Autonomous tilt-rotor UAV

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Autonomous Tilt-Rotor UAV

1. Introduction

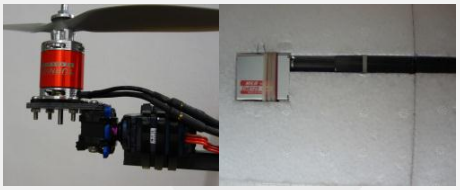
Helicopters can hover and maneuver well while planes can fly fast and efficiently. A hybrid UAV will be tapping the potentials of both systems.

2. Objectives

- To design and develop a tilt rotor UAV.
- To implement fully autonomous features.
- To investigate and optimize transition flight.

3. Prototype development

Ardupilot Mega (microprocessor and sensor) is used to stabilize the UAV during hovering and forward flight using its 3-axis gyroscope and accelerometer.



Improvement of tilt mechanism used to tilt the rotors.

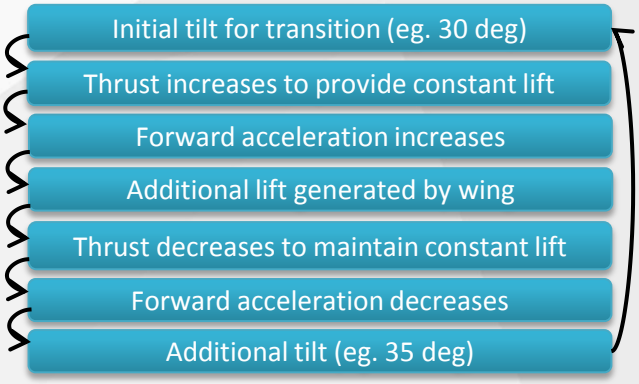
4. Autonomous

In order to carry out missions, autonomous capabilities are require for flights out of visual range. Below is the behavior in autonomous mode.

Hovering	Transition	Forward flight	Landing
Set throttle that maintains accelerometer reading of 0.1m/s^2. When ascended to 20m, maintain altitude.	Tilt motor based on mathematical model outputs. Stabilization by varying thrust based on sensors reading.	Climb to programmed altitude. Waypoint navigation using GPS. Stabilization by control surfaces.	When all waypoints are reached, returns to home GPS location. Laser range finder used for slow descend rate when within 10m altitude.

5. Transition at constant altitude

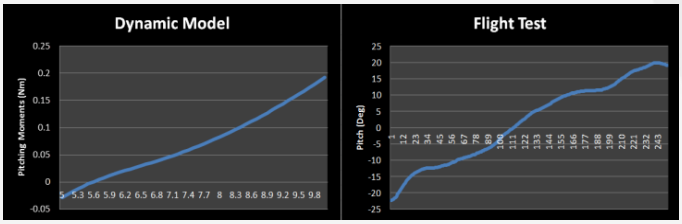
During transition flight, the role of lift generation is transferred from motor to wing. This occurs when the tilt mechanism activates, rotating the upward pointing motor to the forward position. A dynamic model is designed to calculate the rate of tilting in order to achieve constant altitude transition.



6. Stability in Transition and Forward Flight

Having two lifting surface, tandem wings are less stable than conventional fixed wings. To maintain stability during flight, both static and dynamic models are designed.

The dynamic model closely predicts the pitch characteristics during transition and after transition.



The static model aids in designing the tandem wing to have a static margin of 7.4% ensuring longitudinal stability. Lateral and directional stability derivatives were also calculated.

Parameters	Symbol	Value
Static Margin	SM	7.40%
Longitudinal Stability	$C_{m\alpha\ front\ wing}$	0.536
	$C_{m\alpha\ rear\ wing}$	-0.625
	$C_{m\alpha}$	-0.689
Lateral Stability	$C_{l\beta}$	-0.020
Directional Stability	$C_{n\beta}$	0.081