CHAPTER 1
INTRODUCTION

1.1 Background

An Unmanned Aerial Vehicle (UAV), also referred to as a drone, is an aircraft that functions without a pilot physically present onboard. UAVs can either be operated remotely by a human or fly autonomously by relying on pre-set flight routes and sophisticated onboard control systems. They serve a wide range of purposes, including military surveillance, agricultural data collection, environmental studies, and delivery services. The adaptability and cost-effectiveness of UAVs have made them valuable assets in numerous sectors.

Unmanned Aerial Vehicles (UAVs) or unmanned aerial vehicles have increased significantly in various sectors, including military, surveillance, mapping, and agriculture. One of the main challenges in operating UAVs, especially fixed-wing UAVs, is the flight range. The flight Range of UAVs is very important because it directly affects the Area mapping and monitoring and the overall mission of the UAV.

The experience of the UAV UNGGEH TABANG 019 during its participation in the 2019 Indonesian Flying Robot Contest (KRTI) revealed a limitation in flight time endurance. This causes the UAV to be unable to carry out monitoring and mapping missions perfectly.

To improve efficiency and maximize the range of UAVs, one potential solution is to design winglets and wing that increase the lift coefficient and reduce the drag generated. There are many types of winglets and wing configuration out there and different winglets and wing have different effects on the lift coefficient, drag coefficient, and stall behavior of the UAV.

The primary purpose of winglets on aircraft is to improve aerodynamic efficiency by reducing drag, specifically induced drag, which is caused by the formation of wingtip vortices. These vortices form due to the pressure difference between the upper and lower surfaces of the wing, creating spiraling airflows at the wingtip that increase drag.

For wing design it has been observed that the unique tubercles along the leading edges of the humpback whale’s pectoral fins analogous to large vortex generators on aircraft can delay stall and improve maneuverability. This biological insight has inspired various experimental and numerical studies on the aerodynamic effects of leading-edge protuberances, such as sinusoidal patterns, with the aim of developing innovative strategies to enhance airfoil performance. In the context of UAVs, such sinusoidal wing designs offer potential improvements in lift characteristics, stall behavior, and overall aerodynamic efficiency.

Based on the previous research it shows that the winglet modification modeling at a 30° cant angle yielded the highest C_L/C_D ratio compared to other configurations, with the optimal value occurring at a 2.5° angle of attack, reaching a C_L/C_D ratio of 24.728[1], and for sinusisodal wing previous research shows that that sinusoidal wing configuration improved lift characteristic in the post stall region, and make C_L max of up to 17% compared to the baseline case. To know the effect of winglet angle variation and sinusoidal wing profile on the UAV in this research using simulation using Ansys Fluent in case it can generate data that can be studied to observe the influence of the winglet angle cant variation and sinusoidal wing profile.

This proposal outlines a strategy to observe the coefficient lift and coefficient drag on UAV Unggeh Tabang 019. The approach involves designing and optimizing the winglet angle and wing profile, specifically the cant angle, and sinusoidal profile wing to determine the most effective configuration. By identifying the optimal cant angle, the aerodynamic efficiency of the UAV can be improved, ultimately leading to better overall performance of this UAV.

1.2 Formulation of Research Question

4.2.1 How to increase the aerodynamics of UAV Unggeh Tabang AFRG- 019

4.2.2 How the effect of winglet angle variation on UAV UNGGEH TABANG AFRG-019 due to the coefficient lift and coefficient drag.

4.2.3 How the effect of sinusoidal wing profile on Unmanned Aerial Vehicle UNGGEH TABANG AFRG-019 due to coefficient lift and coefficient drag.

1.3 Aim

The aim of this study is to analyze the effect of winglet cant angle variations and a sinusoidal wing profile on the UAV UNGGEH TABANG AFRG-019, in order to determine their influence on the aerodynamic performance and flight characteristics of the UAV. This analysis will be conducted using simulations in Ansys Fluent.

1.4 Benefits

The benefit of this research is to help provide winglet angle variation and sinusoidal wing profile that can be applied to UAV UNGGEH TABANG AFRG-019.

1.5 Problem Scope

The limitation of problem in this final project are:

1. The simulation applied in UAV model of UNGGEH TABANG AFRG-019 with winglet angle (Cant) variation of ,15˚,45˚,75˚ using Ansys Fluent in order to know the lift coefficient and drag coefficient
2. For the sinusoidal leading-edge profile, three UAV configurations are analyzed: the baseline UAV, UAV A with an amplitude of A = 0.03 × chord and a wavelength of λ = 0.5 × chord, and UAV B with an amplitude of A = 0.05 × chord and a wavelength of λ = 0.5 × chord. The chord length is 215 mm for the wing and 125 mm for the wing type of winglet that used in this study is blended winglet type
3. Aerodynamic aspects is obtain by looking at the C_L,C_D , and C_L/C_D ratio.

1.6 Report Outline

This final project consists of five chapters. The first chapter describes the background, problem formulation, purpose, outcome, problem scope, and report outline. The second chapter provides an overview of the literature that becomes a reference in the final project. The third chapter describes the research methodology. The fourth chapter contains the results and discussion. The last chapter is the conclusion of the final project.