**1DOF Model:**

图片包含 设备, 量规

描述已自动生成

**fθ’**

**mg**

**L**

**l**

**T2**

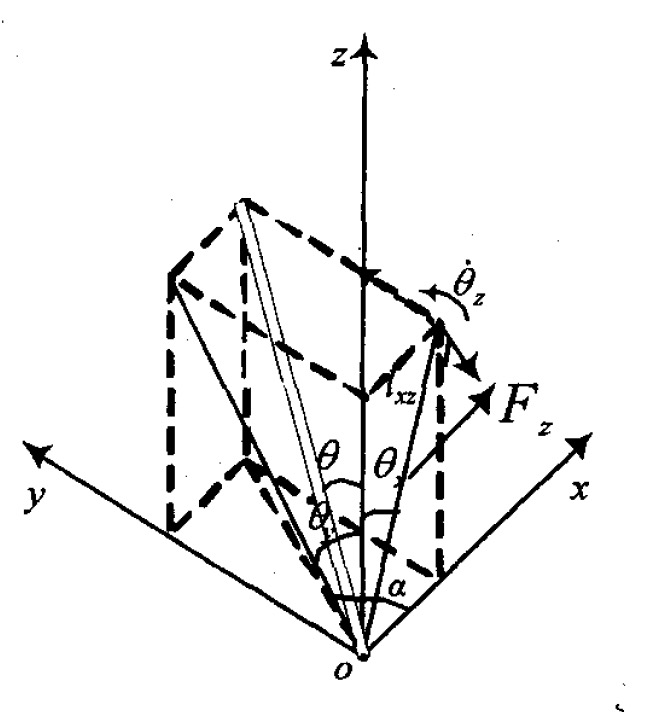
**T1**

Torque equilibrium equation:

Setting , when ,,.

Linear Model:

**2DOF Model:**



**T2**

**T1**

**T4**

**fθx’**

**fθy’**

**mg**

**T3**

By Lagrange's Equations:

Setting, when,,.

Setting , when , .

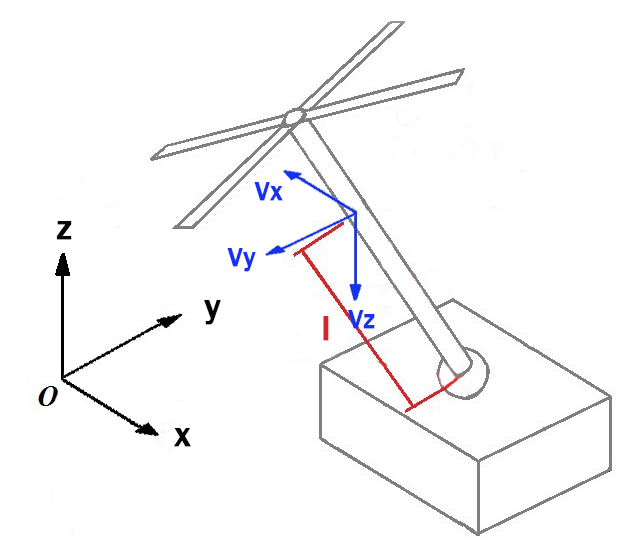
Linear Model of system 1:

By symmetry:

Setting , when , .

Linear Model of system 2:

**3DOF Model:**

****

**Ft**

**O**

**mg**

**f2**

**f1**

**U2**

**U1**

Setting the coordinate system of the pendulum around the point of O, which origin is the pivot connecting the pendulum and cart, is .

By Lagrange's Equations:

, which Tk is the kinetic energy, and Tr is the rotational energy.

**Position Model:**

The composite rotation matrix R depends on the order in which the roll, pitch and yaw rotations are applied as follows:

External moment vectors on each axis of the coordinate system:

Angular velocity around each axis:

Rotating inertia of three axis of this system:

Setting as the

The relationship between Euler angular velocity and be expressed as:

**Table of Parameters:**

|  |  |  |  |
| --- | --- | --- | --- |
| Symbol | Definition | Symbol | Definition |
|  | angle (rad) between pendulum and y axis upward |  | angle (rad) between pendulum and y axis downward |
|  | Disturbance from the cart |  | Mass of pendulum |
|  | Trust force from the right propeller |  | Trust force from the left propeller |
|  | direction of the rotation |  | Distance from the origin to the mass center of the pendulum |
|  | Gravity |  | Friction disturbance (such as air) |
|  | Moment of inertial of the pendulum |  | length of the pendulum |
|  | Radius of propeller |  | Drag coefficient of propeller |
|  | Zero lift drag |  | Lift coefficient of propeller |
|  | Aspect Ratio |  | Span efficiency factor |
|  | Velocity of one propeller |  | Drag force of propeller |
|  | Resistance of propeller motor |  | Propeller motor back emf constant |
|  | Propeller motor torque constant |  |  |
|  | Voltage of propeller velocity |  | Command of Propeller |
|  | Max propeller command |  | Distance from the top center to the propeller center |
|  | Angular velocity of pendulum about each axis |  | Rotating inertia of three axis of the system |
|  |  |  |  |