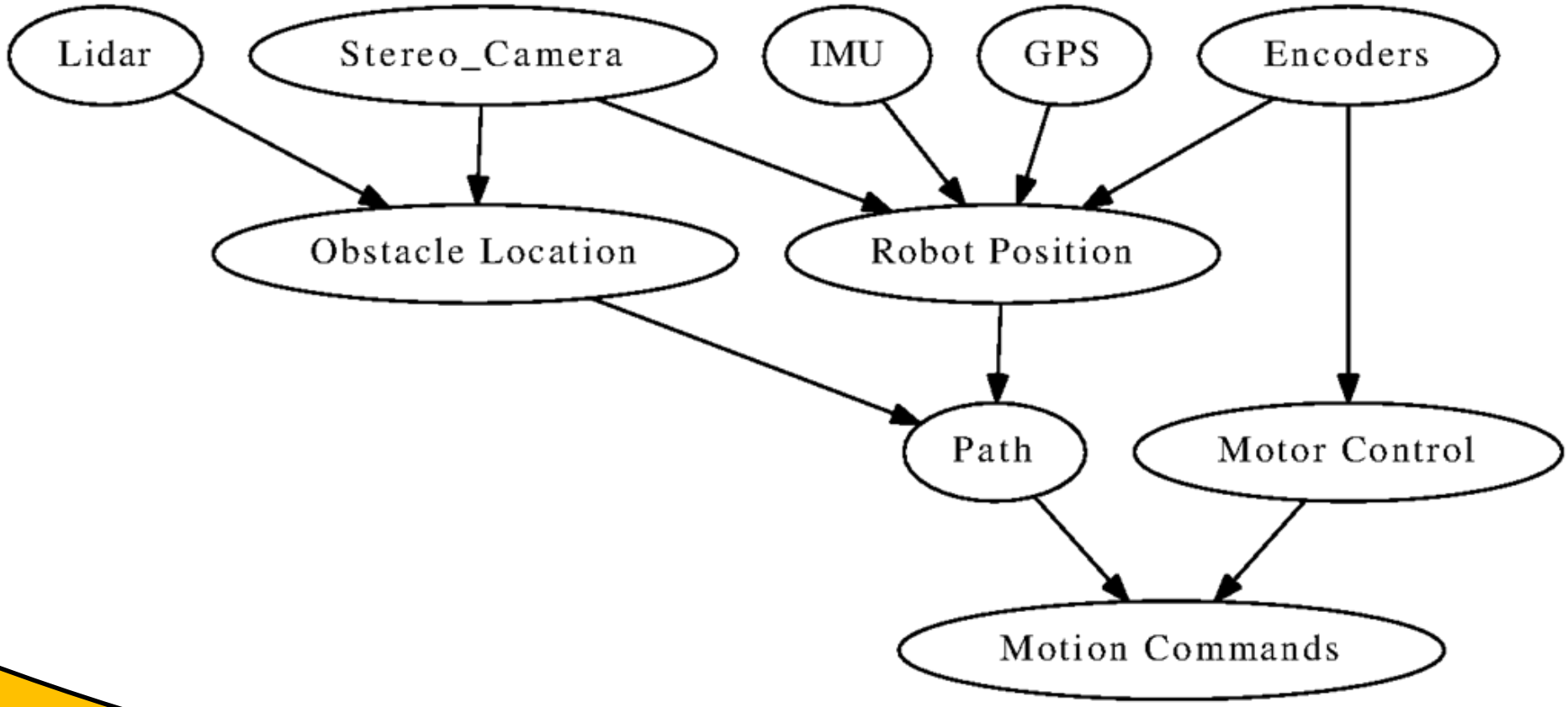
- Reused Sensors:
  - LIDAR
    - SICK NAV200
    - Custom USB Interface
  - GPS
    - Hemisphere A100
  - Encoder
    - US Digital E3
- New Sensors
  - Stereo Camera
    - Point Grey Bumblebee2
  - 9 DOF IMU
    - Ardupilot

Power

- Source
  - 2 x 12v deep cycle sealed lead-acid batteries
  - Total energy capacity of 1052 Watt-Hours
  - ~1 Hour of motor run time
- Distribution
  - 4 different voltage rails
    - 24v – Sensors and motors
    - 12v – Sensors, lights
    - 5v – USB
    - 19.5v – Laptop
  - Fuses on each rail
  - E-stop cuts power to motors – allows other systems to continue operation

SOFTWARE

Architecture and Design



Design

- Extensive use of interfaces and inheritance
  - Ensures consistency and simplicity
  - All sensor data inherits from a common class
- Event/Listener design paradigm
  - Facilitates communication between functional units of the system
  - Allows rapid substitution of algorithms
  - Allows for the creation of sensor simulators
    - Wheels up, in-lab testing

Vision

- Extensive use of the OpenCV library
- Major Vision Algorithms
  - Lane Detection
    - Utilizes LIDAR data to remove potential distracters
  - Visual Odometry
    - Uses IMU data to provide update statements over fixed periods of time
    - Provides a means of lessening uncertainty present in GPS data

Path Planning

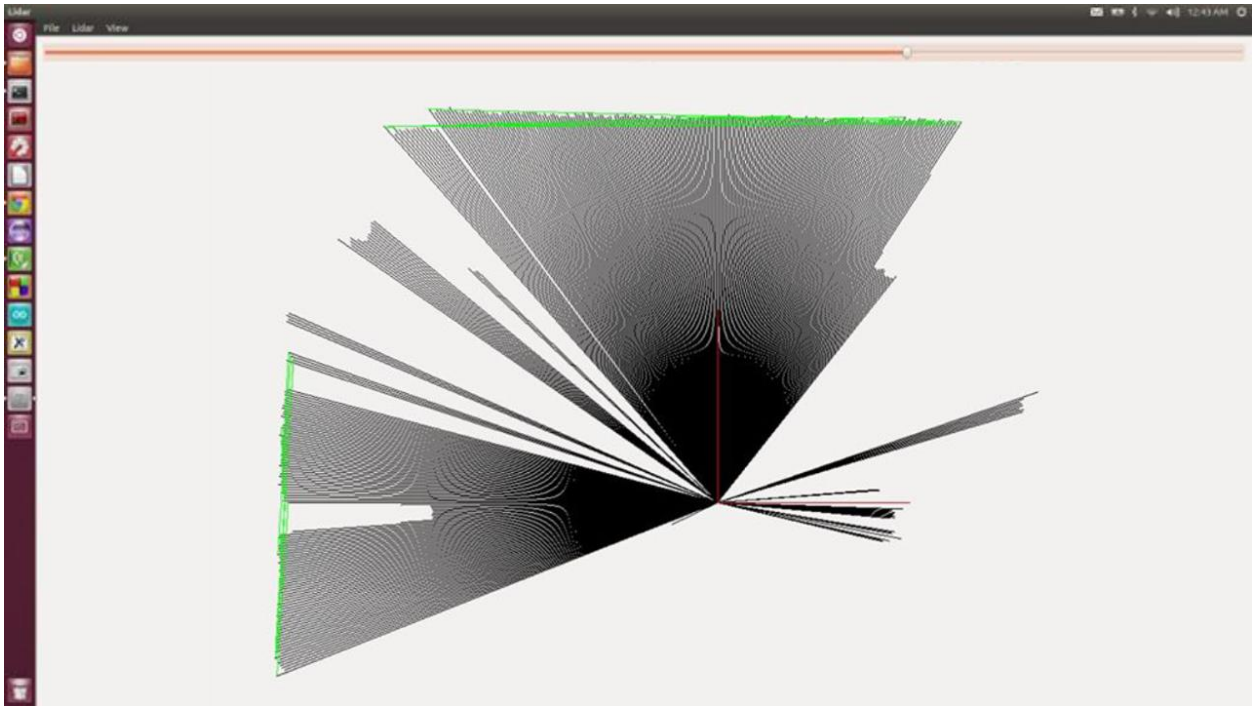
- A* path planning...with a twist.
  - Normal A* assumes holonomic drive.
  - Path smoothing algorithms – more natural motion
  - Modified A*
    - Natural robot motions used as state changes
    - Heuristic penalizes time-inefficient decisions i.e. turning in place

Sensor Fusion

- Overlapping and possibly contradicting data from multiple sensors
- Kalman Filter
  - Additional complexity – to determine appropriate parameters for each fused data type
  - Fairly simple for sensors such as GPS
  - More complex for alternative data sources such as our visual odometry algorithm

Simulation

- LIDAR, Vision sensor simulator



Thank you

QUESTIONS