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1. INTRODUCTION

1.1 Background

Landing gear, which is also called the undercarriage, is a complex system consisting of the structural member, hydraulics, energy absorption components, brake, wheel, and tires.[1] The main function of landing gear is absorbing the energy due to impact load during landing, supporting the body weight at all ground maneuvers, like takeoff, taxiing, and landing rollout.[2] It also contributes to preventing the body from excessive vibration, increasing aircraft flight safety, and achieving good convenience. The phenomenon that commonly occurs in the landing process is called hard landing. A hard landing is one of the typical landing incidents which is the landing gear impact the ground with higher vertical speed and force than in normal landing. It will affect the response of the system in both displacement and acceleration and subsequently causes serious vehicle damage, structural failure, and discomfort due to excessive vibration.

Linkage or kinematic chain is an assembly of links and joints that provide the desired output motion in response to a specified input motion.[3] A link normally is a rigid body that has at least two nodes. Linkage mechanism can be applied in the landing gear of the aircraft, especially for an unmanned aerial vehicle (UAV). Some type of linkage mechanism applied in landing gear has analyzed by the researcher. Hong-Tu Luo and Jing-Shan Zhao[4] analyze the landing gear mechanism by two non-coplanar spatial six-bar linkages to achieve higher stiffness, higher strength, and higher reliability. It is accomplished by static and kinematic analysis. Adipta K.E.[5] explains the characteristic of the landing gear response by four-bar linkage mechanism in terms of static and dynamic analysis. Furthermore, it performs the various geometry in a similar ratio of link dimension to obtain the characteristic of the landing gear. Lastly, this research analyzes landing gear based on the three-bar linkage mechanism. It performs the static and dynamic analysis of landing gear by various geometry with a dissimilar ratio of link dimension. This landing gear also involves the movement of the spring angularly, so that the stiffness has not constant value during the movement of the system. Based on the theory of vibration, one kind of factor that influences the stiffness of the system is geometry configuration such as link dimension, the angle between two links, and

the number of links. By adjusting the geometry, it will produce different characteristics associated with static and dynamic responses. The higher stiffness of the vibration system, the more stability can be achieved, but it also produces a higher impact load subsequently decreases the convenience and increases the failure possibility. Furthermore, the geometry of landing gear also influences the characteristic of the stiffness, whether it has linear or nonlinear behavior.

In this research, the three-bar linkage mechanism of landing gear is designed and performed to find out the characteristic of responses in both static and dynamic by various geometry (link dimension). The model is based on a linkage mechanism and they are connected by a pin joint. Virtually, the landing gear has the capability to control and absorb the energy due to the impact load during the landing process. The higher capability to control and absorb the energy, the higher stability can be achieved. The important parameters that are considered associated with stability are displacement and acceleration responses where the system is desired to have a low of these amplitudes. Therefore, the various geometry of landing gear is performed to know the characteristic of that response related to displacement and acceleration. Furthermore, the optimum model is selected from the various model based on this consideration. In this research, the model of landing gear is designed by using commercial design software and the response in both static and dynamic are obtained from a simulation by computational commercial software.

1.2 Problem Formulation

The landing gear is designed based on a three-bar linkage mechanism. It involves the geometry analysis in order to obtain the characteristic of geometry associated with the responses in both static and dynamic. Furthermore, the landing gear is varied into five models based on geometry (link dimension) configuration. Therefore it needs to know how to obtain the characteristic of landing gear likes stiffness, displacement, and acceleration. Moreover, among the landing gear model, the optimum one is selected based on displacement and acceleration consideration.

1.3 Objective

The objective to be achieved in this research are:

1. To obtain the characteristic of landing gear which vary in geometry (link dimension)
2. To obtain the optimum landing gear model based on displacement and acceleration consideration

1.4 Outcomes

The benefit can be obtained from this research are:

1. Obtain practical knowledge in design and selection of landing gear
2. Obtain knowledge in modelling and simulation of landing gear system using design and computational software.

1.5 Idealization

The idealization of this research are:

1. Motion is considered in vertical direction only
2. The system analyzes in one degree of freedom model
3. Surface roughness of the ground is neglected
4. Tires stiffness is not considered
5. Maximum displacement that allowed of the spring is about 7.5 cm
6. Transient response is not considered

1.6 Report Outline

This research is written in five chapters. The first is an introduction, it contains background, problem, objective, benefit, idealization, and report outline. The second chapter is a literature review, contains supporting theories related to this research. The third is the methodology. It describes the method and flowchart of the research. The fourth is result and discussion and the last is the conclusion of this research.