Design and Manufacture of a Rotorcraft

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Authors: Mohammed Nabulsi (ME), Victoria Rogers (ME), Taniwa Ndebele (ME), Robert Johnson (EE), Chabely Amo(IE), Kimberlee Steninman(IE), Louisny Dufresne(IE).

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Abstract

Rotary unmanned aerial vehicles often fall into one of two classifications: those with a high payload capacity but low portability or those with high portability but a reduced payload capacity. However, there is an increasing need for rotorcrafts that are capable of transporting heavy payloads while still maintaining high portability for different applications such as the military. This senior design project requires the design and manufacture of a rotorcraft. Some constraints on the design includes: ensuring the rotorcraft fits in a standard military size backpack (23” x 15” x 14.5”), and being able to carry 50lbs. The sponsor for this project is the IME department, and the group directly reports to Dr.Okoli. The team will translate its best ideas to detailed drawings of several different designs over the next two weeks.

1 Introduction

Rotary unmanned aerial vehicles often fall into one of two classifications: those with a high payload capacity but low portability or those with high portability but a reduced payload capacity. However, there is an increasing need for rotorcrafts that are capable of transporting heavy payloads while still maintaining high portability. The objective of this project is to design and build a rotorcraft with high portability and high payload capacity. Such a device would be beneficial in situations requiring quick deployment of a device carrying heavy (up to 50 lb) payloads.

The advantages of using a rotorcraft flying machine include an ability to lift off and land vertically, agility, and maneuverability. Some rotorcrafts already exist that can lift 50 lbs, however these rotorcrafts do not have high portability due to the sheer size of the rotorcraft. One of the heaviest loads carried 58.7 kilograms, however it could only hover a few feet off the ground[1]. Major design considerations and potential problems include the rotor number and configuration, the raw materials, folding/transport ability, and specifications of the electrical controls that will influence the overall performance of the device.

2 Project Definition

2.1 Background research

The earliest attempt to make a quadrotor was designed in 1907 by Louis Breguet[2]. The four rotor helicopter was only able to fly at an altitude of a few feet of the ground. Since then the unmanned aerial vehicles (UAV's) have become commonly used for many applications. There are several programs working on improving these rotorcrafts including[2]:

- Bell Boeing Quad TiltRotor
- Aermatica Spa's Anteos
- AeroQuad and Ardu Copter
- Parrot AR.Drone

However, all these programs have not came up with a design that meets this senior design project. Every rotorcraft designed by these programs would not meet the constraint of being able to fit the rotorcraft in a standard military backpack($23" \times 15" \times 14.5"$). These programs have a variety of uses including world class engineering research laboratories, military and law enforcement, and as well as commercial use for aerial imagery[2]. The primary difference between this senior design project and the rest of these programs is the rotorcrafts portability. Most of these rotorcrafts are designed without having limitation on size. So an essence having a rotorcraft capable of lifting 50+ lbs and still being small enough to lift in a military size backpack has never been done before.

Over this past summer, FAMU-FSU College of Engineering have took on the task of building a rotorcraft with the same requirements as this senior design project has. However, Dr.Okoli has decided to keep the literature about the design concept and journals of calculations on the rotorcraft the school is building confidential until our senior design team comes up several new ideas. Based on the next meeting with Dr.Okoli, he will decide if we will continue with the new designs proposed, or if our team will continue the project FAMU-FSU COE started this past summer.

A rotorcraft is a heavier than air flying machine that uses lift generated by wings called rotor blades that revolve around a mast[3]. A quadrotor generates lift by four set of rotors vertically

oriented propellers[4]. So there-for constructing a devise with quick deployment and being able to carry heavy payloads would have significant advantages. Some of these advantages would include transporting equipment to remote areas where there are no airports, roads, or even terrain.

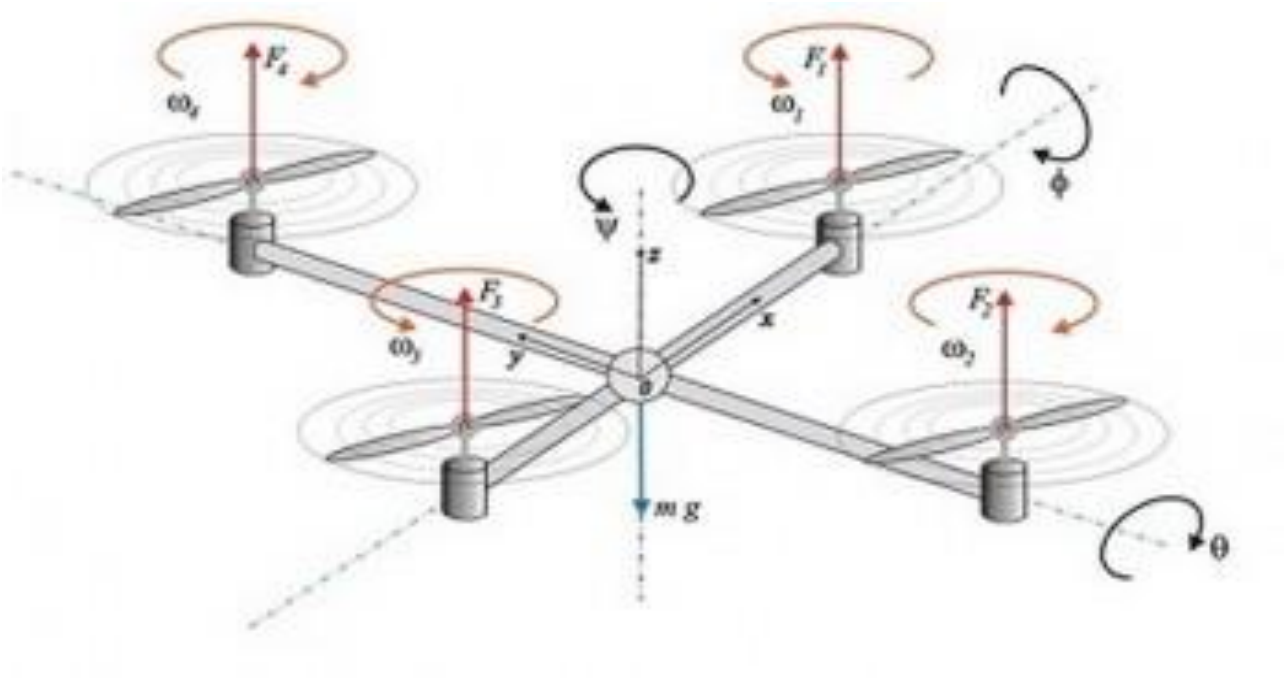

Figure 1. Quadrotor

As seen in Figure 1, a quadrotor uses two clockwise and two counter-clockwise propellers[3]. These variations of RPM can be used to control lift and torque. There are many variations that can be applied to a quadrotor to change its characteristics such as the raw materials, folding/transport ability, and specifications of the electrical controls that will influence the overall performance of the device.

2.2 Need Statement

While there exist rotary unmanned aerial vehicles that carry high pay loads, they lack the portability for practical applications. However, rotorcrafts are beneficial in comparison to more traditional aerial vehicles as they can take off and land vertically. Thus, rotorcrafts have seen an increase of 21.5% in military applications since 1992[5]. The sponsor for this project is Dr.Okolie with the IME department. Thus, creating a backpack sized rotorcraft with high pay load capacity for field applications

2.3 Goal Statement & Objectives

The aim of this project is to create a compact, possibly collapsible rotorcraft for the use of transportation of payloads of at least 50 pounds.

Objectives:

- Determine the rotor number and configuration
- The raw materials selected for fabrication
- The method of collapsing or folding the craft
- Electrical controls selected to enable the rotorcraft of 1 mile flight radius.

2.4 Constraints

This rotorcraft must be both compact and have high pay load lifting abilities. The rotorcraft must have a payload capacity of at least 50 pounds. Additionally the rotorcraft cannot exceed the 23" x 15" x 14.5'' dimensions of a military backpack. The rotorcraft should also be able to travel up to a mile. Further, the rotorcraft's electrical components should be easily obtained at stores where electrical components are sold to prevent costly repairs. The estimated budget of this project should be kept under $2,400.

2.5 Methodology

Our main objective this semester is to have assembled an actual prototype of the rotorcraft that can hover off the ground. The following semester we hope to have it fully functional and available for consumer use. In order to attain this overall goal we have broken down our goals into section time intervals, in which certain things will be accomplished.

- Firstly were researching different articles, papers, journals on rotorcraft designs and their functions.
- Come up with our own design that every group member is satisfied with.
- Compare our design with the original design that was created during the summer and decide on whether we want to improve upon that design or continue forward with the new design that has been implemented.
- Work on the calculations that accommodate the forces on the blades to acquire lift, the strength of the required motor, and the material selection.

- Build a small prototype first through computer drawings (Cero Parametric 2.0, Solid Works, and AutoCAD) then perhaps a 3D printing for a scaled down model that will give a visual and physical grasp on our goal.
- Begin programming the control unit.
- Put together the parts we have and begin testing and analyzing the data recorded.
- We will than compare with our theoretical calculations and whether we achieved what we had intended.
- From this point onwards we will be working with the assembled unit and aiming to perfect its overall functionality.

2.6 Schedule

Your schedule puts dates to your proposed plans. We use Gantt Charts in particular. This year we require MS Project for Gantt Charts, like in

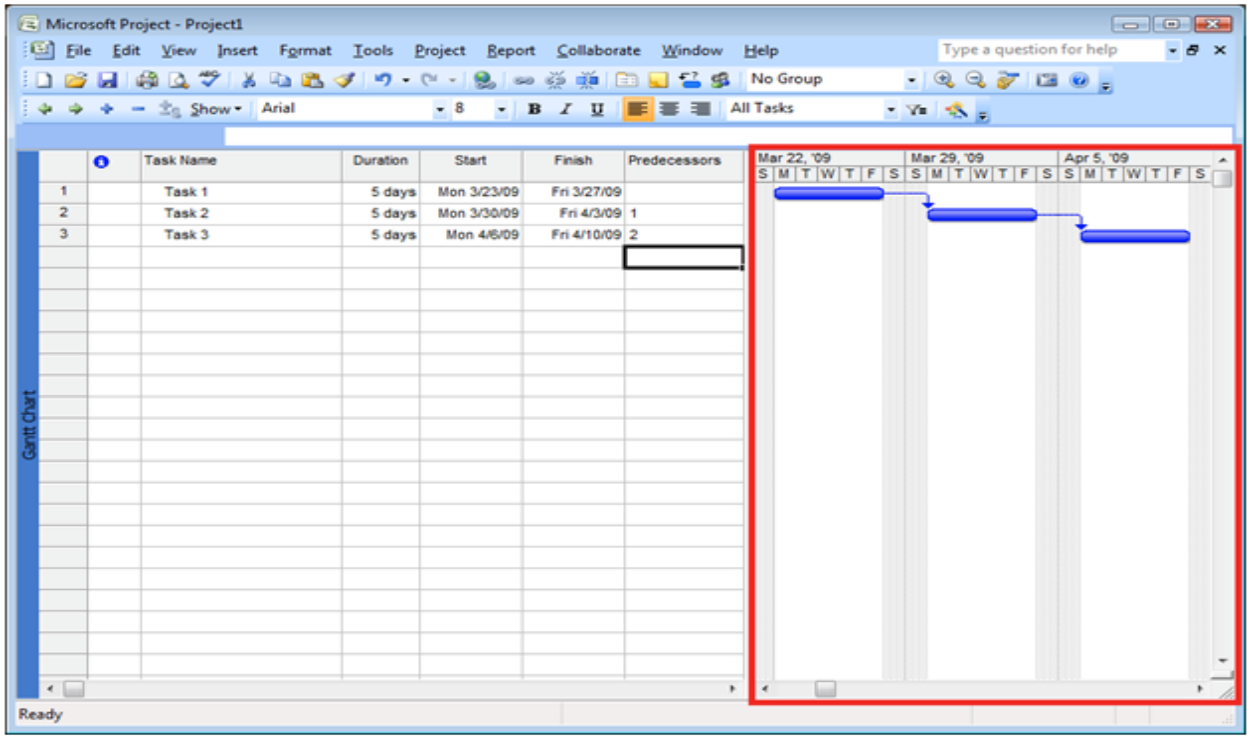

Figure 1. If you are unfamiliar with it, please take the Lynda.com training course as far as needed.

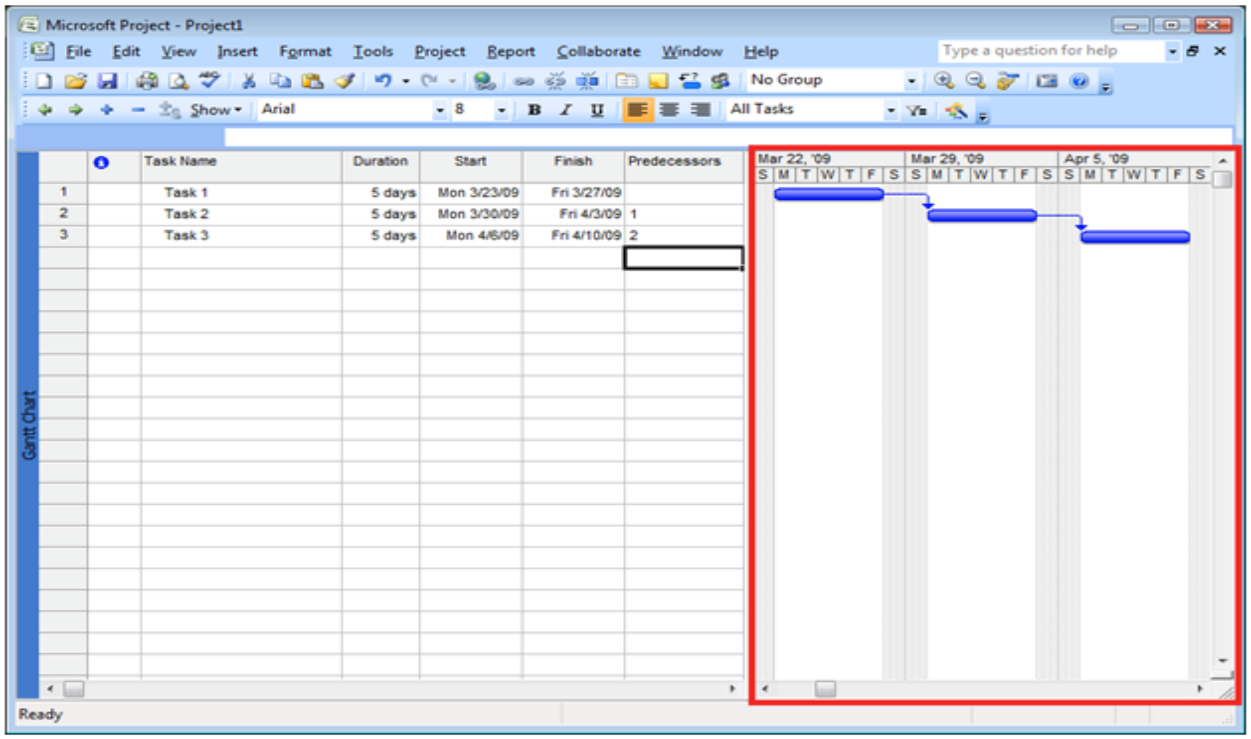

Figure 1. Example Gantt Chart from online[i]

3 Conclusion

In conclusion, the goal of this senior design project is to construct a rotorcraft that is capable of lifting 50 lbs while still being able to fit in a military backpack. The sponsor for this project is the IME department, and we will being reporting to Dr.Okolie. For the next report, the group will have several different designs with some detailed drawings. The group will present these designs to Dr.Okoli to see if we will proceed with the design that FAMU-FSU College of Engineering started this past summer or weather we will continue with the design the group made. Although it seems very challenging as this has never been done before, the group is motivated and ready to take this project head on.

4 References

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