NEEDS ASSESSMENT

Indoor Quad-rotor Control
M.E. Team Number 01

Members:

ECE DEPARTMENT:

Jigar Patel: Team Leader

John Chung: Software/Hardware Engineer

Matthew Kishe: Team Webmaster/Test Engineer

ME DEPARTMENT:

Adam Sobiewski: Team Leader/Treasurer

Andrew Silva: Sponsor Liaison

Gabriel Morales: Design Engineer

SPONSOR

EGLIN AIR FORCE BASE

Contents

I. Problem Statement

The objective of this project is to utilize an existing RC-controlled quad-rotor, and design it in a way that will allow autonomous velocity controlled flight using a PX4FMU and PX4Flow. The Quadrotor will also provide a payload capacity of approximately 500g to a 2.2 kg. Protective housing will also be designed to protect the components in case of failure during flight.

FIGURE 1. 3DR ARDUCOPTER

II. Background

The unmanned aerial vehicle, also known as the UAV or drone, has become very useful for the Air Force for special applications, and missions that may be too dangerous for an aircraft requiring a human pilot. Currently the majority of UAV's used in the field by the Air Force are remote controlled airplanes. However, high velocities are required to generate enough lift for an airplane to fly, which limits their mobility.

For certain applications it is desirable that an aircraft be able to hover, easily change direction and maintain low velocities. The quad-rotor control has become very popular in UAV research because of its maneuverability and small size. The diagonal length of a typical quad-rotor control system ranges from 2-4 feet, which is significantly smaller than most of the UAV airplanes being used by the Air Force today. Their ability to hover and quickly change directions allows the quad-rotor control to fly indoors and in obstacle-dense areas that would be too risky for an airplane to fly. The quad-rotor control also has vertical takeoff and landing capability, negating the use of a long airstrip.

III. Objectives

As specified above, the main objective for the project is to transform a RC-controlled quad-rotor into an autonomously velocity controlled quad-rotor. It should have the ability to carry a payload of 500g to a 2.2 kg, which would carry onboard sensors for specific applications such as Gmapping. The methods listed below will be utilized to ensure the objective is met.

a. Model the Quadrotor in a CAD software to get the measurements of the dynamic model.
b. Research velocity based autonomous flight control algorithms.
c. Implement and simulate flight control algorithms and modify algorithms as needed.
d. Implement the simulated flight control algorithms onto the PX4 Autopilot to run tests on the actual model.
e. Design and install a shock absorbing enclosure to prevent any damage from occurring when the system fails.

IV. Methodology

i. Theoretical Analysis

a. System Development and Protection

i. Research the background of protective gear for quad rotor helicopters
ii. Investigate how such a device will effect flight of the system (e.g. effects on lift, effects on fluid flow, etc.)
iii. Conceptualize valid designs
iv. Identify key physical characteristics of the overall system

b. Flight Control

i. Establish algorithms to model velocity based flight controls.
ii. Implement algorithms into simulation to ensure validity of the algorithms.
iii. Run simulation test cases to imitate actual flight and analyze data collected from tests
iv. Modify and update algorithms and re-evaluate the design as needed

c. Communications

i. Research communication methods between the computer and quad-copter for telemetry

ii. Experimental Analysis

i. Implement simulation onto the PX4 Autopilot, run tests to verify the theoretical analysis.
ii. Compare experimental results to theoretical results, make changes as needed.

V. Expected Results

We expect to meet the requirements set forth by our sponsors and have a functioning velocity controlled quad-rotor by the end of Spring 2014. The quad-rotor will have the ability to hover, and fly autonomously without failure in an indoor environment. The quad rotor system will also include a protective component housing which will prevent any serious damage to the propellers or the electronic equipment used to control the system, in the event of a crash. This protective housing will also protect the system if it flies into obstacles, and will also protect the users of the system from moving components on the system.

VI. Constraints

The system will be greatly constrained by it's over all weight. A sturdy, durable, and reliable protective housing is desired. However, this housing cannot be so heavy that it limits the flight capabilities of the machine. For this reason extensive testing must be done on proposed designs to ensure that they do not hinder the functionality of the quad-copter.

The system is also constrained by the equipment which our sponsor has requested that we use. The quad rotor will be controlled by a PX4 autopilot system, and thus limited by whatever constraints the hardware might innately have.

The major constraint is communication with our sponsor. Since the project is sponsored by the Eglin Air Force Base, any information from the sponsor must be authorized through the proper chain of command. As of now, we have a rough idea of what is expected for this project, and currently waiting on a final components list.

VII. Design Requirements

i. Mechanical Requirements and Goals

a. Size
Insert expected/desired dimensions here

b. Weight
It is desired to keep the entire system under 2.2 kg.

c. Payload
Desired between 500 g to 2.2 kg

VIII. Gantt Chart

Period Highlight: 4

Plan Actual

% Complete Actual (beyond plan)

	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Project assignment/ Ice breaking project	1	2	1	1	100%
Code of Conduct	2	1	2	1	100%
Need Assessment	3	2	3	2	10%
Project Plans/ Product Specs	4	4	0	0	0
Project Scope	4	2	0	0	0
Goals and Objectives	5	2	0	0	0
Measurable criteria	6	2	0	0	0
Constraints	6	2	0	0	0
Product Specs	6	2	0	0	0
Concept Generation and Selection	7	3	0	0	0
Functional Analysis	7	3	0	0	0
Individual Tasks and assigments	7	3	0	0	0
Design concepts development	7	3	0	0	0
Concept evaluation and selection	7	3	0	0	0
Product Specifications for hardware	7	3	0	0	0
Performance and functional Specs	7	3	0	0	0
Midterm presentation/ report	7	3	0	0	0
Team Evaluation Report	10	1	0	0	0
Interim Design Review Presentation/ Report	9	3	0	0	0
Presentation to MEAC	11	1	0	0	0
Ordering of hardware, material, and others	7	10	0	0	0
Final design presentation and report	11	6	0	0	0%