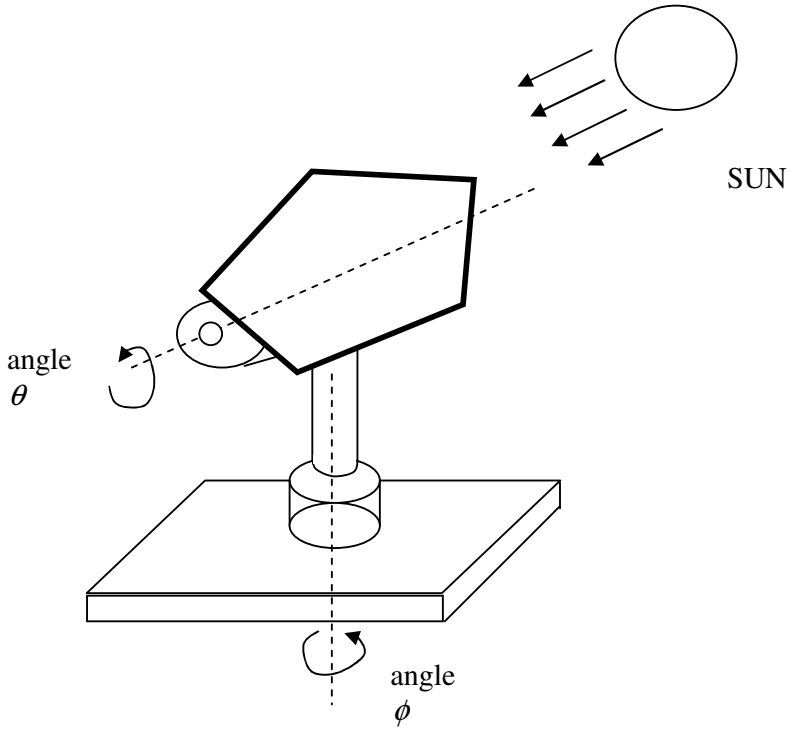
EE4002 Case-study 2012

In a mobile environment, (for example, on a yacht), it is essential that the array of photovoltaic cells is automatically positioned in order to maximise the energy capture from the sun. This is done in this example using two DC motors as follows, under microcontroller control.



Both permanent magnet DC motors are identical with the following parameters,

L=30mH R=2 ohms Km=2Nm/A

The moment of inertia and the viscous damping about the phi axis is,

$$J_\varphi = 15 Kgm^2 \qquad B_\varphi = 0.5 Nm\, rad^{-1} s$$

The moment of inertia and the viscous damping about the theta axis is,

$$J_\theta = 8 Kgm^2 \qquad B_\theta = 0.5 Nm\, rad^{-1} s$$

The DC motor model used in each case is (here given for the theta axis):

$$J_\theta \frac{d^2\theta}{dt^2} = Km\, i_\theta(t) - B_\theta \frac{d\theta}{dt} - T_\theta(t)$$

$$L\frac{di_\theta}{dt} = v_\theta(t) - R\, i_\theta(t) - Km\frac{d\theta}{dt}$$

Where $T_\theta(t)$ is the load torque about the theta axis.

A single photovoltaic sensor provides a measure of the error in radians for each angle from its optimum value. The following models have been fitted to the sensor data:

$$e_\theta(t) = 6.2\tanh(\theta_{opt}(t) - \theta(t))$$

$$e_\phi(t) = 6.2\tanh(\phi_{opt}(t) - \phi(t))$$

where the angles θ_{opt} , ϕ_{opt} are the optimum angles for maximum power, and of course depend on the position of the sun.

The sample time is 50ms.

Construct a Simulink simulation of the process.

Design digital controllers to track the sun as it moves through the sky. You must clearly state any assumptions and design criteria that you are using.

Demonstrate the tracking accuracy of your controller. Show how the closed loop process responds to realistic disturbances.

Provide a design report consisting of at most five pages of text (diagrams and plots extra), highlighting assumptions made, design method, simulation results for various tests, and conclusions.

NOTES

The deadline for this report is Friday 9th March at 12:00
Reports must be presented to Mr Ralph O'Flaherty (1st Floor EE)- a receipt will be given.
Late Submissions will be penalised at 5% per day
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