NAME OF THE SCHOLAR: DHIRAJ GUPTA
NAME OF THE SUPERVISOR: PROF. SHAHIDA KHATOON
NAME OF THE CO-SUPERVISOR: PROF. L.K. DAS
DEPARTMENT: ELECTRICAL DEPARTMENT

TITLE OF THE THESIS: “MINIMALLY CONTROLLED AERIAL VEHICLES FOR GEOGRAPHICAL SURVEY APPLICATION”

ABSTRACT

Unmanned Aerial Vehicle (UAV) also called pilotless aircraft, means such a set of planes with no human driver required on them and can aviate automatically under the control of a few programs, or be remotely controlled by operators who are on the ground. The UAVs can do long distance navigation with the help of automatic pilot, program control scheme, remote control and measurement system, navigation system, etc. Compared with their manned counterparts, the UAVs have the advantages of light weight and space-occupancy, low cost, good concealment. Unmanned Aerial Vehicles are potentially better suited for performing these DDD aerial activities. A quad rotor is a highly unstable nonlinear system with stringent system constraints. Modeling of such vehicle as quad rotor is not a simple task due to its complex structure. The aim is to develop a model of the vehicle as realistic as possible. For carrying out stability analysis of a quad rotor type UAV’s, deriving mathematical modeling of quad rotor is of utmost importance. The model consists of the defining characteristics of the quad rotor, the equations of motion, and the forces and torques responsible for the system’s dynamics. This operation allows predictions to be made about the quad rotor's flight dynamics and for the study of various influences, such as environmental conditions, that could alter its behavior. The controllers assumed in this work are conventional PID and a classic LQR controller. The PID controller is chosen for quad rotor model because of its versatility and facile implementation, while also providing a good response

for the model dynamics attitudes. The LQR controller seemed to be a good comparative controller due to its great performance and robustness in the plant. In this study, it is accomplished that both the controllers provide satisfactory feedback for quad rotor stabilization. Various controllers designed can be compared on the basis of robustness and speed of response. Faster controllers do not necessarily mean consistent responses under disturbances. The longitudinal moments i.e. position and velocity present a natural instability. Looking back at the step responses it is clear that each controller has the different responses for the same attitude; however it is possible to choose most suitable technique based on the characteristics needed for quad rotor control. Open loop pitch control system is highly unstable system. The closed loop unity feedback system giving steady state error 5% but the settling time is very high about 60 sec. The system with PID controller (without tuning) gives steady state error of 20% but settles at 28 sec. The system with PID controller (Tuned) gives steady state error of 5% and settles at 20 sec. The system with Fuzzy logic controller gives steady state error of 20% but settles at 16 sec. The system with Hybrid Fuzzy logic controller gives steady state error of 10% and settles fastest with 7 sec. A low-cost civilian UAV platform have been designed, which is specifically designed as an economical, moderately functional, small airborne platform intended to meet the requirement for fast-response to time-critical events in many small private sectors or government agencies. A novel in-flight autonomous control strategy has been implemented on the experimental UAV. The experimental results demonstrate that the UAV design presented in this paper can be used for surveillance application. The assembly has been done using low cost components easily available in Indian market. The experimental prototype quad-copter has been successfully implemented and tested for 15 minutes smooth flight time. The flight control strategy is attempted in manual and autonomous modes both have been validated successfully.