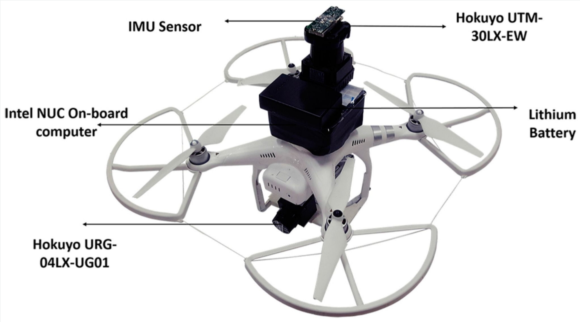
Major Projects

Integration (Numerical)

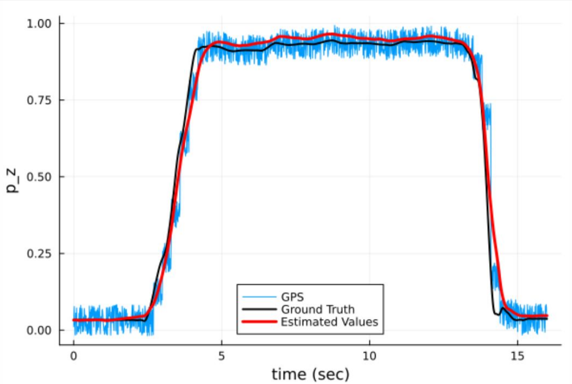


Differentiation
Const. Optimization

ODEs and Laplace

Project 1: Numerical Integration of Drone Data

- Real drone data in 3D
- Focus is on Trapezoidal Rule
- Batch & Recursive Implementations
- Correction for IMU acceleration drift
- Mentally prepares for solving ODEs



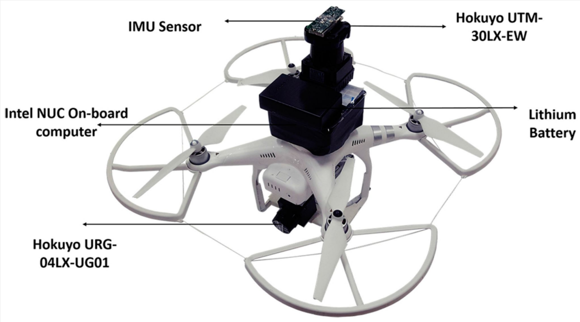
$$v(t_i) = v(t_{i-1}) + \int_{t_{i-1}}^{t_i} a(\tau)\, d\tau \qquad \text{model prediction step}$$

$$v(t_i) = v(t_i) + K_v \cdot (vGPS(t_i) - v(t_i)) \cdot dt \qquad \text{measurement update step}$$

$$\text{for all } t_i \in [t_0, t_f]$$

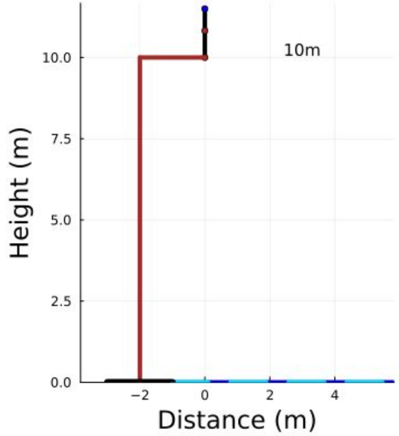
$$p(t_i) = p(t_{i-1}) + \int_{t_{i-1}}^{t_i} v(\tau)\, d\tau \qquad \text{model prediction step}$$

$$p(t_i) = p(t_i) + K_p \cdot (pGPS(t_i) - p(t_i)) \cdot dt \qquad \text{measurement update step}$$



Project 2: Constrained Optimization

$$\begin{array}{ll} \text{minimize} & f(x) \\ \text{subject to} & g_i(x) = 0,\ 1 \le i \le m \end{array}$$



- Gradient descent with equality constraints
- Use linearization to derive conditions
- Translate into linear algebra via dot (aka, inner) product
- Find step direction via Gram Schmidt
    - Descend on f
    - Constraint qualification

$$\nabla f(x_k) \bullet \Delta x < 0$$

$$\nabla g_i(x_k) \bullet \Delta x = 0,\ 1 \le i \le m$$

ROBOTICS

Project 3: ODEs and Laplace Transforms

- Derive Lagrangian model for ROB 311 BallBot: NL ODE, 4 dimensional
- Linearize for transfer function (Laplace)
- PD-controller for ballance, P-controller for speed (more Laplace)
- Simulate controller on NL ODE model