Analysis on Propeller Design for Medium-Sized Drone (DJI Phantom 3)

Mohammad Iqmal Mohd Ali, Azri Nazarain Afandi, Ahmad Maulan Bardai

Abstract: ***Unmanned aerial vehicles, UAV, has increases in the drastically in these past several years because of their reliability, cost effectiveness and multi-functionality. Stage, research has been made on quadcopter by worldwide researchers. The 3D model of propeller blade of the drone was created using CATIA with dimension. Computational Fluid Dynamics (CFD) software is used in this project to analyze the effect of different shape of propeller. There are 3 type of propeller that used in this project which is normal propeller, bullhorn propeller and hybrid bullhorn propeller. The focus of this project is to study and identify the best propeller design for specific drone which is DJI Phantom 3. There is certain parameter is kept constant which are the velocity of the wind, the propeller shape and the RPM of the propeller. The data will be collected to make comparison between the type of design. The best design will be chosen based on good in lift and drag coefficient. These data will be compared among of three propellers to know which one has the best performance.***

Keywords: UAV, propeller design, computational fluid dynamics, DJI Phantom 3

I. INTRODUCTION

General introduction

Nowadays, drones have been phenomenal in being a trendy gadget owned by millions od people around the globe. Originally developed for military and research purposes, they have been further developed to be readily available and user-friendly not only for professional tasks, but also for entertainment and recreational purposes. Just like how researchers have been rapidly focusing more on improving aviation-related technology [1-9], procedures [10-13], and intellectual concepts [14-19] quite recently, drone developmental studies are no exception. Hence, this research will focus one specific part of a drone – the propellers.

Research Objectives

Propeller size and design play important roles in getting thrust. Thus, the purpose of this study is to identify the best propeller design for specific size of drone which is DJI Phantom 3 drone. Furthermore, with the best design of propeller makes the drone fly smoothly. To get the best propeller design, Computational Fluid Dynamics (CFD) software being used. The result gain from CFD software will be compared in term of thrust and drag coefficient and the best propeller will be chosen.

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II. LITERATURE REVIEW

Airfoil

Airfoil that is placed in a stream of air will produce two forces that is perpendicular to the direction of air. The force that goes upward is called lift, the lift force must overcome or greater than the weight for it to generate lift. This lift depends on the relative velocity of air and the angle of attack [20].

To calculate the lift, if the lift coefficient (Equation 1) of an airfoil (wing) at a specified angle of attack is given, it can be determined by using the equation:

$$L = \frac{1}{2}\rho v^2 A C_L$$

Equation 1: lift coefficient

Where,
L = lift force,
ρ = air density,
v = true airspeed,
A = planform area, and
CL = lift coefficient at the desired angle of attack

Quadcopter

Quadcopters can be described as a small vehicle with four propellers attached to rotor located at the cross frame. This aim for fixed pitch rotors is used to control the vehicle motion. The speeds of these four rotors are independent. By independent, pitch, roll and yaw attitude of the vehicle can be control easily. Pitch, roll and yaw attitude off Quadcopter are shown in Figure 1 [21].

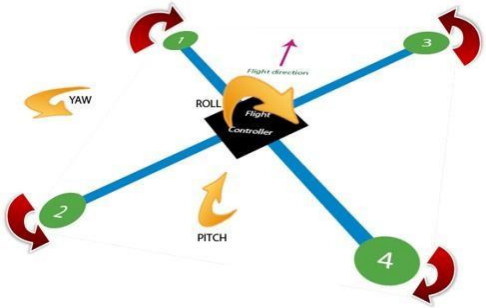

Fig. 1 Movement of a quadcopter

Early propellers, or those designed before the end of the Second World War, were designed using an empirical approach.

One such example of this approach is documented in National Advisory Committee on Aeronautics (NACA) Technical Note (TN) 212 (Weick, 1925), which allows for a propeller to be designed for a light aircraft by calculating it.

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