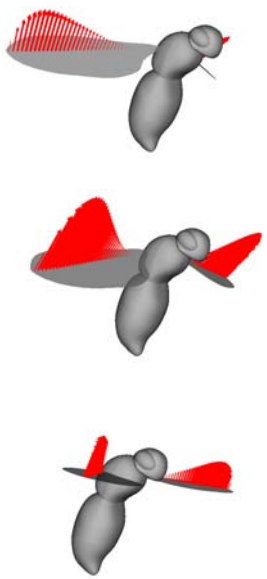
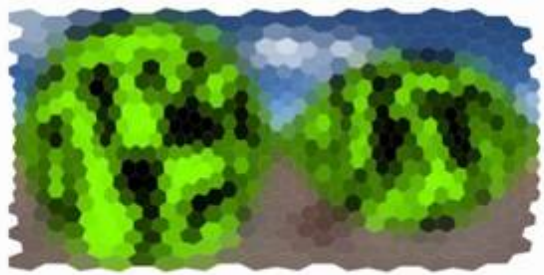
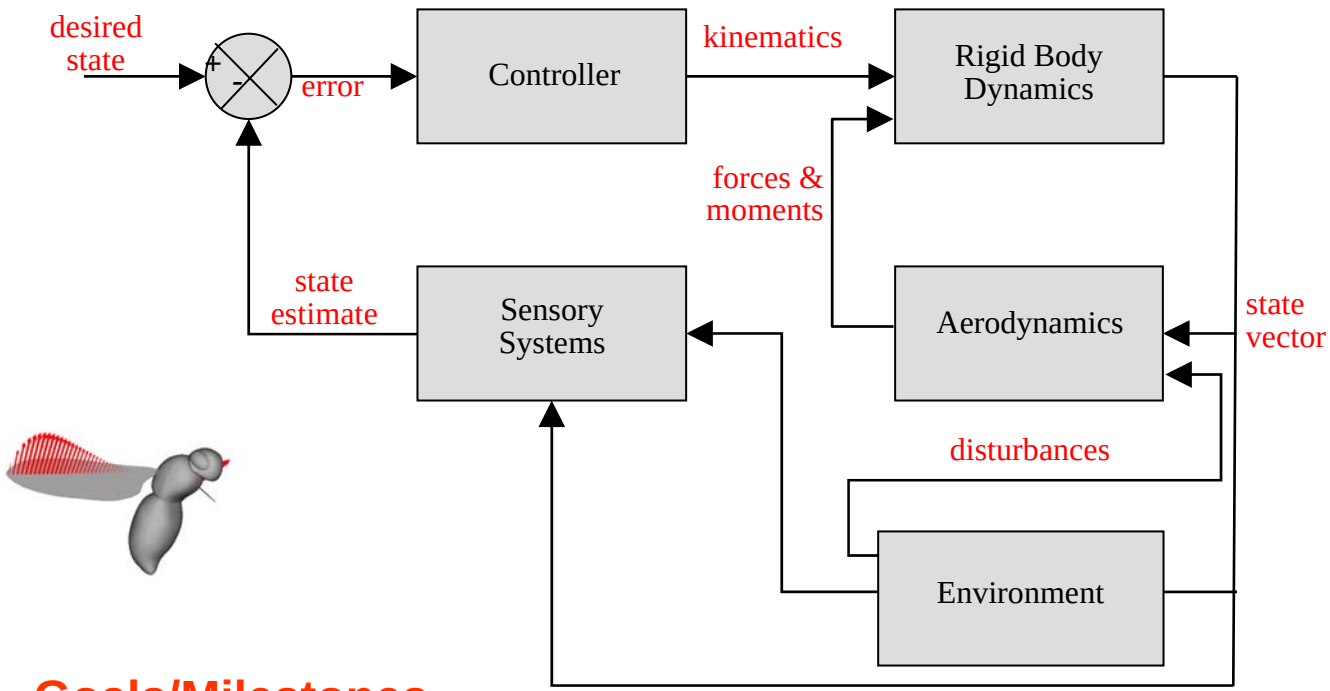
Drosopholia Grand Challenge
CDS 273

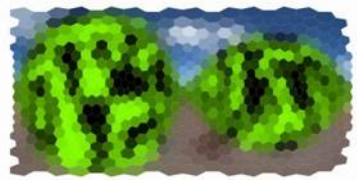


Sawyer Buckminster Fuller
Mike Epstein
Steve Waydo
Will Dickson
Andrew Straw



Project Overview





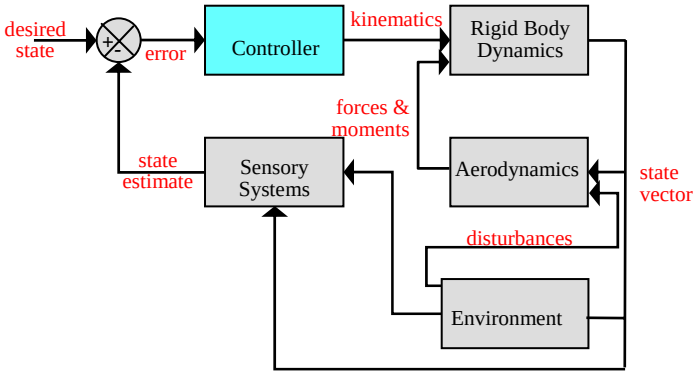
Goals/Milestones

- Stabilize hover & forward flight with feedback from
  - Full state
  - Pitch rate (halteres)
  - Visual system
- Tunnel following
- Beat the fly!!

Main Tasks

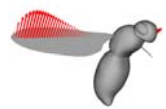
1. Controller design
2. Extraction of state information from visual data

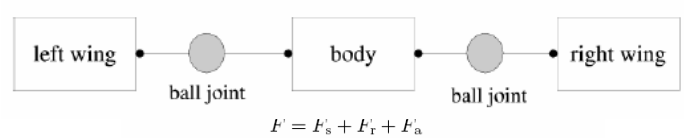
Controller Design – Simplify the Dynamics

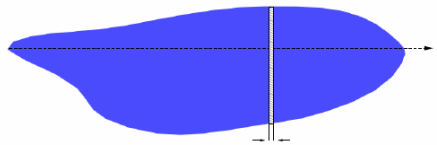


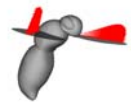
Truth Model of Fly Dynamics

- 3 Rigid Bodies
- Blade Element









Simplified Model

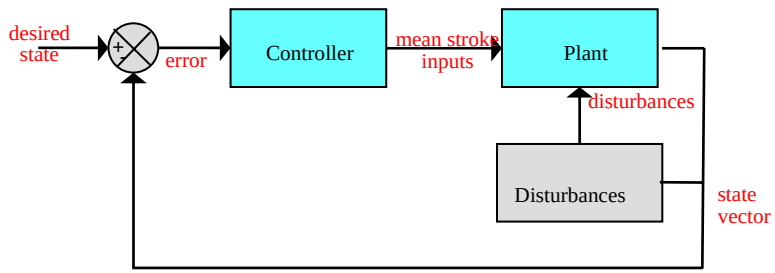
- 1 rigid body
- Average over each stroke
- Used for controller design & analysis
- Need characterize mapping from stroke parameters to forces & moments

Design controllers based on simplified model for different operating points to map from state data to the stroke parameters

Stroke inputs
- mean position
- frequency & amplitude
- inclination plane

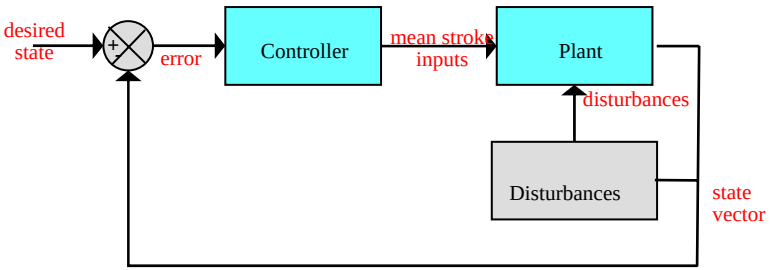
Operating point
- Orientation and velocity

→ **Simulation of Truth Model & System Id (least squares)** → Forces & Moments



Controller Design – Longitudinal & Lateral Dynamics

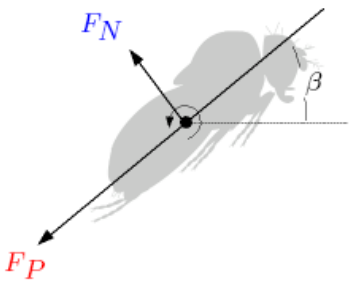
Separate into longitudinal and lateral dynamics and design controllers to stabilize hover and forward flight using full state feedback



Modulate the wing beats

- Pitch – mean stroke position
- Yaw – differential stroke amplitude
- Roll – differential stroke plane inclination
- Throttle – frequency & amplitude

Longitudinal Dynamics



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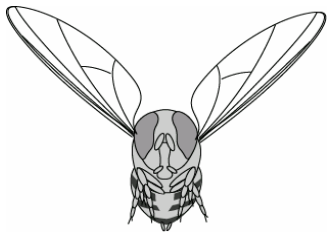
Lateral Dynamics



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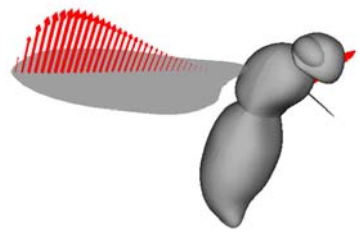
Full 6 DOF Rigid Body & Aerodynamics Blade Element Simulation

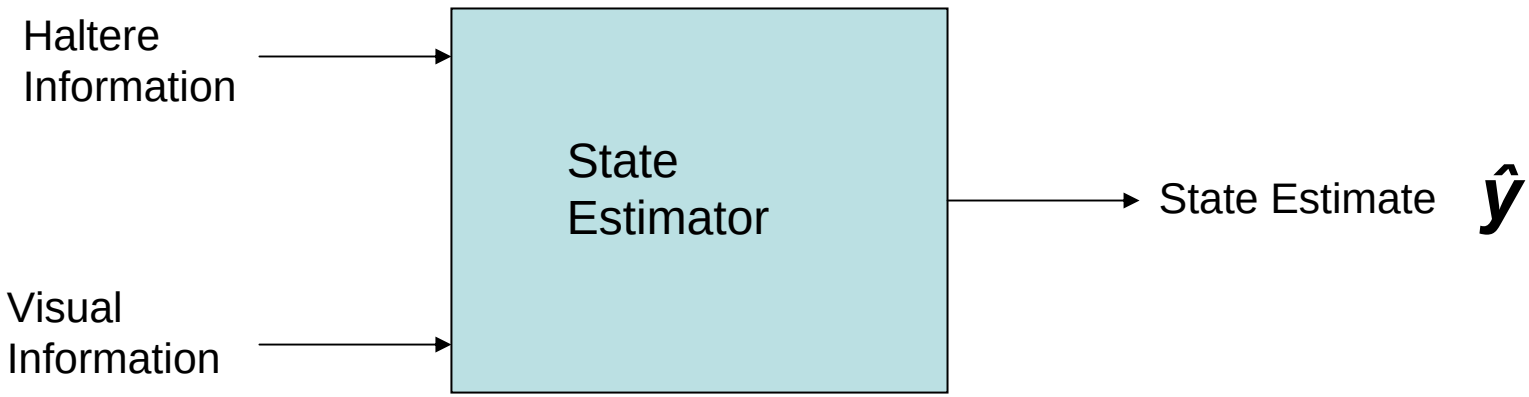


Design controllers assuming full state data is available

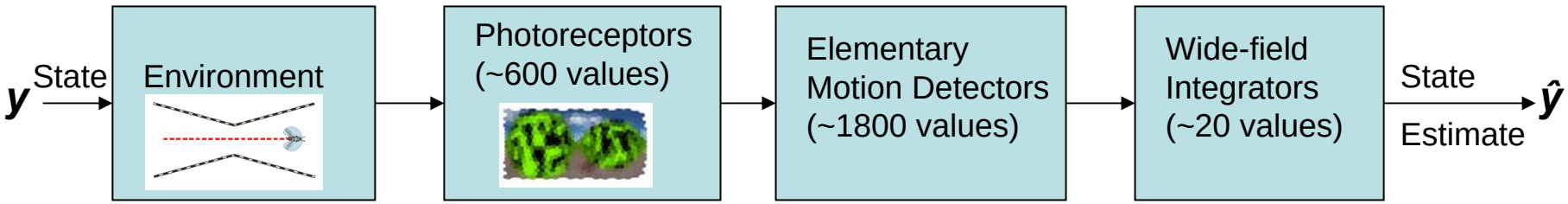
Next step is designing estimators to extract state data

State Estimation

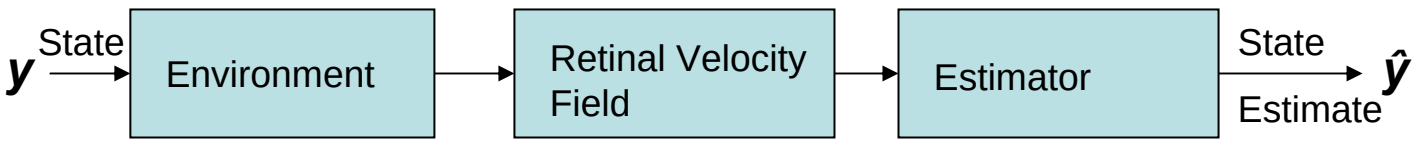
- From sensory information to state estimate



Visual State Estimation

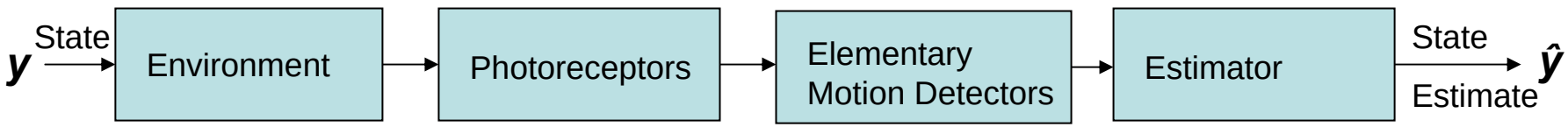


1. Idealized

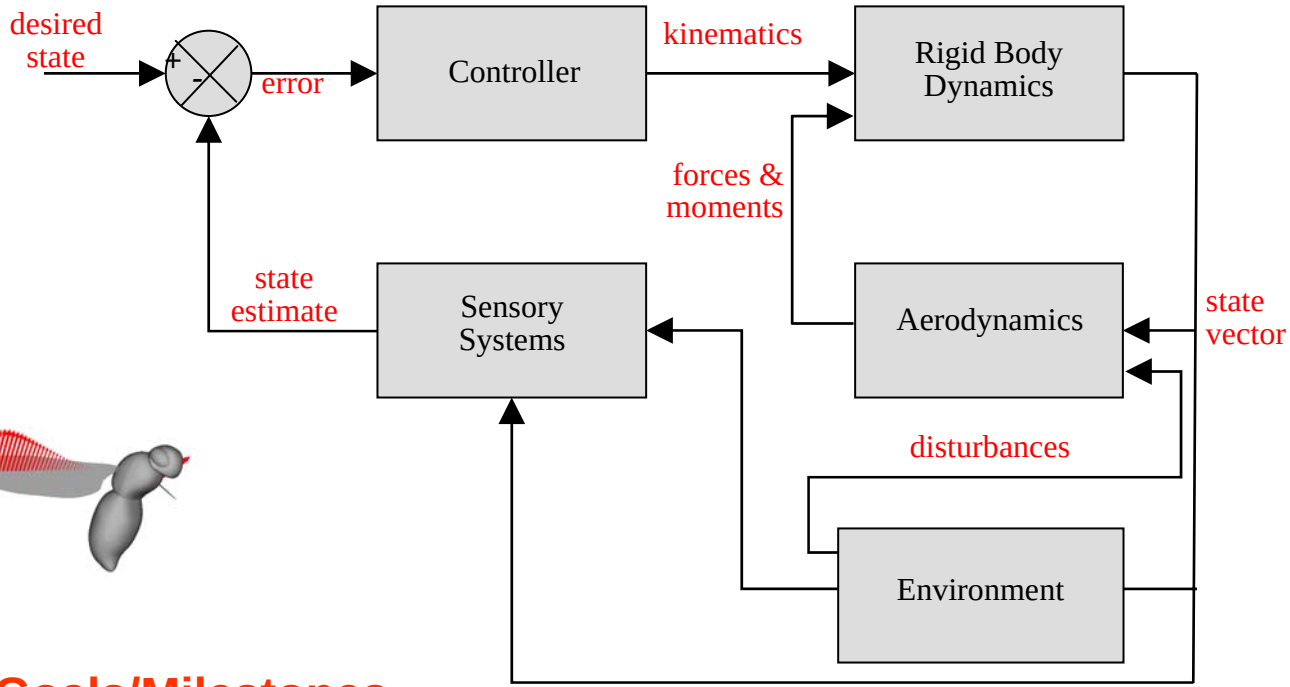


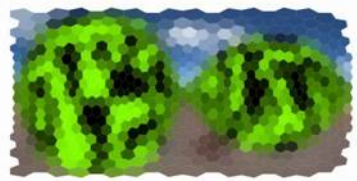
- Matched Filters [least squares, analytic]
- Nonlinear Estimation

2. Full model



Work Ahead





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Integrate these!