Self-supervised Learning From High Dimensional Data for Autonomous Off-Road Driving

The Solution: Online Self-Supervised Learning

Problem: Autonomous, Vision-based Navigation in Complex Off-Road Environments

Challenge: Vision-based Navigation for Mobile Robots

Why is it hard?

- Extreme environmental variability
- Visual complexity – shadows, clutter
- Hilly, bumpy, uneven terrain
- Real-time constraints on processing
- Tricks – collapsible vegetation, hidden obstacles
- Position estimation errors – wheel slip, GPS
- Planning with uncertainty
- Lighting variability – glare, time of day

-Stereo-based navigation uses simple heuristics to identify pixels as ground or obstacle. Stereo is insufficient:
  - sparse, noisy, and short-range (0-12 meters)
  - pure stereo navigation is myopic – driving in fog

-Challenges for machine learning solutions:
  - supervised learning limits the variability of environments
  - online learning is adaptive, but has no memory
  - large image patches are necessary for accurate learning: high dimension
  - generalization from near-range to far-range (inverse size/distance)
  - planning with uncertainty from classifiers
  - concept drift

Results: Evaluation of Learning and Driving Performance

Results of classifier on selected frames (green = traversable, red = non-traversable, pink = obstacle foot)