MODELING AND CONTROL OF A CLASS OF AERIAL ROBOTIC SYSTEMS

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To my beloved mother and father

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ABSTRACT

The objectives of this thesis are to propose a new linear uncertain model with bounded uncertainties for an Unmanned Aerial Vehicle (UAV) helicopter system and to propose two new advanced nonlinear kernel controls for the UAV helicopter flight control system using the newly obtained linear uncertain model. The two new control algorithms are based on the Model Following Variable Structure Control (MFVSC) and the deterministic control. They are able to cope with system parameters variations due to the different flight conditions. The first proposed controller is the deterministic control approach augmented MFVSC. The second proposed controller is the deterministic control approach augmented MFVSC with nonlinear state feedback control. Two theorems have been derived based on the two newly developed control algorithms. The two theorems are stable in terms of the second method of Lyapunov provided that the assumptions for the proposed theorems are satisfied. Extensive simulations with different flight conditions and various controller design parameters have been carried out in this study to evaluate the performance and the robustness of the two new control techniques. The simulation results show that the two proposed control algorithms are capable of rendering the system state to track the desired state motion.

ABSTRAK

Tesis ini bertujuan untuk mencadangkan satu model linear baru yang tidak menentu bagi sistem helikopter Kenderaan Udara Tanpa Pemandu (UAV) dan mencadangkan dua kawalan kernel baru tak linear termaju bagi UAV helikopter tersebut dengan menggunakan model yang baru diperolehi. Kedua-dua algoritma bagi kawalan baru itu adalah berdasarkan kepada teori kawalan ikutan model struktur boleh ubah (MFVSC) dan teori kawalan berketentuan. Algoritma kawalan baru tersebut mampu untuk menampung variasi parameter sistem yang disebabkan oleh keadaan penerbangan yang berbeza. Pengawal pertama yang dicadangkan ialah kawalan pendekatan berketentuan kukuhan MFVSC. Pengawal kedua pula ialah kawalan pendekatan berketentuan kukuhan MFVSC dengan tambahan kawalan suap balik tak linear. Dua teorem diterbitkan berdasarkan dua algoritma kawalan yang baru dikemukakan. Kedua-dua teorem tersebut adalah stabil berdasarkan kaedah kedua Lyapunov dengan syarat andaian bagi teorem yang dicadangkan itu dipenuhi. Simulasi yang menyeluruh telah dibuat dengan keadaan penerbangan yang berbeza dan pelbagai parameter rekabentuk kawalan juga telah dilakukan dalam pengajian ini untuk menilai prestasi dan kemantapan kedua-dua teknik kawalan baru ini. Keputusan simulasi menunjukkan bahawa kedua-dua algoritma kawalan yang dicadangkan itu mampu untuk mengawal kedudukan sistem helikopter tersebut untuk menjejaki pergerakan yang dikehendaki dengan memuaskan.