SUMMARY OF MASTER’S DISSERTATION

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Title

Practicality Evaluation by Conceptual Design of Flying Cars Considering Battery Constraints

Abstract

The development of Flying cars is still in its infancy ,and the market does not yet exist, so the dominant design has not been decided. In the Previous research, assuming the use case of critical care, the requirements are set by interviewing stakeholders, and the aircraft is designed in the mission profile. However, the weight of the battery is fixed at 1/3 of the total mass, and the weight energy density of the battery is calculated from the required amount of energy. Therefore, it has not been clarified whether the weight energy density of the existing battery can meet the demand and the limit of the weight of the battery that can be loaded.

In addition, there are three types of aircraft that are considered as Flying cars: Multi-rotor type, Vectored thrust type, and Lift + cruise type, each with different characteristics. Therefore, the required weight energy density and the weight ratio of the battery may differ depending on the aircraft type. Therefore, in the design method of this study, the total energy amount is calculated from the requirements of a specific use case, and the weight of the battery is calculated by dividing by the set weight energy density. This is the originality of this research.

The purpose of this research is to compare the flight performance of three types of aircraft devised as Flying cars and to verify the practicality of Flying cars from the viewpoint of the weight energy density of existing batteries. In addition, the feasibility is evaluated from the viewpoint of battery constraints by calculating improvement targets based on the weight energy density parameter study and comparing them with the battery development goals.

The research was conducted according to the following flow.

(1) Requirements analysis is performed from stakeholder interviews in emergency medical use cases to define design variables such as flight mission profile, cruising speed, cruising range, and payload.

(2) Define restrictions on the sizing method for Flying cars, aircraft specifications common to all three types of aircraft, and different aircraft specifications for each aircraft type.

(3) Estimate the battery weight from the total amount of energy required for flight so that the flying car meets the design variable conditions. In addition, the weights of the aircraft components are summed to estimate the total mass of the Flying car.

(4) The sizing method of this study will be verified by comparing the sizing results of the the previous study with the nominal data of Flying car manufacturers.

(5) Enter the requirements obtained in (1) as design variables for the sizing method, and check whether the requirements are satisfied by the possibility of convergence calculation while considering the constraints. If the requirements are not met, the weight energy density parameter study calculates weight energy density improvement goals.

As a result, the following results were obtained. In addition, the requirements are Must requirement (cruising speed 150 km / h, range 50 km, 2 passengers), Should requirement (cruising speed 200 km / h, range 150 km, 3 passengers), Could requirement (cruising speed 300 km / h, range 300 km, 4 passengers).

① Multi-rotor type cannot meet any of the requirements due to the limit of the cruising range.

② Vectored thrust type can meet the Should requirement with the weight energy density of the existing battery.
In order to meet the Could requirement, it is required to improve the weight energy density to 348.92 Wh / kg.
This is a value that can be achieved within 2025 compared to the development goals for in-vehicle batteries.

③ Lift + cruise type can meet the Must requirement with the weight energy density of the existing battery.
In order to meet the Should requirement, it is required to improve the weight energy density to 272.86 Wh / kg.

Although this study only evaluated the flight performance of each aircraft, aircraft design requires a variety of aircraft types to choose from. Manufacturing costs, operating costs, noise, safety, etc. As a future study, it is necessary to comprehensively consider and evaluate the feasibility.

Key Word(5 words)

Flying Cars, eVTOL , Airframe Design , System Design , Sizing Method