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A FUZZY-ACTIVE FORCE BASED CONTROL ARCHITECTURE FOR CHARACTERIZING A NONLINEAR MIMO SYSTEM

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulation of Universiti Teknologi MARA. It is original and is the results of own my work, unless otherwise indicated or acknowledged as reference work. This thesis has not been submitted to any other academic instituition or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

This study examines the modelling and control of a twin rotor multi-input multi-output (MIMO) system (TRMS). An intelligent Active Force Control (AFC) scheme is utilised to compensate disturbances that a conventional PID control algorithm alone is unable to due to the system's highly nonlinear behaviour. Fuzzy logic (FL) is used to estimate intelligently the inertial properties apart from crude approximation method to initiate the AFC effect. The AFC scheme complements the PID controllers acting on the main as well as the tail rotor. It is evident from the simulation studies performed that the inclusion of the intelligent PID-AFCFL scheme produces a more robust controller as compared to the conventional PID as well as crude PID-AFC systems in compensating unwanted internal as well as external disturbances. The intelligent hybrid control algorithm also significantly improves the system overshoot, rise time and settling time apart from its adaptability towards disturbances as compared to its traditional counterpart.

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CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

The physical nature of air flight systems is considered as a complex system when researchers are often faced with the complexity of designing such system owing to its inherent nonlinear properties. Over the years, rapid development on the advancement of technology in the aviation field took place where the technologies utilised and adapted differs significantly from their predecessors. Advanced control algorithms are amongst the elements that drive the technology of robust air flight.

The aid of computer simulation contributes considerably to the rapid development of flight technology. The development of this technology requires many tests that consume time in collecting data in order to define optimised parameters in designing helicopters and airplanes system. The utilisation of computer simulation reduces this time-consuming process, as well as cost as the development of physical prototypes as well as real tests. Simulation works allow researchers to expand the novel methods in addressing the nonlinear behavior of air flight systems through linearisation, dynamic inversion, Winner-Hammerstein, polynomial identification and artificial intelligent amongst others [1].

Extensive use of helicopter in daily human life has resulted in the rapid development of helicopter technology. Its ability in landing and taking off vertically makes it unique for specific missions. Amongst its advantages are its ability in hovering for a certain period, as well as operating under low airspeed conditions. It is often used for search and rescue missions, cargo and people transportation, military operations, observation, medical transport, tourism, aerial observation, and construction [2].

Helicopters are considered as a rotorcraft vehicle in which the rotors produce the lift that allows the helicopter to land and take off vertically whilst maintaining its altitude. Conversely, its cyclic control regulates its forward, backward and sideway movements. These characteristics allow helicopters to be used in areas where fixed-wing aircrafts are