"Moe" the Autonomous Lawnmower

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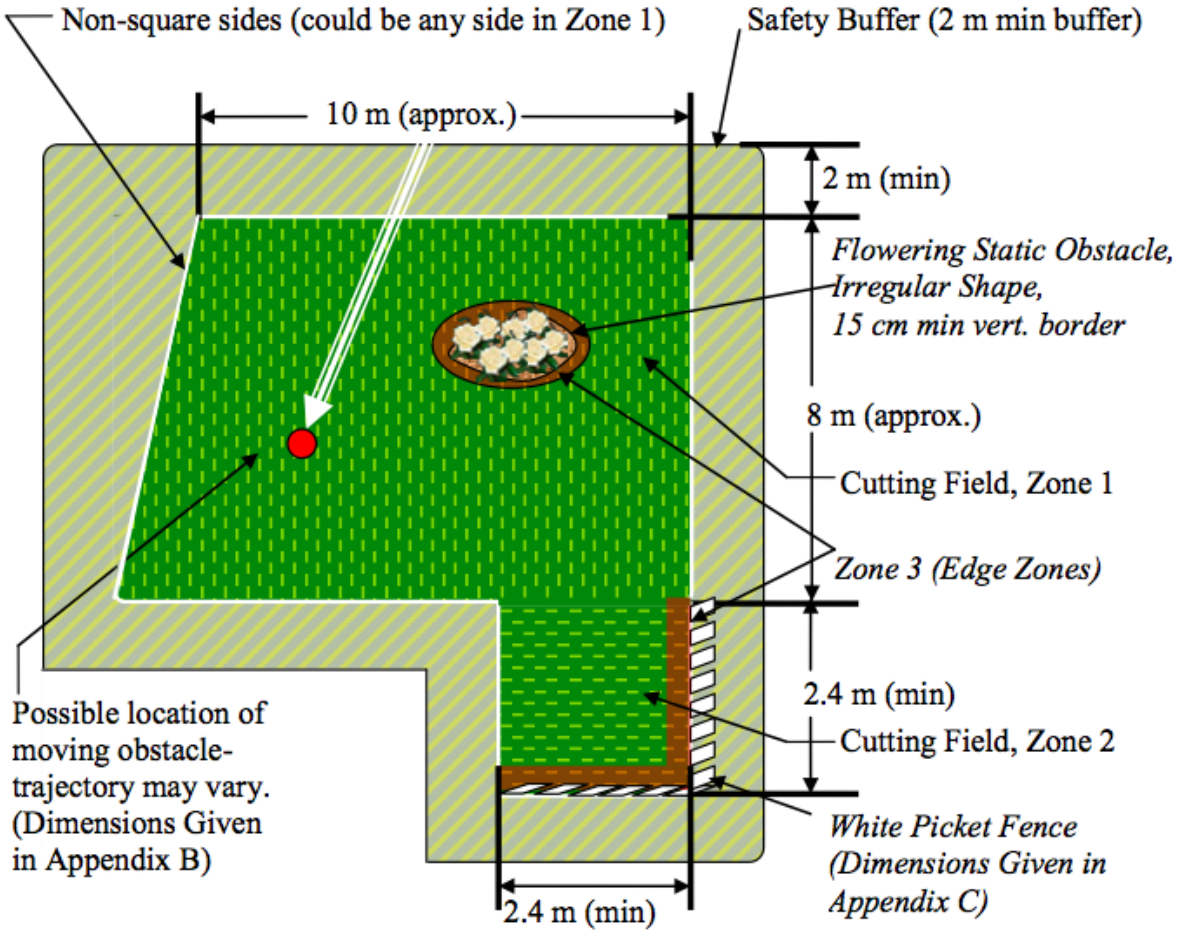
Overview

- Competition Overview
- Overview of “Moe”
- Team History
- Moving from robot_pose_ekf to custom EKF
- Use of move_base
- Architecture of path planning
- Edge Cases
- Conclusion

Competition Overview

- Hosted by ION and AFRL
- automow.com
- Dayton, OH
- June 2nd
- Dynamic Competition
- 2010 - Third
- 2011 - Second
- 2012 - First?



Overview of "Moe"

ROS Features:

- App Manager
- ROSOSC Teleoperation
- Full URDF
- Gazebo

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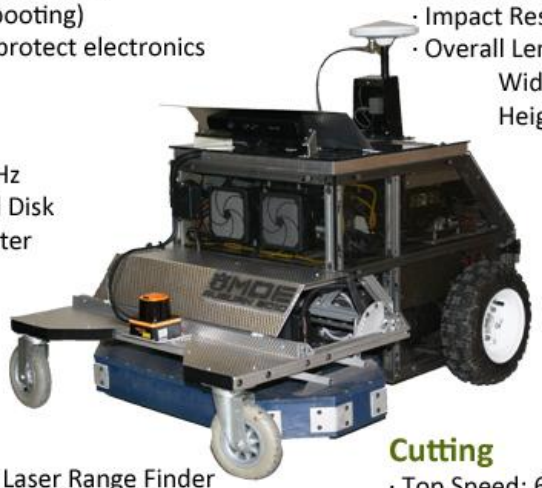
Autonomous Lawnmower
Capabilities and Features

Power
- 24 Volt, 64 Amp-hour Main Battery Stack
- On-board 24 Volt power supply (recharge without rebooting)
- Self-restting fuses to protect electronics

Chassis
- 80/20 © Modular Framing
- UV Resistent Polycarbonate Panels
- Impact Resistant UHMW Polyethylene
- Overall Length: 1.60 meter (63 inches)
  Width: 0.76 meter (30 inches)
  Height: 0.86 meter (34 inches)

Computing
- Core i7 Quad @ 2.8GHz
- 64Gb Solid State Hard Disk
- Wireless 802.11n Router
- Ubuntu Linux 10.10
- ROS (**R**obotics **O**perating **S**ystem)



Sensors
- 270°, 11 meter range Laser Range Finder
- Differential RTK GPS
- 9 Degrees of Freedom Attitude & Heading Reference System
- 1000 pulse per rotation wheel encoders
- Microsoft Kinect

Cutting
- Top Speed: 6.6 km/hr (6 ft/s)
- Cutting Speed: 1.6 km/hr (1.5 ft/s)
- Cutting Deck Width: 28 inches
- Cutting Area: Up to 6,000 ft^2 per charge
- Battery Life: 1.5 hours in light grass
  1 hours in thick grass
- Charge Time: 2 hours quick charge
  6 hours full charge

Safety & Reliability
- Button and Remote E-stop
- E-stop blade lockout (start on powerup prevention)
- Cutter blade stoppage in 0.5 seconds
- Independently fused sensors, motors, and cutters

Economics
- Retail Cost: $18,800.00
- Team Cost: $8,572.25

Department of Electrical and Computer Engineering

Team History

- 2010:
  - 9 Mechanical
  - 7 Electrical
  - 2 Software
- 2011:
  - 1 Electrical
  - 2 Software
- 2012:
  - 1 Electrical
  - 1 Software


ROS

Reasons for Custom EKF

- "Tighter" integration of raw messages
  - Wheel encoders used directly in model
- Zero-velocity updates
- Using lawnmower specific heuristics
  - Monitor GPS covariance and fix type
  - Monitor cutting blade status, as they affect the magnetometers in the AHRS
- Remove the "black-box" effect
- Learning Experience

Result of Custom EKF

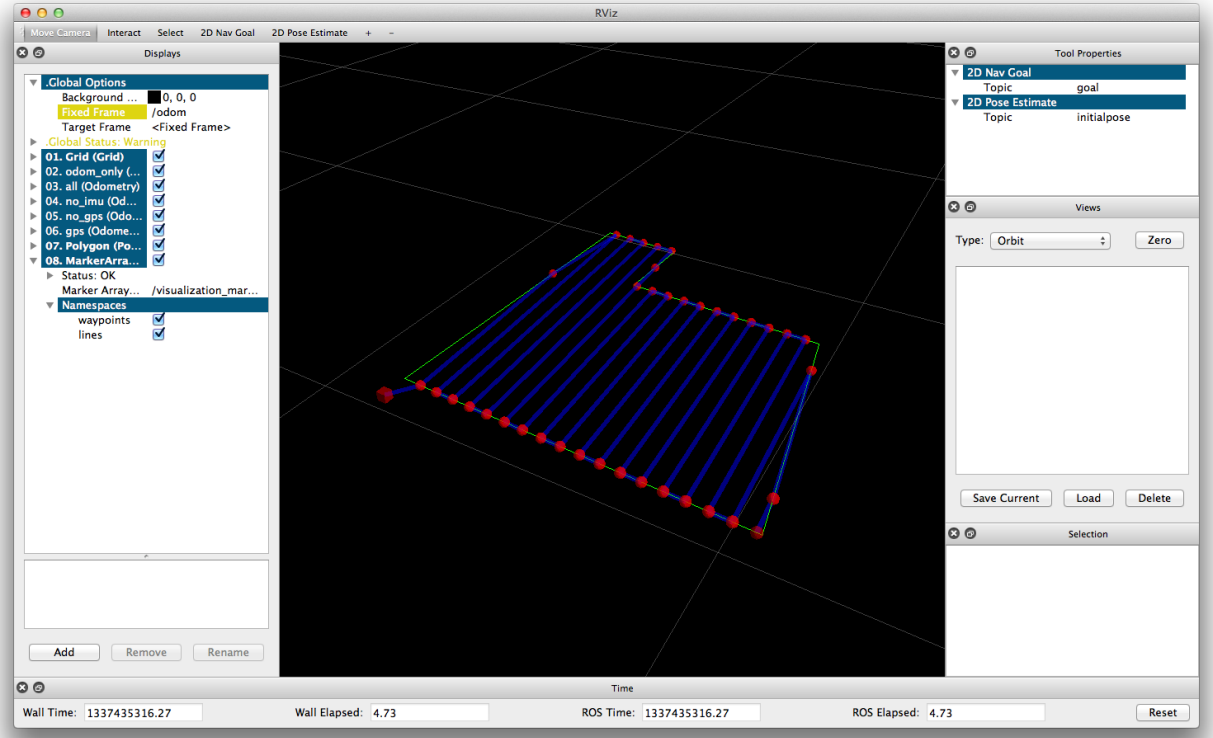
- Better Solution for the Lawnmower
- Tighter control over resulting solution
- ROS interfaces provide sufficient decoupling to easily drop-in replace the filter into the system

Move Base

- Great General Solution
- Point A to B without hitting things
- Coverage Planning
- Another "black-box"
- Frustrations from tuning with noise from GPS

Coverage Path Planning with Move Base

- A to B != Coverage
- Custom global/local planner or feed move base waypoints?
- What's the best way to combine coverage and obstacle avoidance?



Edge Cases

- Most valuable grass is near obstacles
- Move Base is difficult to predict in tight maneuvers
- Scheduled Controllers
  - Move Base for general navigation
  - Specialized local controller for edging obstacles

Conclusion

- ROS provides great general solutions to common problems
- Those solutions can sometimes be configured to be good enough for domain specific tasks, but can also struggle
- ROS grew with the team
- Autonomous Lawnmowers are awesome

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