CONTROL DESIGN FOR AN EXPERIMENTAL TWIN ROTOR MULTI INPUT MULTI OUTPUT SYSTEM

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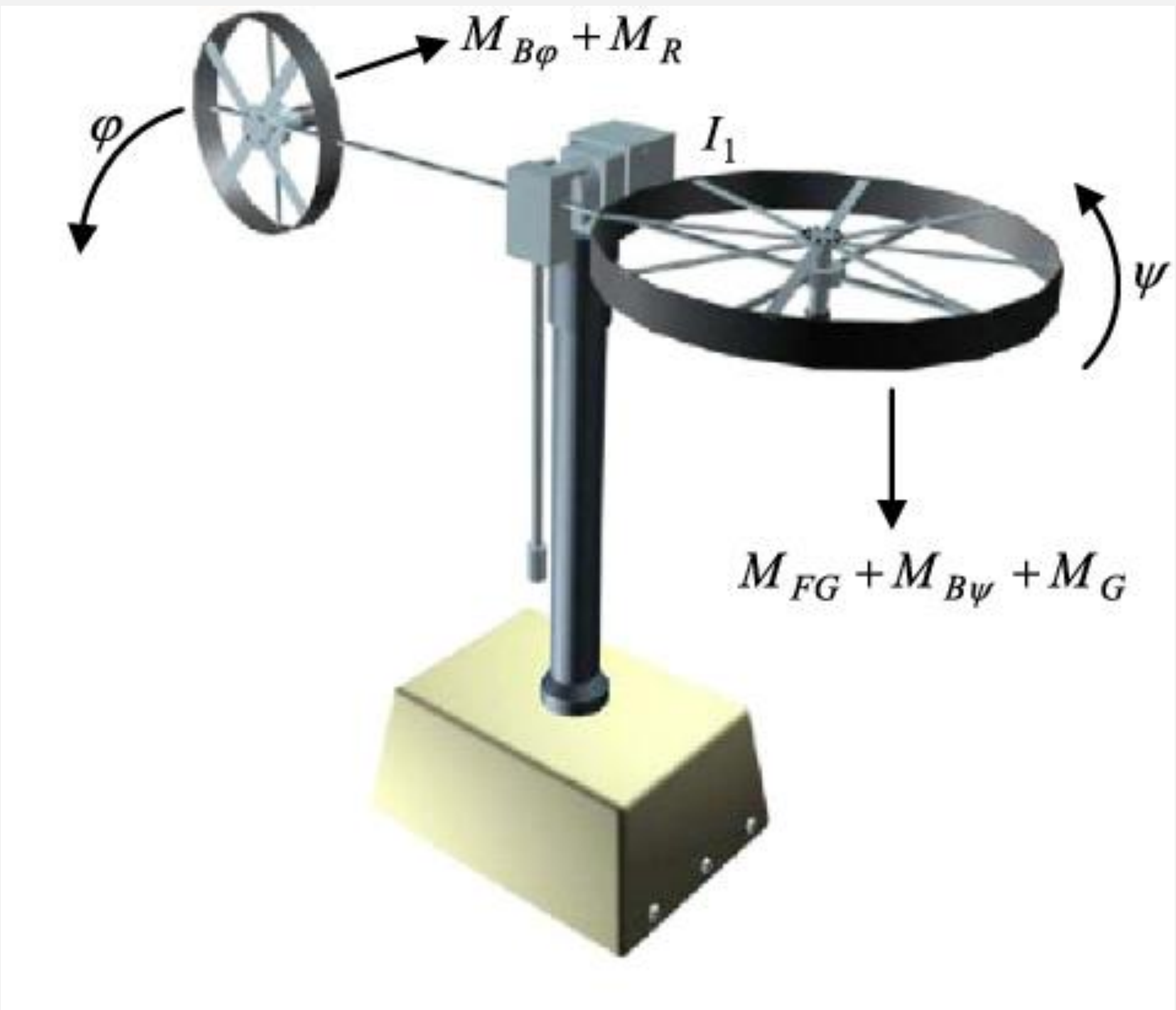
Abstract

In this project,we designed the controller of the twin rotor multi-input multi-output system, also called the experimental helicopter model. Our main goal in this project is to design a controller that will allow the system to follow the signal given by us. The given desired angles can be determined by the user. r. It is difficult to design a controller for a twin rotor MIMO system due to its nonlinear behavior between two axes . The main circuit communicates with the computer via the serial port and sends the necessary speed information to the motor circuits in line with the commands from the computer. It receives the data from the angular position and velocity measuring circuits and sends it to the computer.

1. Introduction

The twin rotor multiple input multiple output system (TRMS) is a experimental set designed by Feedback which resembles the behavior of a helicopter in certain aspects, due to the complicated nonlinearity and high cross coupling effect between main rotor and tail rotor like helicopter. The control effort is to make the beam of TRMS to move quickly and accurately to the desired attitudes both in terms of pitch angle and azimuth angle under decoupling effects between two axes. TRMS system has a higher coupling impact than a helicopter. TRMS device consists of tail and rotor. Each of them has a sensor to observe the position angularly. We will refer to the data we receive from these sensors as the actual angle. There is also the angular value of the position requested by the user from the system. We will refer to this as the desired angle. The difference between the desired angle and the actual angle is the error. The main purpose of the controller is to get the actual angle closer to the desired angle. The aim of our practice is to provide system stabilization by trying to get error to zero.

2. TRMS Model



3.System Model And Proporties

Our first mathematical model is:

$$M(Q)\dot{Q} + N(Q, \dot{Q}, t) = \tau$$

$Q(t)$: angular position (measurable)
$\dot{Q}(t)$:angular velocity (measurable)
$\ddot{Q}(t)$:angular acceleration (measurable)
$M(Q) \in IR2X2$:positive define,symmetric inertia matrix
$N(Q, \dot{Q}, t)$: centripental and coriolis effect
τ: Control input vector

4.Error Definition

1. e(t) defined as $Qd - Q$ (1) e€IR also it is 2x1 matrix
   Qd :Desired angle Q:Actual Angle

2. r=$\dot{e}$+αe (2) open loop error system

r€IR also it is 2x1 matrix α€IR it is constat,positive defined, 2x2 diagonal gain matrix

$$M\dot{r} = M(\ddot{r} + \alpha\dot{e}) \; M\dot{r} = M(Q\ddot{d} - \ddot{Q}) + M\alpha(r - \alpha e)$$

$$M\dot{r} = MQ\ddot{d} + N - \tau + M\alpha(r - \alpha e)(3)$$

Design: $\tau = MQ\ddot{d} + N + M\alpha(r - \alpha e) - kr$ (4)

kr €IR is positive definite, constat, 2x2 control gain matris

Substitute (4) in (3) $M\dot{r}$ =kr (5) closed loop error system

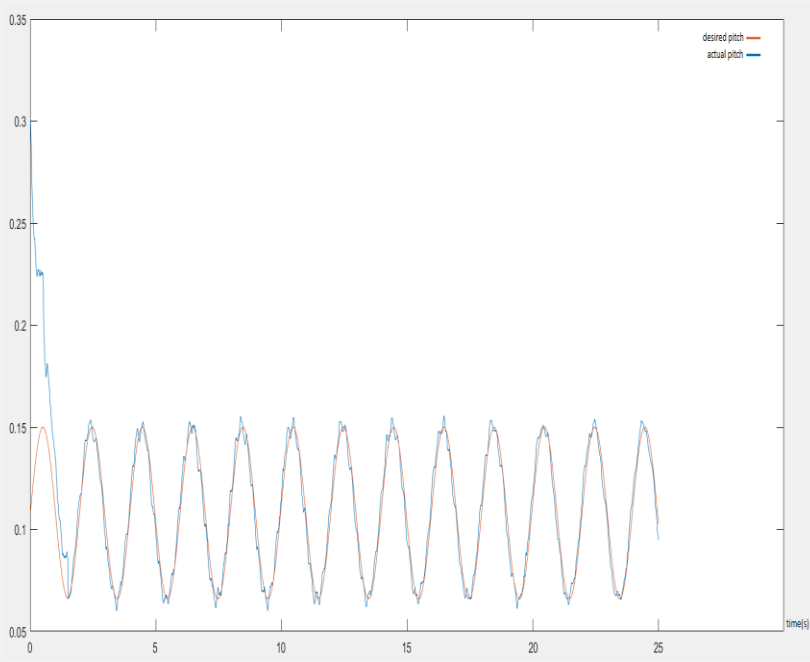
5. Lyapunov Function Candidate

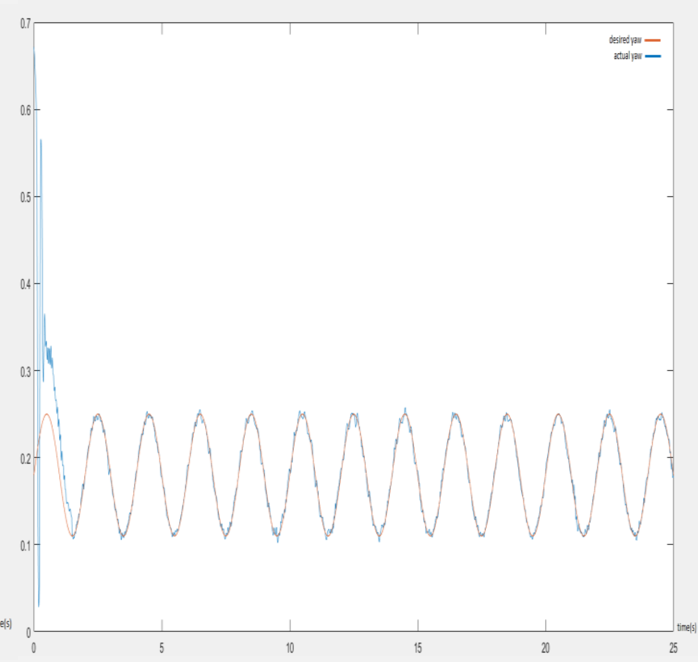
$$V = \frac{1}{2} r^T . M . r + \frac{1}{2} . e^T . r$$

$$\dot{V} = \frac{1}{2} . e^T . \dot{M} . r - e^T . k . r + e^T . (r - e^T) . \alpha e$$

V is a function such that its derivative is always negative, but V never takes a negative value. If we make our model behave like V, the system will be stable and the error will always decrease.

6. Simulation Results





4. Conclusions

This project's main purpose was to create a trms controller. Control begins with a system model. To build the controller, we should first set the parameters. We used these parameters to generate equations.Values such as inertia of the system, physical dimensions, speeds of moving parts, angles, input values are made into a system mathematically. we defined the error, which is defined as the difference between the desired angle At this point, we try that the error went to zero by using the non-negative lyapunov analysis. we used robust control for the controller. we defined an error in the system and attempted to reduce this error number to zero. Because if the error drops to zero, the designed controller is work it. A sinusoidal input is applied and the movement of the controller and drivers is determined according to this input. When measuring the angles of the axes, the initial conditions are important because an incremental measurement system is used to go to the target location by taking the current location as a reference. We used matlab simulink to simulations. then we saw that, controller working it. And than we came to real world. We've also tried different values to get the optimum system potential. And when we got to the end of the term , our controller was working in trms with the best data we had.

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