Moment of Inertia measurement for Propulsion system

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1 Objective

The objective of this experiment is to determine the moment inertia of the propeller and motor shaft in the electric propulsion system of the Yardstik aircraft for the simulation model.

2 Setup of experiment

The electric propulsion system that is rotating consists of the following items that are rotating about a common motor shaft axis. They are:

1. APC 12 x 3.8 SF propeller
2. Align 450s outrunner motor
3. Propeller adaptor

Since all these items are rotating about a common axis and they are semi-symmetrical, we determined the moment of inertia of the system using a composite assembled system. The bifilar pendulum method is used to determine the period of the undamped oscillation, which is used to calculate the moment of inertia of the composite system. Figure 1 shows the experiment setup for the bifilar pendulum.

The formulae for the calculation of the moment of inertia is given by:

$$J = (\frac{T_n}{2\pi})^2 \frac{mgR^2}{L} \tag{1}$$

where

1. J = Moment of inertia of the system to be determined (kg/m^2)
2. T_n = undamped oscillation period(s)
3. m = mass of the system (kg)

Figure 2 shows the schematic of the bifilar pendulum system.

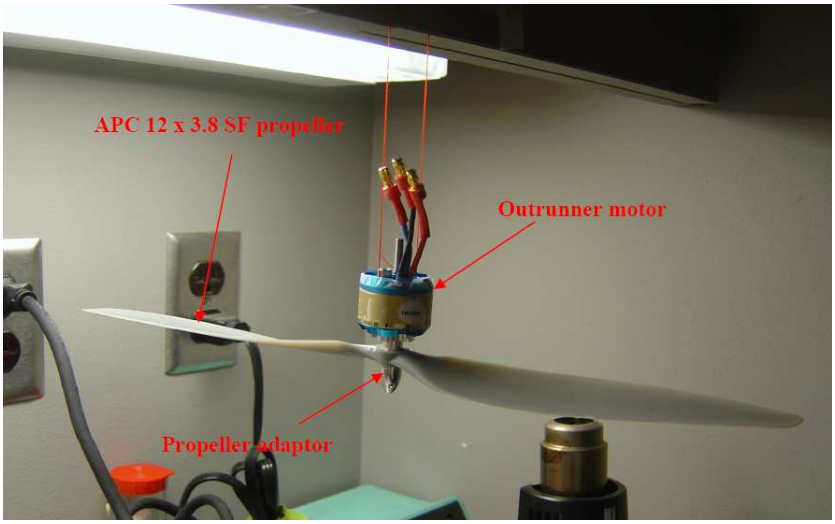

Figure 1: Bifilar pendulum setup for experiment

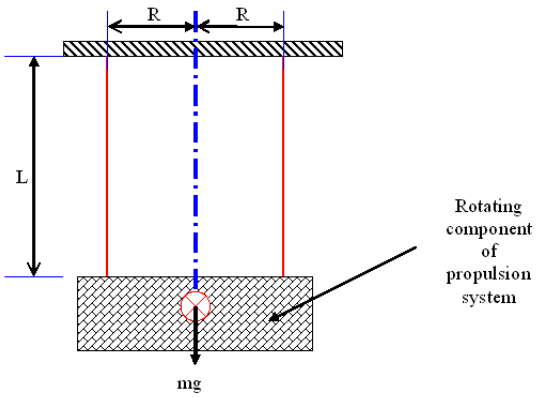

Figure 2: Bifilar pendulum schematic

3 Experiment data

The parameters for the experiment are as follows:

$$\begin{aligned} m &= 0.070kg \\ L &= 0.147m \\ R &= 0.013m \end{aligned}$$

3 set of data are taken for 5 oscillations with small angular displacement of the system. The period for 5 oscillations are as follows:

1. Test 1, $T_1 = 13.69$ sec
2. Test 2, $T_2 = 13.71$ sec
3. Test 3, $T_3 = 13.65$ sec

Hence the period of the average oscillation is 2.737 seconds, which gives a moment of inertia of 1.1216 x $10^{-4} kgm^{-2}$.