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Design & Performance Evaluation of 3- Blade Propeller for Multi-Rotor UAV

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***Abstract*— This work emphasis on research, designing and development of an 3-blade efficient propeller for an existing UAV to produce maximum thrust in an operating range of 2000 rpm to 3000 rpm. And CFD analysis will be performed to determine the performance characteristics of the propeller.**

Keywords—UAV, Quadcopter, Propellers, Multirotors, VTOL

I. INTRODUCTION

A propeller is a device that converts mechanical energy into a force, which we call thrust, and is used to propel the vehicle to which it is attached. The propeller features one or more lifting surfaces called propeller blades1 that are rotated rapidly using an engine. The thrust is the aerodynamic lift force produced by the blades and is identical to the force produced by a wing. Propellers are, by far, the most common means of generating thrust for any general Aviation aircrafts or modern UAVs.

II. 3-BLADE PROPELLER GEOMETRY

A.

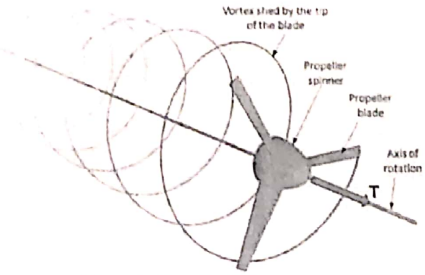

Figure 1 – Propeller Helix

A three-bladed propeller is shown in Figure 1, rotating about an axis. The spinner is an aerodynamically shaped cover, whose purpose is to reduce the drag of the hub of the propeller and to protect it from the elements. The propeller blades are what generate the thrust of the device, denoted by T. The pressure differential between the front and aft face of the propeller blade results in a vortex that is shed from the tip of the blade and is carried back by the airflow going through the propeller. This forms the typical helical shape shown in the figure-1. A frontal projection of the three-bladed propeller is shown below.

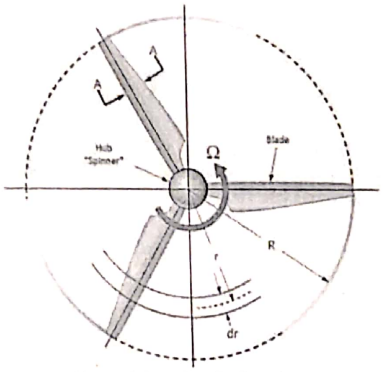

Figure-2 Frontal projection of the 3-blade propeller

Where R is the blade radius, r is the radius to an arbitrary blade station, and U is the rotation rate, typically in radians per second or minutes. The blade of a propeller is really a cantilevered wing that moves in a circular path rather than along a straight one. Just like an airplane's wing, the plan form of the propeller blade has a profound impact on the magnitude of the thrust force created, as well as at what "cost." What constitutes "cost" is the amount of power required to rotate it, as well as side effects such as noise.

III. GEOMETRIC PROPELLER PITCH

Consider the propeller in **Figure - 3**, whose diameter is D and radius is R. As the propeller rotates through a full circle, its tip rotates through an arc length (circumference) of C = 3.14xD = 2x3.14xR. As the propeller rotates it "screws" itself forward a certain distance P for each full rotation. The distance it would cover in one full revolution is called the geometric pitch or pitch distance, PD, of the propeller. It is commonly specified in terms of inches of pitch. Thus a propeller designated as a 42-inch pitch prop would move 42 inches forward in one revolution (using the metal screw through wood analogy). The angle the helix makes to the