The University of Texas at Austin
Aerospace Engineering
and Engineering Mechanics
Cockrell School of Engineering

ASE 375 Electromechanical Systems
Section 14115

Monday: 3:00 - 6:00 pm

Final Report: Propeller Twist Effect on Efficiency

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Contents

1 Introduction

The purpose of this lab is to investigate the effect of propeller twist on propulsive efficiency. We will be using a brushless DC motor to spin a propeller at different speeds and measure the thrust produced by the propeller using strain gages. We will measure the electrical power consumption using a wattmeter. The wattmeter also outputs the current and voltage readings while the motor is spinning. Thus efficiency of the propeller will be calculated by taking the ratio of the thrust to the electrical power consumption measured. We will compare the efficiency of two propellers with the same diameter but different twist angles spinning at a chosen PWM signal, which is sent to the motor to rotate at a certain angular rate.

2 Equipment

Measurement devices and hardware used in this lab include:

1. Carbon Fiber Beam with motor mounting holes:

   A cantilevered carbon fiber beam will be used to mount the motor, strain gages, and electronic speed controller. Below is the setup of the experiment:

2. Dummy resistors. Specifically, a 10kΩ resistor, a 1kΩ resistor, and two 350Ω resistors will be used in the circuit. The two 350 Ω resistors will be used as dummy resistors for the wheatstone bridge configuration, and the 10kΩ and 1kΩ resistors will be used for the photodiode circuit.
3. Two strain gages, one placed on the top of the carbon-fiber beam and one placed on the bottom. The strain gages will be connected to a DAQ to measure the strain on the beam.
4. NI-9215 DAQ
5. Amplifier (AD623)
6. Miniature Magnet
7. Laser Pointer
8. Photodiode
9. BLDC Motor with the proper rated Brushless Electronic Speed Controller
10. Power Supply supplying operational voltage, with Voltmeter, Ammeter, and Watt-meter
11. PWM Wave Generator or PWM/Servo Tester
12. 2 Two-Blade Propellers of same diameter and different twist (6x6 in and 6x5.5in)
13. Thrust Stand/Arm with mounting for BLDC Motor
14. Breadboard

To prepare the carbon fiber beam for the strain gages, we sanded down the beam with 80, 120, and 220 grit sandpaper. We then cleaned the beam with isopropyl alcohol and applied the strain gages to the beam with superglue as performed in lab 4. The strain gages were connected to a DAQ and dummy resistors to calibrate the strain gages.

3 Procedure

4 Data Processing

5 Results and Analysis

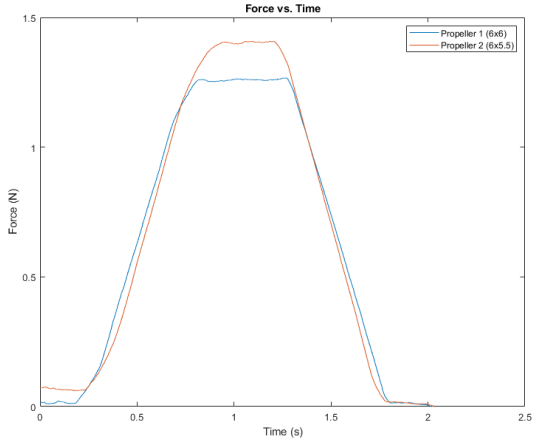

Figure 1: Force vs Time for Trial 1

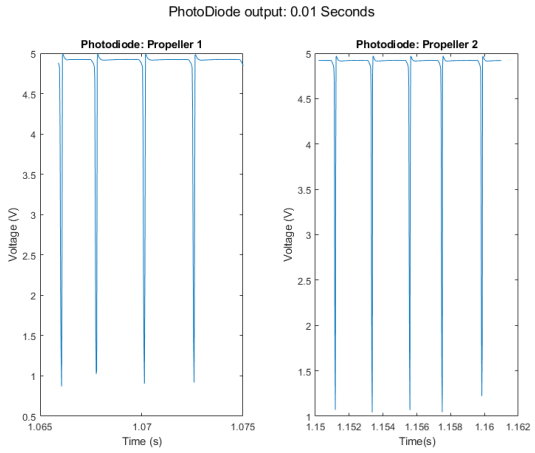

Figure 2: Photodiode Output for Trial 1

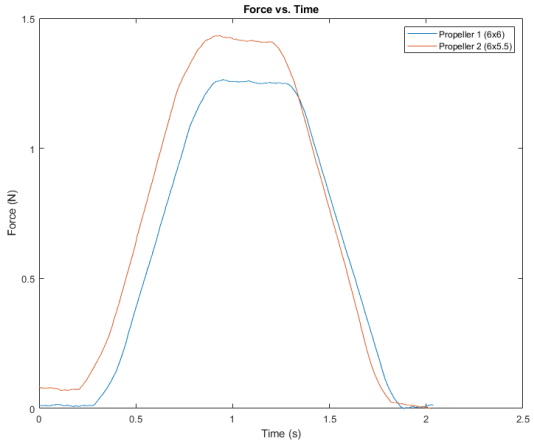

Figure 3: Force vs Time for Trial 2

Parameter	**Propeller 1 (6 x 6)**	**Propeller 2 (6 x 5.5)**
Name	6 x 6	6 x 5.5
RPM (measured)	26453.2969	27705.3444
RPM (Theoretical)	26197	26990
RPM (% error)	0.97834	2.6504
Force (N)	1.2674	1.4088
Wattage (W)	45.55	46.7
Efficiency	2.7823	3.0168
Uncertainty (%)	0.017541	0.016756

Table 1: Comparison of Propeller Performance - Trial 1

Parameter	**Propeller 1 (6 x 6)**	**Propeller 2 (6 x 5.5)**
Name	6 x 6	6 x 5.5
RPM (measured)	25883.3191	26272.3077
RPM (Theoretical)	26197	26990
RPM (% error)	1.1974	2.6591
Force (N)	1.2653	1.4337
Wattage (W)	44.25	47.3
Efficiency	2.8594	3.031
Uncertainty (%)	0.017554	0.01674

Table 2: Comparison of Propeller Performance - Trial 2

6 Conclusion

Appendix

A Datasheets

[1] Multistar Elite 2300KV Motors

[2] ESC

[3] Propeller

[4] Servo Tester

[5] Photodiode

[6] NI9215

[7] AD623