

CHAPTER

6

FLYING MACHINE USING FLAPPING WINGS FOR PROPULSION

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6.1 INTRODUCTION

Natural flyers such as birds and insects have evolved to fly by flapping their wings. Unlike, airplane and helicopters are designed to have fixed wings and rotary blades, to fly up from the ground, and to move forward in the air. These demonstrate distinctive style of flight compared to evolutionary characteristics of animals especially natural flyers. Flapping wings flight is more manoeuvrable than steady flight (Shyy et al., 2008). However, flapping wings flight is more complicated than the fixed wings flight because of the structural movement to generate propulsion. From Cambridge Dictionary, propulsion means a force produced by a system that pushes something forward. The flapping wings mechanism is also called an ‘ornithopter’.

In developing a flying machine that uses flapping wings for propulsion, several elements need to be studied. For instance, the natural flyer’s flight characteristics, an anatomy of the wings, and the principles and theories of flight and aerodynamic. In this project, with a proper design process, a motor-powered flying machine is designed and built.

6.1.1 Problem Statement

Flight elements and wings mechanism that is significantly used by birds and insects to fly up from the ground and keep hovering in the air need be studied in designing a motorised flying machine that uses flapping wings for propulsion.

6.1.2 Objective

To design and build a motorised flying machine that can work from the ground and hovering in the air by flapping its wings for propulsion.

6.1.3 Scope and Limitation

The scopes for this project include works of literatures on bird and insect physical and flight characteristics, conceptual design generation, analysis, three-dimensional modelling, fabrication of a prototype, and testing.

6.2 DESIGN PROCESS

This section explains the conceptual design process.

6.2.1 Problem Identification

Problems are identified by performing critical background research, understanding physics and aerodynamics concepts, and analysing similar existing products.

6.2.2 Product Design Specification

A product design specification (PDS) is made to guide the development of concepts for the flying machine with flappy wings. The elements of PDS considered in this study are performance, dimension, material, and ergonomics.

Table 6.1 Product design specification

Criteria	Descriptions
Performance	(1) The machine flies up using a motor. (2) One flapping cycle is divided into upstroke and downstroke to generate lift and thrust. (3) The left and right wings must be symmetrical for both sides for the stability of the wings. (4) The wings area aspect ratio is in the range of one to five for ideal lift performance. (5) The machine can stay in the air for at least 30 seconds. (6) The machine flies and hovers in indoor and outdoor environments.
Dimension and Weight	(1) The wingspan is not more than 120 cm. (2) The overall mass of the machine is in the range of 2 kg to 5 kg. (3) The geometry of the wings can be quarter elliptical shape. (4) The weight of the machine is less than the value of lift.
Materials	(1) The machine is light in weight to ease the take-off. (2) The machine is portable. (3) The machine is not easily damaged due to fall impact during testing or operating. (4) The wings are made of air-resisting materials to capture the air for pressure manipulation. (5) The flapping mechanism has worn resistance. (6) The surface roughness (air friction) of the wings can be negligible.
Ergonomics	(1) The machine is easy to carry, hold, and store. (2) The machine has no unnecessary exposed sharp edges that can be harmful to users. (3) The rotating and moving parts is minimized or covered for safety purpose during operation.

6.2.3 Functional Analysis

Functional decomposition is a way of breaking down a complex problem into simpler problems based on the tasks that need to be performed. Based on the objective of this project—to design and to build a machine that can fly up from the ground by flapping its wings—several functional mechanisms by bird and insect flight need to be considered.