1. PRELIMINARY

1.1 Background

AFRG 006, a UAV flying-wing, was produced by Andalas Flying Robot Generation (AFRG Team) in 2017. This aircraft has participated in the national level competition on KRTI (Kontes Robot Terbang Indonesia) 2017 in Surabaya as a final candidate for the mapping area. Once, when AFRG 006 got training, the wings were flapping appreciable. The large deformation exhibited by these aircraft increase the interaction of the rigid body dynamics and structural vibration modes - usually the first wing bending mode[2]. It indicates that the stiffness of aircraft is low as well as natural frequency so that it is convenient to be exited at low frequency. This condition causes the aircraft easier to oscillate at low loads (which is low frequency and same with the natural frequency of aircraft) due to aerodynamics forces so that the aircraft potentially failed. To avoid this condition, it is necessary to add a slight stiffener spar to the UAV structure that able to keep mass constant relatively (slight increase in mass) so that the natural frequency can be increased. Previous research (Affandi, 2019) found that the addition of the spar is directly proportional to the natural frequency. The main aim of this final project is to avoid resonance condition by increasing the stiffness of AFRG 006 UAV's structure using variation of spar cross-sectional profile. These profile variations change the moment of inertia of the spar which is expected to be able to increasing the wing stiffness of AFRG 006 without change the total mass of the UAV. This effect can increase the natural frequency so that the AFRG 006's structure is more resistant to dynamic load than before. The first step of this study is to design the aircraft structure using the Autodesk Inventor Student Version, then exported it to the commercial simulation software for modal analysis. The optimum condition for the spar profile is obtained by simulating the UAV natural frequency using some variation of the spar moment of inertia. In this final project, there are 7 different spar variations based on their area moment of inertia, namely U profile, circular, T profile, Square, L profile, I profile, and Z profile.

1.2 Problem Statement

The problem formulation of this study is how to avoid the resonance condition by increasing the stiffness of AFRG 06's structure without change the UAV total mass significantly.

1.3 Objective of Research

The objective of this final project is to increase the natural frequency of AFRG 006 UAV by modifying the profile of addition spar on aircraft wing and fuselage.

1.4 Benefit of Research

If the goal of this final project has been achieved, another benefit that will be generated is that the UAV is expected will be safe from oscillations which can cause fractures on the wings due to its natural frequency has shifted forward several percent ahead from the previous natural frequency.

1.5 Idealization

Problem limitations in this study are:

1. The structure is assumed to be one single unit.
2. Spar is assumed supported by perfectly fixed.
3. The examining and analyzing of natural frequency and mode shapes are only at the first and second elastic modes.
4. The materials used in the design and analysis of this final project are aluminum for spar, balsa wood for rib, and glass FRP for skin.
5. Fluid flow analysis and electrical system of UAV do not consider.
6. Research is limited only to AFRG 06 UAV.

1.6 Report Outlines

This final project is generated in a systematical manner that complies with scientific writing guidelines. Chapter I contains the introduction consists of background, problem statement, research objectives and benefits, idealization, and report outlines.

Chapter II contains the theoretical foundation or comprehensive literature study. The research methodology is described in Chapter III which covers the type of research, time and location, instruments, procedures, data processing and analyzing. Furthermore, chapter IV will be discussed about the results and evaluation of research, then conclusions and suggestions summarized in CHAPTER V.