System Model

System Schematic

Diagram

Description automatically generated

System Diagram

Diagram

Description automatically generated

We need to create (code) a function that translates desired position into a control signal for fan speed.

Dynamic Model

Constants

Variables

Equations

1) Force balance :

2) drag force:

3) buoyancy force:

4) applied force:

5) gravity force:

Substituting equations 2 to 5 into equation 1:

6)

If the ball is stationary (:

**Discrete Time Model**

Let

Need to estimate given:

From continuous time:

7)

Equation 7) can be discretized to the following:

8)

Where:

It is assumed that and remain “constant enough” throughout the timestep.

MRAS Model - 1st order controller

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Sensitivity derivative

Model following condition :

Adaptation Law from System Dynamics

Sensitivity Derivative From System Dynamics:

Substitute into sensitivity derivative:

Adaptation Law :

Adaptation Law from System Model

Sensitivity Derivative From System Model:

Substitute into sensitivity derivative and apply model following condition:

Adaptation Law :

MRAS Model - 2nd order controller

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Sensitivity derivatives

Model following condition :

Adaptation Laws from System Dynamics

Sub in sensitivity derivatives

Adaptation Laws :

Adaptation Laws from System Model

Sub in sensitivity derivatives + model following condition

Adaptation Laws :