DESIGN AND DEVELOPMENT REMOTE CONTROL (RC) SOLAR PLANE

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DECLARATION

I declare that this thesis entitled "DESIGN AND DEVELOPMENT REMOTE CONTROL (RC) SOLAR PLANE is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature : 

Name : MOHD LUQMAN HAKIM BIN BERAHIMA

Date : 13/01/2023

APPROVAL

I hereby declare that I have checked this report entitled " DESIGN AND DEVELOPMENT REMOTE CONTROL (RC) SOLAR PLANE ", and in my opinion, this thesis fulfils the partial requirement to be awarded the degree of Bachelor of Electrical Engineering with Honours

Signature : .....

Supervisor Name : MOHD SAIFUZAM BIN JAMRI

Date : 16/01/2023

DEDICATIONS

To my beloved mother and father

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ABSTRACT

By gaining practical experience in the actual construction of flights or other aerodynamic structures in real time, one can gain a better understanding of the theoretical underpinnings of the intensive models used in the study of aeronautics. As a result, a new effort to design, develop, and fly a radio-controlled airplane was initiated. In most cases, the RC plane is powered by a rechargeable battery, which places a cap on the amount of time it can spend in the air. A few solar-powered aircraft, both manned and unmanned, have been designed and flown in past few years. RC aircraft utilizes solar cells to collect solar energy for immediate usage, while storing the remainder for night flight. Solar-powered RC plane are attracting a growing amount of interest in the recent research and development efforts of several sectors due to the significant lengthening in flight duration that they promise. The goal of the project was to design and build a RC plane with a wingspan of 1400 millimeters that would be powered by a mix of solar cells and batteries. The primary goal is to significantly extend the amount of time that the RC plane may remain in the air by using the power that is generated from the solar cells. The design of the power system begins with the selection of an appropriate system architecture, followed by the selection of an appropriate set of components relating to solar system. During stable level flight, the solar-powered RC plane's battery voltage decreases at a significantly slower rate than the same configuration without a solar-power source. The study of the configuration of solar system and the battery consumption had been through this project.

ABSTRAK

Dengan memperoleh pengalaman praktikal dalam pembinaan sebenar penerbangan atau struktur aerodinamik dalam dunia sebenar, seseorang boleh mendapatkan pemahaman yang lebih baik tentang asas teori model intensif yang digunakan dalam kajian aeronautik. Akibatnya, usaha baru untuk mereka bentuk, membangun, dan menerbangkan kapal terbang yang dikawal radio telah dimulakan. Dalam kebanyakan kes, pesawat RC dikuasakan oleh bateri yang boleh dicas semula, yang meletakkan had pada jumlah masa yang boleh dibelanjakan di udara. Beberapa pesawat berkuasa solar, baik dengan dikendali dan tanpa pemandu, telah direka dan diterbangkan dalam beberapa tahun kebelakangan ini. Pesawat RC menggunakan sel solar untuk mengumpul tenaga suria untuk kegunaan segera, sambil menyimpan bakinya untuk penerbangan malam. Pesawat RC berkuasa solar telah menarik banyak minat termasuk dalam usaha penyelidikan dan pembangunan dalam beberapa sektor kerana pemanjangan yang ketara dalam tempoh penerbangan yang dapat janjikan. Matlamat projek ini adalah untuk mereka bentuk dan membina pesawat RC dengan sayap 1400 milimeter yang akan dikuasakan oleh campuran sel solar dan bateri. Matlamat utama adalah untuk memanjangkan jumlah masa yang pesawat RC untuk kekal di udara dengan menggunakan kuasa yang dihasilkan dari sel solar. Reka bentuk sistem kuasa bermula dengan pemilihan seni bina sistem yang sesuai, diikuti dengan pemilihan satu set komponen yang sesuai yang berkaitan dengan sistem solar. Semasa penerbangan tahap stabil, voltan bateri UAV berkuasa solar berkurangan pada kadar yang jauh lebih perlahan daripada konfigurasi yang sama tanpa sumber kuasa solar.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

UAS	-	Unmanned Aircraft System
UASs	-	Small Unmanned Aircraft System
UAV	-	Unmanned Aerial Vehicle
RC	-	Remote Control
HALE	-	High-Altitude Long-Endurance
MPS	-	Mobile Sending Platform
ESC	-	Electronic Speed Controller
PWM	-	Pulse Width Modulation
PV	-	PhotoVoltaic
DC	-	Direct Curent
Ni-Cd	-	Nickle-Cadmium battery
Ni-MH	-	Nickle-Metal-Hydride
Li-S	-	Lithium Sulphur
Li-Po	-	Lithium Polymer
BLDC	-	Brusless DC
HLG	-	High Lift Glider
VR	-	Virtual Reality
IOS	-	iPhone Operating System
PPM	-	Pulse Position Modulation
FPV	-	First person View
GPS	-	Global Positioning System
kg	-	Kilo Gram
Rpm	-	Rotation per Minutes

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Small unmanned aircraft system (UASs) have become a cornerstone in modern military operations, providing essential information, surveillance, and reconnaissance (ISR) to combat soldiers for decision-makers[1]. UAS also known as UAVs (drone) which is a reusable military aircraft that autonomously guided, by remote control through a hand-held radio transmitter by an operator on the ground. The UAVs also consist of microprocessor and multiple sensors for the aircraft estimates its present of kinematic condition and automatically controls its flight. In recent military confrontations, the UAVs have shown to be beneficial in military surveillance [2].

The technology of UASs has move advance over past decade, where the sensor, processing and the battery have gotten smaller, powerful, and more economical. Particularly, The development of UAS for military use has been aided by commercial available low-weight, low-power, low-cost sensors based on microelectromechanical systems technology [2]. Due to this, the practical of UASs applications have widened to include more than just military purposes but also civil use, academic research, and recreation. UASs come in a range of sizes and shapes and have been used in military and civilian applications such as ISR, search and rescue, and atmospheric research.

Depending on the purpose, different sizes of UAVs are intended to perform at different levels. As indicated in Figure 1.1, UAVs are divided into four categories: large, medium, tiny, and micro. Small UASs are a blend of sophisticated electronics and hobby remote-controlled (R/C) plane components that take use of developments in sensor, computing, and battery technologies. For the small airplane it might design for the RC plane used for hobbies or commercial use such as surveillance. It uses a battery-powered electric motor or a gas engine for powered flight depend on application.

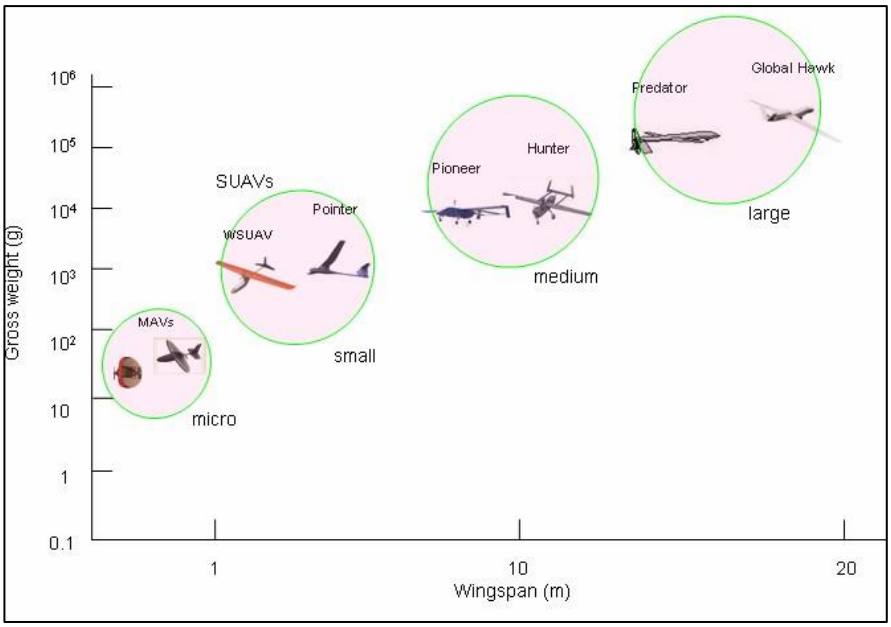

Figure 1.1 Four Group of UAV [1]

1.2 Motivation

Since the application scope for the UAVs become widen as the driving force, the researcher and the commercial industry had been attracted more intention in development of solar-powered UAVs. The use of solar power as an energy source on UAVs could be one way to get over this physical limitation of the plane. By installing the solar cells on the wing of the plane it can capture solar energy reaching the plane surface during daytime hours. The generated electrical energy was used to operate the plane's motor and other electronics devices such as sensor, camera and servo, as well as to recharge the batteries onboard.

1.3 Problem Statement

The main problem for the Remote-Control plane was the flight endurance or flight time, since the commercially produced RC plane was using battery as the main source will runs out quickly due to low battery storage capacity. The ability of commercial battery-powered electrical UAVs to store energy is a major issue limiting their range of operation. The energy stored in the batteries was used to power the electrical mechanism inside the conventional UAVs to keep the propulsion system running and the flight control electronics working. The total amount of electrical

energy that stored in the battery already limiting flight endurance before the departure (takeoff). Even though, the idea of increasing the size of battery or adding more battery an enhance the energy storage capacity of the plane, but its make plane become weightier. Although, the energy capacity increased, there were more power is consumed to carry the additional weight, and the flight endurance is not necessarily extended. Only rechargeable batteries with a gravimetric energy density that is independent of capacity are evaluated for electrical energy storage for RC plane**.** Lithium-Ion batteries now store between 50 and 260 Wh/kg, which is the highest energy density of commercially available cells [3]. Since the RC plane was using rechargeable battery which is lithium-ion battery the integration of solar panel was used to increase the flight endurance of RC solar plane.

The weight of the plane also plays importance roles for the RC solar plane to fly. The material to build the structure of the plane must be lightweight so less force needed for plane to fly and stay airborne. The highest power-per-weight ratio of solar sell was chosen, and the solar cells must be thin and light as possible so it will not affect the performance of the plane. The size of both wings must fit the solar cells and it supposed to be horizontal position in order for the whole surface area of both wings is to be entirely covered in solar cells. The weight of both wings must also be same after solar cells installed in order to achieve stabilization when RC solar plane flied.

1.4 Objective

The objectives of the research are further described into more discrete and detailed manner that listed below:

1. To design and develop solar RC plane .
2. To Integrate the solar system into the RC plane.
3. To verify the performance of flight duration with and without solar cells

1.5 Scope of The Project

The scope of this study has been narrowed down to a more specific and specialized field of inquiry, with the following limitations:

1. Design and developing the RC plane by using electrical mechanism and Depron Foam as body structure.
2. Implement the solar cell on the wings of RC plane.
3. Use the trigger switch as a method to integrate the solar system into the RC plane.
4. Analyze the performance in term of flight duration after the integration of solar system.

1.6 Project Planning

Background, problem statement and objectives are important to determine the direction of the study and then be able to focus the priority of producing the study. Based on the problem statement and objective, the study will be done in the next chapter on previous studies, appropriate methods, related components, and methods to develop a prototype. The scope of the project ensures the boundaries of a project in order to achieve the objectives easily.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature Review is a secondary source taken from thesis, articles, books and other document that have author, date of publish and publisher. The main aim of literature review is to review the previous project related to RC solar powered aircraft. This chapter introduce some of the information related to project that are useful to innovate the project such that to produce a RC solar plane that can have higher flight.

2.2 RC Plane Design Development

The ability to harness renewable energy such as solar energy has been studied and is definitely not new. The evolution of the ever so alluring idea of RC planes is the capability of using electrical power from solar energy and the plane design itself.

2.2.1 Solar plane history progress

It is crucial to take note of the demeanor of solar-powered aircraft evolution over time, as better conclusions and decisions could be made when designing a blueprint of a plane. The reasoning and the motivations of the previous project regarding this matter are of the utmostimportance to distinguish the compatibility of ideas that will be included in this current project.

For starters, the first-ever flight of a solar-powered plane took place on the dry lake at CampIrwin, California, on November 4, 1974. Named the “Sunrise I”, it was built under contract by ARPA and developed by R.J. Boucher of Astro Flight Inc. which flew for 20 minutes at an altitude of roughly 100 meters. It had a wingspan of 9.76 meters, weighed 12.25 kg, and produced 450 watts of power from 4096 solar cells. The plane then improvised to Sunrise II, roughly a year later, but eventually failed after weeks of testing due to command failure thatinvolved its

control system. Solaris, another plane model worked on in Germany by Helmut Bruss capable of three 150-second flights at 50 meters altitude. The design took a year since the original prototype experienced overheating of its solar cells. [4]

Successes of the previous solar plane to have flights motivated a few to come up with challenges, such as the design of manned solar planes. In 1977, Gossamer Penguin was the result of the challenge to build one and the plane was fragile and had limited control while being airborne, which meant almost zero tolerance for incoming wind gusts and crosswinds. Note that Gossamer Penguin was derived from its pioneer, the Gossamer Albatross which is 75% much bigger. Small capability control against wild weather renders the plane to fly only in the morning for its gentler winds, however, the downside was the solar panels needed to be adjustable and tilted towards the low sun in the morning. Afterward, a more advanced aircraft was designed, called the "Solar Challenger" [5].

As time progresses, evolution and breakthroughs were achieved as well, and high-altitude long-endurance (HALE) solar planes were implemented. The potential to raise up against thechallenge of designing solar planes for HALE conditions and missions started to make fruition as Zephyr, recorded an 83 hours flight continuously, thus setting a record for the new world endurance record back in 2008. Zephyr was created for military purposes, a civil version of itwas designed and adjusted subsequently, called the Mercator.

2.2.2 Design Consideration of RC planes

Solar RC plane design creations need to consider multiple parameters which could consist of the very basic geometrics as well as the level of high complexity aspects such as aerodynamics.Throughout many years of research and prototypes that had been done implemented various conceptual designs where maximizing efficiency and endurance testing are in question during that time. In general, the size of the plane determines the manner of flight that could be established, which is to man the plane or simply by a remote, depending on the researcher's aim and motivation of its prototypes.

This current research on remotely operating the RC planes collates well with the purpose of being an unmanned aerial vehicle (UAV), however, it omits the mobile sending platforms (MSP) criteria as the original intention was to be able the plane to maneuver within a certainaltitude, adjusting the flight endurance when seeing fit [6].

Prof. Alpesh Mehta et.al experimented with other means of power source for flight. Basic hurdles for the solar plane design include the geographical area of operation, energy collection and utilization, payload, and design parameter. Aside from the parameter of the solar panels, or solar cells as mentioned in the article, the fuselage and rudder draft, and aerofoil blueprint and its analysis were taken into consideration. Electrical components' parameters such as the motors were concluded with an electronic speed controller (ESC), an electronic circuit used to change the speed of an electric motor, its route, and also to performas a dynamic brake [7]. Which isbased on pulse width modulation (PWM). With the reference to the article, it provides moreoptions for drafting the plane's conceptual design for this research.

Soumyo Dutta et.al, [8] had a project that incorporated multiple components for their design which were mainly payload, propulsion, aerodynamic, structure, and the building aspect. A score analysis was set in order to drive the importance onto certain components compared to others easily, in which the focus was delivery flight and payload flight. In addition, sensitivity analysis was included as well in the project as a derivation from the score analysis equation. Even though the current project does not involvepayload or any extra weight, the score analysis may prove to provide more accurate insight into the design considerations. Sketches for conceptual design were also incorporated as there are five configuration sets containing the wing types choices, motor mounting positions, and tail designs. It is generally known that an aircraft's wings are one of, if not the most, vitalsections of the plane. The wings provide lift, which allows the plane to leave the ground and take off, as well as hold the fuel [9]. As such, it is best to note that choosing the best design thus determining them bytheir own merits and compatibility with the current projects is one of the essential steps to take in designing the current RC plane.