Learning System Dynamics For Wind Resistant MAV Flight

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Motivation
- Follows trajectory well in static testing environment.
  - No wind
  - No initial velocity
- Control failure accounts for >80% of our crashes during tests in forests.[1]
  - Most caused by wind
  - Dynamic initial conditions amplify problem.

Platform

PID Control
- Follows trajectory well in static testing environment.
  - No wind
  - No initial velocity

System Modeling
- For a linear time invariant system:
  \[ x(t+1) = A*x(t) + B*u(t) \]
- Minimize quadratic cost function:
  \[ c(x,u) = x^TQx + u^TRu \]
  - \( Q \) determines cost of state errors
  - \( R \) determines cost of control inputs

LQR Control
- Model learning requires accurate state estimation.
- Piksi RTK GPS used for ground truth.
- ~5% error/distance traveled

Model Evaluation
- Trajectory Estimation
  - Real Trajectory
  - Estimated Trajectory

State Estimation
- Motion due to wind or dynamic initial conditions

Future Work
- Move from wind detection to active with control correction with online learning.
- Generate dynamically feasible trajectories based on current state estimate.

References