Project Definition Document

Aerospace Senior Projects (ASEN 4018 & 4028)
Fall 2004 and Spring 2005

1.0 Information

1.1 Project Title

Short Takeoff AutoRotation Craft (STARCraft) – Short takeoff UAV for surveillance and reconnaissance.

1.2 Project Customers

US Military

2.0 Background and Context

In recent years research on unmanned aerial vehicles (UAV) has increased rapidly along with their applications in both military and civilian sectors. The need for a short take off, large velocity envelope, surveillance and reconnaissance UAV able to carry a designated reconnaissance payload would be useful in both military and civilian applications.

Much like a helicopter, an autogyro creates lift through the use of a rotary wing. Unlike a helicopter, an autogyro's rotary wing is unpowered and rotation is achieved through the forward air velocity passing through the rotor plane; this is a phenomenon known as autorotation. Due to the unpowered rotary wing, another power source is required to provide forward thrust. The thrust is usually provided via a conventional propeller engine, however, a jet engine could also be applicable. Also, due to the unpowered rotor, there is no adverse torque to counter, therefore, there is no need for rotary powered yaw control. A rotating wing sees a higher relative velocity than the body of the vehicle. Therefore, an autogyro provides enough lift to take off at a slower forward velocity and consequently a shorter distance than a similar size fixed wing aircraft. A helicopter must tilt the rotor plane forward to achieve a higher forward velocity; this makes high velocities inefficient for a helicopter. To enable autorotation, the plane of rotation is tilted back acting like a conventional angle of attack. At higher velocities the rotary wing of an autogyro behaves similar to a fixed wing of circular planform. Therefore, the angle of attack of the plane of rotation for an autogyro is reduced as the velocity is increased. This enables a more efficient forward flight velocity than a helicopter.

This aircraft will provide lift through the phenomenon of autorotation which will enable a short takeoff; it will be called a Short Takeoff AutoRotation Craft (STARCraft).

3.0 Objectives

3.1 Overall Objective

The overall objective of the proposed project is to conceive, design, fabricate, test and verify an autorotation assembly that will be integrated with an existing airplane kit. The fuselage, tail assembly, landing gear and engine from a kit will be used and the wing will be removed or modified since an autogyro does not need a wing. The autorotation assembly will then be integrated with the kit to produce an aircraft capable of takeoff and landing in short distances for use as a surveillance and reconnaissance vehicle.

3.2 Takeoff and Landing Conditions

3.2.1 Objective

At takeoff, the vehicle will clear a height of 10 feet within a horizontal distance TBD. The vehicle will also land within an area TBD.

3.2.2 Discussion

For use in the field, it will often be necessary to clear obstacles such as bushes, trees, etc. within a short distance of takeoff. This is the reason for the requirement of clearing at least 10 feet within a TBD distance.

3.3 Roll Control

3.3.1 Objective

Through design of the autogyro, roll capabilities will be provided using gyroscopic precession principles. The roll-rate performance is TBD. Pitch and yaw will come from the existing control surfaces on the kit's tail assembly.

3.3.2 Discussion

The aircraft will be remotely piloted from the ground, so no autonomous control is necessary.

3.4 Weight/Lift

3.4.1 Objective

The autorotation assembly will be able to lift the total weight of the craft and have the capacity to carry a 2-5lb payload. The total weight of the craft will consist of the kit with a weight TBD, and the weight of the autorotation assembly TBD.

3.4.2 Discussion

Lift will be tested though construction of a mechanically simple scale model that will fit into a TBD windtunnel. The payload is meant to be surveillance equipment.

4.0 Stretched Goals

4.1 Pitch Control

4.1.1 Stretched Goal

If feasible, pitch will be controlled though gyroscopic precession at a pitch-rate TBD.

4.1.2 Discussion

Pitch control through gyroscopic precession will eliminate the need for a horizontal stabilizer and elevator control surfaces.

5.0 Antipated Engineering Expertise

Technical Expertise	**How Applied**
Precision Mechanical Design	Develop conceptual and detailed solid 3D models of the vehicle components
Analog Electronics	Design of the actuation subsystem
Data Acquisition Software	Measurement subsystem for position and velocity
Aerodynamics	Construction and testing of rotor airfoil
Structural Material	Integration of the autogyro device with the existing kit
Radio Controlled Piloting	Piloting the autogyro from the ground to give throttle, roll, pitch, and yaw inputs
Precision Mechanical Fabrication	Part machining
Electronic Fabrication	Analog and digital electronic subsystems
Rotorcraft Dynamics	Design and application of a lifting rotor
Mechanical and Dynamic Test	Verification of the project

6.0 Resources

6.1 Facilities

The project will have access to the Aerospace Machine Shop and storage facilities including the Lockheed Martin room. The wind tunnels at the Air Force Academy and CSU have 3 foot test sections, which will be adequate to test the rotor blade airfoil, in addition to the wind tunnel at CU. An open field will be used to test the vehicle.

6.2 Additional Advisors

Currently none.

6.3 Funds

Funding from the University of Colorado in the amount of $4000.