Propeller Arm Control System Planning for Flying Electric Vehicles

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ABSTRACT

This research aims to design and develop a propeller arm control system for a flying electric vehicle. With the increasing need for efficient and environmentally friendly vehicles, this research focuses on control mechanisms that can improve vehicle maneuverability and speed performance. The research methods used include design planning, making motor mounts, and setting up the control system using the FLYSKY FS-i6 remote control and Lithium Iron Phosphate (LiFePo4) batteries. The results of the research show that the designed propeller arm control system can function well, providing a fast and accurate response to commands from the remote control. This research is expected to make a significant contribution to the development of flying electric vehicle technology, as well as opening up opportunities for further research in the field of automotive electronics.

***Keywords**: flying electric vehicle, control system, propeller*

1. INTRODUCTION

Modern urban transportation faces urgent complex challenges, especially in terms of traffic congestion, air pollution, and travel time efficiency. Population growth and rapid urbanization have encouraged the need for innovative mobility solutions that can overcome the limitations of land infrastructure. In this context,

Flying Electric Vehicles (FEV - Flying Electric Vehicles) or often referred to as Urban Air Mobility (UAM) appears as a promising revolutionary solution. FEVS is designed to provide air transportation that is fast, efficient, and environmentally friendly in the urban environment, opening new dimensions in the journey of commuter and logistics. However, realizing this vision requires the development of a very sophisticated control system, especially for the arm propeller arm which is a crucial component in FEV's maneuver, stability, and safety. Planning for precision and adaptive propeller arm control systems is the main relevant challenge at this time to ensure that FEV can operate safely and effectively in a dense urban air space.

Various studies have been conducted in the last five years to overcome challenges related to the development of the FEV and the control system. FEV performance design and analysis has been extensively studied by [1] and [2]. The flight control system for multi -motorcycle vehicles that form the basis of FEV has been investigated by [3] and [4], with a focus on the PID and Adaptive control algorithm. Aspects of stability and attitude control (attitude control) in FEVS are the main concern in studies by [5] and [6]. Research on energy management and efficiency of propulsion for FEVS has also been carried out by [7] and [8]. Furthermore, the integration of sensors and navigation systems for autonomous operations FEVS is discussed by [9] and [10]. Challenges related to the transition between vertical and horizontal flying modes have also been studied by [11] and [12]. The development of mild and strong material for the FEVS structure is the focus of the study [13]. In addition, the problem of noise and its impact on urban environment has been explored by [14]. Simulation of Aviation Dynamics and Model Validation for FEVS is a research topic [15]. Error control and tolerance of component failure in the FEVS propulsion system is discussed by [16] and [17]. The design of a high capacity battery system and its thermal management for FEVS is also a research subject by [18]. The aspects of cyber security in the FEVS control system have also been investigated [19]. Finally, research on flight path optimization and avoidance of obstacles for FEVS in urban environments has been carried out by [20].

Continuing from the existing literature, specific studies on the control of the propeller arm showed several interesting research directions. [21] Has reviewed the design of the folding mechanism on the arms of the propeller for FEV that can change the configuration. Meanwhile, [22] focuses on the active vibration damper system on the propeller's arm to increase the comfort of passengers and the durability of the structure. [23] Exploring the use of intelligent actuators on the arms of the propeller for a faster and precise dynamic response. Optimizing the distribution of the push force through individual control of each propeller's arm has been examined by [24]. Aerodynamics aspects The interaction between the arms of the propeller and the body of the FEV has also been analyzed by [25]. In addition, [27] conducted research on the integrated detection and prevention system of collisions at the tip of the propeller's arm. Finally, [28] discusses the modularity of the propeller's sleeve design to facilitate the maintenance and replacement of components that are easier.

Although substantial progress has been achieved in the development of FEV in general and its flight control system, there is still a significant research gap related to planning a specific control system for propeller arm (propeller arm). Most research tends to focus on overall flight control (for example, attitude control, position), energy management, or structural design, but there is no in-depth investigation that comprehensively designs and optimizes the control system that is fully dedicated to the dynamics and individual maneuvers of each propeller arm. This vacancy includes the planning of control algorithms that consider complex interactions between motorcycles, propeller, and arm structure, as well as the ability to adapt to changes in operational conditions (for example, partial damage or wind disorders). The purpose of this study was to overcome the gap by developing a precision, adaptive, and able to increase the overall FEV stability and stability.

Based on the identification of problems and research gaps, the main purpose of this study is to design and implement adaptive and precise propeller armor arms control systems for flying electric vehicles (FEV). This study will focus on the development of control algorithms that can manage individual dynamics of each propeller arm, ensure a rapid response to control commands, and maintain stability in various flight conditions. Specific objectives include: (1) Developing an accurate dynamic arms of the FEV propeller arms; (2) designing a control strategy that is able to compensate for external disorders and changes in system parameters; and (3) evaluating the performance of the proposed control system through extensive simulations to verify the capability of position control, angular velocity, and response to changes in load. The results of this study are expected to make a fundamental contribution to the advancement of FEV technology, especially in the aspects of flight control and safety in complex urban environments.

2. Research Significance

This study has a large significance from both theoretical and practical perspectives, especially in advancing the field of Flying Electric Vehicles (FEV) or Urban Air Mobility (UAM) which is developing rapidly. Theoretically, this study will enrich the treasures of science in the field of aviation and robotics control systems, especially in the dynamics of modular propulsion system complexes. In-depth understanding of the interaction between the actuator, the structure of the propeller arm, and the dynamics of local aerodynamics will provide a fundamental basis for the development of more accurate control models and sophisticated adaptive algorithms. Data and analysis resulting from the planning of this propeller's arm control system can function as a foundation for other researchers to develop more robust autonomous control systems, as well as to validate complex simulation models. It also contributes to the theoretical framework to the distributed act of act of control system design on the flight platform.

Practically, the findings of this study will provide concrete guidelines and innovative solutions for FEV engineers and producers in designing and developing vehicles that are safer, more stable, and efficient. Planning of the precise propeller arm control system is very crucial to improve the ability of FEV maneuvers in dense urban air spaces, allowing more agile and responsive movements. Adaptive controls on each propeller's arm can also increase tolerance to component failure (for example, partial damage to motor or propeller), which significantly increases FEV safety factors. Furthermore, the optimization of the control system at the right of the propeller's arm has the potential to reduce energy consumption and noise level, two important factors for the sustainability and public acceptance of FEV. Thus, this research not only encourages the limits of FEV technology, but also contributes directly to the implementation of FEV that is commercially proper and socially accepted, opening the way for a new era of urban transportation.

3. RESEARCH METHODS

This research uses a design and build method with data collection obtained from descriptive analysis of the results provided by the tool. Before realizing it, first create a complete system design to achieve the research objectives.

3.1. Material

The design of the propeller arm control system on a flying electric vehicle uses 4

1. Remote control
Used to operate drones with precision and efficiency, ensuring safe flights that are fit for purpose and use.
2. Servo motors
Used to control BLDC motor mounts.
3. Battery
Used to supply servo motor voltage.
4. Step down
Used to regulate the voltage according to what the servo motor requires.
5. Bearings
Used to facilitate rotation or movement.
6. Iron pipe and iron plate
Used for BLDC motor mounts.
7. Rod end bearings
Used for BLDC lever mounts and servo motors.
8. Full thread axles
Used to connect servo motors and BLDC mounts.

3.2. Flying Electric Vehicle Design

Two servo motors are used to achieve dual tilt actuation with each rotor. This design was designed in Solidworks, the mechanical design of a flying electric vehicle is shown in Figure 1

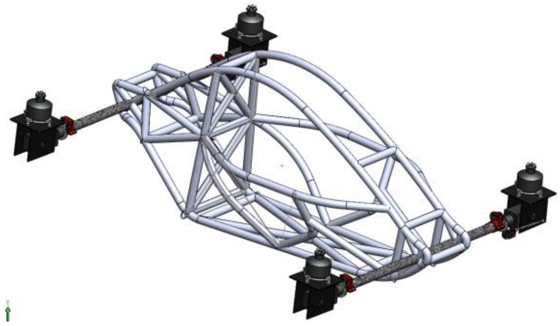

Figure 1 Drone design

The proposed actuation concept for the arm and BLDC motor is shown in Figure 3.2 and Figure 3.3 The dual tilt mechanism of the arm is based on the use of a servo motor connected horn and rod end via a BLDC motor mount. Another servo motor is installed on the BLDC motor mount which is connected to the BLDC motor mount via a push pull mechanism which rotates parallel to the servo lever, as seen in Figure 3.3. The two angles produced by the servo motor are the configuration of the propeller rotation axis.

Figure 2 Push-pull mechanism for roll motion

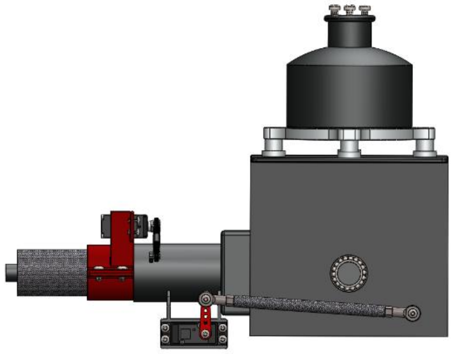

Figure 3 Push-pull mechanism for pitch motion

Figure 2 shows the mechanism used to move the BLDC motor mount. The working mechanism is the same as Figure 3. This kind of mechanism is often used to change the rotational movement of a motor into a linear or certain angular movement.

4. RESULTS AND DISCUSSION

The first stage is creating a wiring diagram design for the propeller arm control system carried out in Edwarmax software. This wiring diagram makes the assembly process easier so that there are no short circuits or other undesirable things. In Figure 4.1 is the wiring diagram of the propeller arm control system.

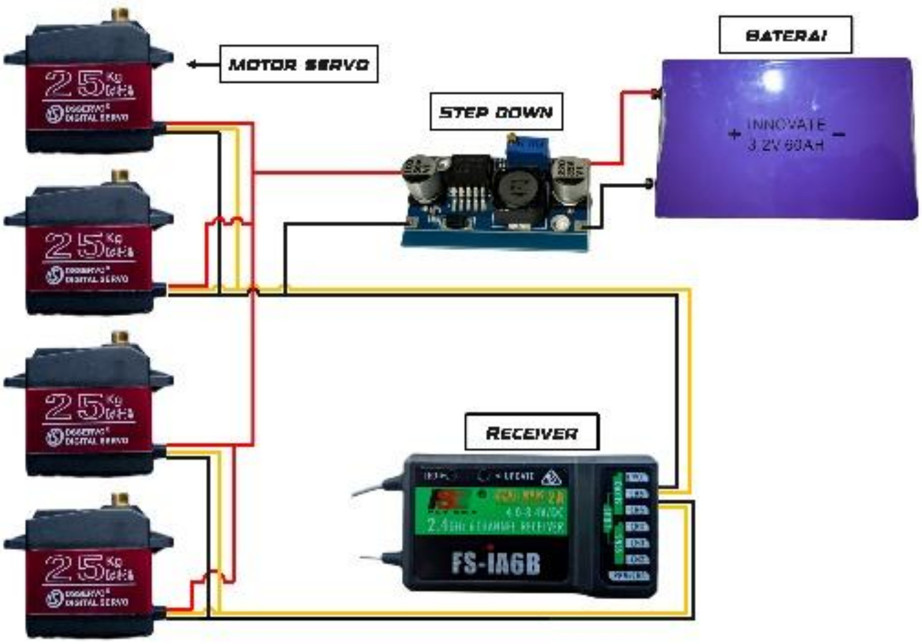

Figure 4. Wiring diagram of the propeller arm control system

The receiver receives a signal via the remote control (transmitter) and sends the signal to the servo motor. On each channel the receiver can drive 2 servo motors by combining the servo motor cables into one.

The battery provides power through step down to adjust the power required for the servo motor. So that the performance of the servo motor can be maximized according to its specifications. The following is an explanation of the wiring in Figure

1. Receiver

The receiver receives a signal from the remote control then sends the signal to the servo motor to move the BLDC motor mount. The signal cable from the servo motor is connected to the CH3-CH4 pins of the receiver.

2. Servo motors

4 servo motor cables combined into one are connected to CH3 to move the servo motor in the pitch direction. And 4 servo motor cables are combined into one connected to CH4 to move it in the yaw direction.

3. Step down

The output from the step down is to supply the power needed by the servo motor. The output from the step down can be adjusted to suit the needs of the servo motor.

4. Battery

The main battery provides power supply for the entire system.

Figure 5 show that the servo motor can be assembled. And as a result of the wiring assembly, the servo motor can move according to the remote control as shown in Figure.

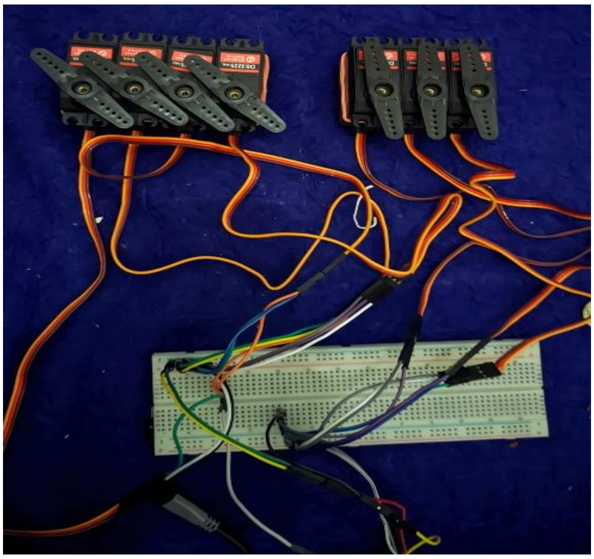

Figure 5 Servo motor cable assembly

Figure 5 show that an experiment in assembling servo motor cables, by combining 4 servo motor cables into one. And after everything is assembled then check the movement of the servo motor.

5. CONCLUSION

The conclusion of the journal states that the propeller arm control system on the designed flying electric vehicle can function well. The system provides fast and accurate responses to commands from the remote control, demonstrating effectiveness in increasing vehicle maneuverability and speed. This research is expected to make a significant contribution to the development of flying electric vehicle technology and open up opportunities for further research in the field of automotive electronics.

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7. AUTHOR CONTRIBUTIONS

Concept and design: Muhammad Ainul Mafazi
Electrical wiring design: Muhammad Ainul Mafazi
Written publication: Sugeng Hadi Susilo

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