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Control of Quadrotor Miniature Flying Robot

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ABSTRACT

An unmanned aerial vehicle (UAV) is an unpiloted aircraft which can either be controlled from any remote location or a preprogrammed flight plan is used to fly it. They are very useful in military and civil applications. Quadrotor is a successful design of rotating wing UAV with four horizontal rotors. Two of them rotate in clockwise and other two in counter clockwise direction. This movement is very effective in eliminating gyroscopic effect that occurs in helicopters. It is controlled by varying the speed of anyone or all. The ability of Quadrotor UAVs to take off and landing vertically and hovering at any point have become most popular among researchers. Quadrotor UAV has four inputs and six degrees of freedom. As Quadrotor is an underactuated system, we can track its three angular positions (Yaw, pitch and roll) and altitude. There is an additional advantage of quadrotor that is diameter of four rotors is smaller than the equivalent helicopter's rotor which allows it to consume less kinetic energy.

In this thesis first of all a model of Quadrotor is developed using Newton-Euler's formalism. Then a nonlinear adaptive backstepping strategy based on Lyapnov stability theory is proposed to track the desired trajectory in presence of disturbances. Backstepping control is a flexible method that allows building up a nonlinear control law without cancelling useful nonlinear dynamics. Consequently less control effort is used to track reference signal. In the proposed strategy un-modeled dynamics are taken as disturbances and four virtual control laws are designed to estimate disturbances and stabilize the quadrotor on desired position.

To validate theoretical design proposed controller is tested on SIMULINK. Responses are taken on different set points of altitude and three angular positions in presence of uncertainties. These simulations demonstrate that designed controller is very effective in controlling the position of Quadrotor UAV with very small settling time and overshoot.

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LIST OF ABBREVIATIONS

BC	Before Christ
UAV	Unmanned Air Vehicle
KW	Kilo Watt
VTOL	Vertically Take Off and Landing
PID	Proportional Integral Derivative
LQR	Least Quadratic Regulator
QR	Quadrotor
MEMS	Micro Electromechanical Motion Sensors
GPS	Global Positioning System
IMU	Inertial Measurement Unit
PD	Proportional Derivative
NN	Neural Network
SGUUB	Semi Globally Uniformly Ultimately Bounded