Quadcopter Control Based on Experimental Dynamic Identification

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ABSTRACT

The development of reliable and robust flight control systems is an exigent concern in the field of unmanned aerial vehicles (UAVs), particularly in light of the inherent open-loop instability associated with quadrotors, which renders the direct application of controllers impracticable without prior design. In this investigation, we advance a method for regulating quadcopter flight based on experimental dynamic identification. Our approach involves utilizing a black-box direct methodology to construct a model of the quadrotor's attitude behaviors through data collection and the application of various linear and nonlinear representations. The veracity of the models is subsequently ascertained via stringent validation protocols. Consequently, predicated on the resulting dynamic model, a control system is developed to optimize the quadcopter's stability and maneuverability. This approach to controller design engenders a dependable and efficient solution for regulating quadcopter flight.

Keywords: Quadcopter, Control, Identification

1 Introduction

Unmanned aerial vehicles, particularly quadcopters, have gained prominence across various domains, given their versatility and capabilities. However, their complex and nonlinear dynamics present challenges for precise control. This study quadcopter control, emphasizing experimental dynamic identification to enhance stability and maneuverability [1]- [11].

2 Methodology

The methodology in this paper encompasses several key steps. First, it involves the collection of data through experimental testing of a quadcopter's attitude dynamics. Next, various model structures, including Transfer Function, Discrete-time ARX, Discrete-time ARMAX, Nonlinear ARX, and ANFIS, are employed to construct mathematical representations of the quadcopter's behavior. These models are rigorously validated to ensure accuracy. Furthermore, the paper details the process of controller redesign, optimizing gains through a genetic algorithm, and implementing the controller on the quadcopter for improved performance. The study ultimately demonstrates the effectiveness of this approach in enhancing quadcopter stability and control.

3 Results and Discussion

The research yielded several key findings. Firstly, it successfully identified and modeled the dynamic behavior of a quadcopter's attitude, utilizing various mathematical structures including Transfer Function, ARX, ARMAX, and Nonlinear ARX models. Among these models, the ANFIS model exhibited the highest accuracy and precision in describing quadcopter behavior. Through controller redesign and optimization using a genetic algorithm, the study improved the quadcopter's performance, achieving better stability and control. The paper demonstrated that the identified models could effectively guide controller design without the need for physical prototyping [12]- [18].

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DOI: 10.21467/abstracts.163 ISBN: 978-81-965621-5-1 (eBook)

4 Conclusion

This study successfully identified and modeled the dynamic behavior of a quadcopter's attitude using various mathematical structures, with the ANFIS model exhibiting superior accuracy. By redesigning and optimizing controllers, the research improved the quadcopter's performance and stability.

5 Declarations

5.1 Acknowledgments

This work was supported by the Laboratory of Energetic System Modelling (LMSE) of the University of Biskra, Algeria, under the patronage of the General Directorate of Scientific Research and Technological Development (DGRSDT) in Algeria. The research project was approved by the Ministry of Higher Education and Scientific Research in Algeria, under the number A01L08UN070120220003.

5.2 Competing Interests

No conflict of interest exists in this work

How to Cite

K. TELLI, O. KRAA, B. Mohamed, "Quadcopter Control Based on Experimental Dynamic Identification", *AIJR Abstracts*, pp. 13–14, Feb. 2024.

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