Student Satellite Project
Indian Institute of Technology, Bombay
Powai, Mumbai - 400076, INDIA

Website: www.aero.iitb.ac.in/satlab

Readme file for actuator.py

Attitude Determination and Control Subsystem

resistorPWM(v_duty_cycle,t)

Author: Sanket Chirame
Date: 05/06/2018
This function models magnetorquer as a resistor. The voltage signal given to actuator is a PWM wave. It is assumed that PWM signal starts with high voltage level at $t = 0$.
Input: Duty cycle vector with sign for polarity of voltage. The time since the start of current signal in seconds
Output: The electric current vector applied to torquer.

Input duty cycle vector has three components, each corresponding to three orthogonal torquers. V_{PWM} is amplitude of PWM voltage signal. Duty cycle goes from 0 to 1. Iterate through three components. If t modulo T is less than $|duty| \times T$ i.e. voltage level is high, then current will be $I = \frac{V}{R}$. The current is multiplied by sign of duty cycle component to decide polarity. If t modulo T is greater than $duty \times T$ i.e. voltage level is low then current will be zero.

lrPWM(v_duty_cycle,v_i_prev,v_t_prev,t)

Author: Sanket Chirame
Date: 05/06/2018
This function models magnetorquer as a series $L - R$ (inductance-resistance) circuit. The voltage signal given to actuator is a PWM wave.
Input : Duty cycle vector with sign for polarity of voltage, electric current when previous shift in voltage level occurred, time at the moment of that shift, The time since the start of current signal in seconds. (Figure [1])
Output : The electric current vector applied to torquer.

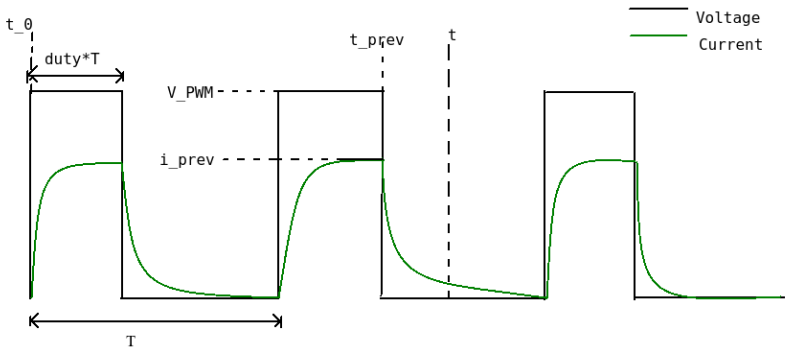

Figure 1: Schematic of PWM signal and associated variable naming

if t modulo T is less than $|duty| \times T$ then voltage level is high. The differential equation governing the current is given by

$$V - iR - L\frac{di}{dt} = 0 \tag{1}$$

Solving this equation we get

$$i(t) = \begin{cases} i_{prev} \exp\left(\frac{t_{prev}-t}{\tau}\right) \\ \frac{1}{R}[V - (V - i_{prev}R) \exp\left(\frac{t_{prev}-t}{\tau}\right)] \end{cases} \tag{2}$$

where $\tau = L/R$ is time constant of magnetorquer. The polarity of current is determined using sign of duty cycle component.