Remote Control Helicopter

By

Abdul Aldulaimi, Travis Cole, David Cosio, Matt Finch,

Jacob Ruechel, Randy Van Dusen

Team 04

Problem Formulation and Project Plan

Document

Submitted towards partial fulfillment of the requirements for
Mechanical Engineering Design I – Fall 2013

Department of Mechanical Engineering
Northern Arizona University
Flagstaff, AZ 86011

Table of Contents

Introduction

We are team four, and our capstone project is the remote controlled helicopter. In this report we will be discussing, who our client is and why he has given us the task of up scaling a remote controlled helicopter by 1.5. We will also discuss what our needs, goals, objectives and constraints are, as well as our quality function deployment chart and where we are headed next through the Gantt chart. To begin with we will introduce our client Dr. Srinivas Kosaraju.

Client Information

Our client is none other than the capstone instructor Dr. Srinivas Kosaraju, also known as Dr. Raju. He is a current mechanical engineering professor at Northern Arizona Univesity. He has his doctorate in mechanical engineering. He had an idea that it would be a great all around engineering project to have students research and buy a remote controlled helicopter that was roughly ten inches and then upscale it for various applied applications. This project includes many different engineering subjects such as machine design and aerodynamics. It will prove to be a challenging project, but our team is very enthusiastic and ready to do what is necessary for a successful project.

U13A Remote Control Helicopter

Figure 1: Taken by RC Helicopter Team, Team 04.

For this project we will be up scaling a U13A Remote Controlled Helicopter made by UDIR/C (Figure 1). The helicopters body is 11 inches long and 2 1/4 inches wide. One of the blades of the center rotor is 4 3/4 inches long and the rear rotor is 1 7/8 inches. It has four blades on the center rotor two blades are spinning clock wise while the other two are spinning counter clock wise. The helicopter has several led lights on it one in the front and five along the tail. This helicopter has a 3.7 V battery it lasts for 5 to 8 minutes per 90 minutes of charge. This helicopter is already equipped with a camera so it has the capability to take photos and video which can be viewed through a micro S.D. card. This helicopter does not have live feed. There is a gyroscope inside of the helicopter it also has a balance beam along the top of the center rotors both of there are to help keep the helicopter stable during flight.

The controller for the helicopter controls the functions such as up and down and right and left. It also has a screen on the controller to display the throttle percent and the trim of the helicopter. The screen also displays how well the frequency is reaching the helicopter. The remote sends out a 2.4 GHz signal and has a controlling radius of 40 m. the controller is powered by four AA batteries and displays how much power is left in the batteries on the display. The controller has buttons on it to use the video and the camera fetchers and the display shows which fetcher is being used at a given time. The controller also has a button to turn on or off the lights and a button to accelerate the helicopter.

Needs

The main need for this project as stated by Dr. Raju is to “create an upscale fully functioning remote controlled flying vehicle that has the capability for attachments for various real world applications.” Through this statement, we have broken it up in to several smaller needs to make the process of working on it more fluent. One of the first needs we have to work on is studying this helicopter and determining any problems with it that we may need to fix or any aspects of the helicopter that we can improve upon. We will need to upscale the model by 1.5 per the client's request. Lastly, one of the client's requests was to have capability for attachments so we need to determine what attachments may be useful and how to attach them.

Goals

From studying all the clients requests and all the needs we have determined a goal for this project. Our goal is to "successfully improve and upscale a remote controlled helicopter by 1.5 with the ability to add mission specific accessories." We believe at this point this goal covers all the aspects of this project. As we work on this project we may have to alter our goal but this will happen as we go.

Objectives

The objectives for this project is to design and build a remote controlled helicopter that has interchangeable attachments. A camera will be attached to the final design that can provide live video to the users. A flash card will be installed to save the videos, and display them later after the demonstration flight test. The helicopter weight will be minimize in order to have the ability to add many attachments if needed.

The design should be able to accept batteries from different manufacturers. This includes using the ability to switch adaptors that can connect the battery to the helicopter. There will be two sets of batteries, one set in the helicopter, and one set in the remote control. The helicopter will contain a chargeable battery that can lasts for one-third the charging time. The remote control will consist of four AA batteries that provide a power to send/receive signal to the helicopter.

Carrying capability will be maximized in the prototype design. The materials that will be used in our design should be light and stiff, to maintain a high level of performance. The carried weight will be used to achieve stability in our design. Also the weight will be placed in the center of mass in the helicopter to increase the stability and resist wind flow.

We also are playing with the idea of using waterproof materials in building the helicopter, so it can be used in different weather conditions. There is still no specification of what materials that will be used, and how much would it cost. Upon further investigation and cost analysis we will be able to decide whether this is a task worth pursuing.

The altitude that the helicopter will achieve is forty meters in all directions. Currently we are considering stiff plastic propellers will be used in building the design to minimize the overall weight of the helicopter and create a maximum lift for the prototype. The range will be determined more specially based on the attachments and the weight lifted for each different run.

Constraints

For the final design of the upscale remote control helicopter, the preliminary constraints are the following:

The helicopter must be at least 1.5 times the size of the model helicopter. In order to successfully upscale the helicopter 1.5 times, the dimensions of all of the components of the design, ranging from the tail length to the frame width must be at least 1.5 times larger than the original remote control helicopter.

The helicopter must be made out of a durable material that is also lightweight. In order for the helicopter to succeed at flight and survive all of the stresses associated with flying, landing, and even crashing the helicopter, it must be made of a lightweight and durable material with a high strength to density ratio.

Additionally, the operator must be able to control the helicopter at a long range. The range at which the helicopter can be controlled will be measured by the longest distance at which the remote control can still communicate with the helicopter.

The helicopter must have a satisfactory battery life. The duration of time that the helicopter can stay in the air for a single flight is determined by the battery life; it must be maximized to allow for the longest flight possible.

In addition to the battery life, the battery power must be capable of creating a lift force great enough to carry the weight of the helicopter and any accessory that may be mounted to the helicopter.

In order to demonstrate that accessories can be added to the helicopter, an onboard video camera will be mounted to the design. The data gathered aboard the helicopter must be communicated to the operator at real time and the helicopter must transmit a live video feed from the onboard camera to the remote operator.

Lastly, all costs associated with designing and building the upscale helicopter must be thoroughly justified with the customer, Dr. Raju, before funding will be received.

Quality Function Deployment

In the approach of making the quality function development matrix our team discussed the engineering requirements that needed to be included in the design. This includes the different possibilities of customer and engineering requirements. To begin with, our client requires that we scale our helicopter to a certain size ratio. The engineering target that our team chose to work with is English Standard units. The reason is because our helicopter was given in inches. Upon being given the request of scaling the helicopter to a 1.5 to 1 ratio, as shown in (table 1), the team is going to measure the weight and length of the helicopter. This will determine how our helicopter will perform during test flight. The yield strength and lift force on the helicopter needs to be addressed as well because the customer wants to have a helicopter that does not fail. Failure of the helicopter can cause the customer to give bad reviews on the product. In order to make a successful design, our team discussed the power usage of each flight by recording its duration time. On average, our flight time approximated out to be 8 minutes. The customer expects a longer duration time so that it would make charging the battery less of a hassle for people. Lastly, our team decided to add attachments to the helicopter to make it more treasured. Each of these requirements in (Table 1) are important to note when designing the helicopter. It satisfies our customer needs and engineering requirements.

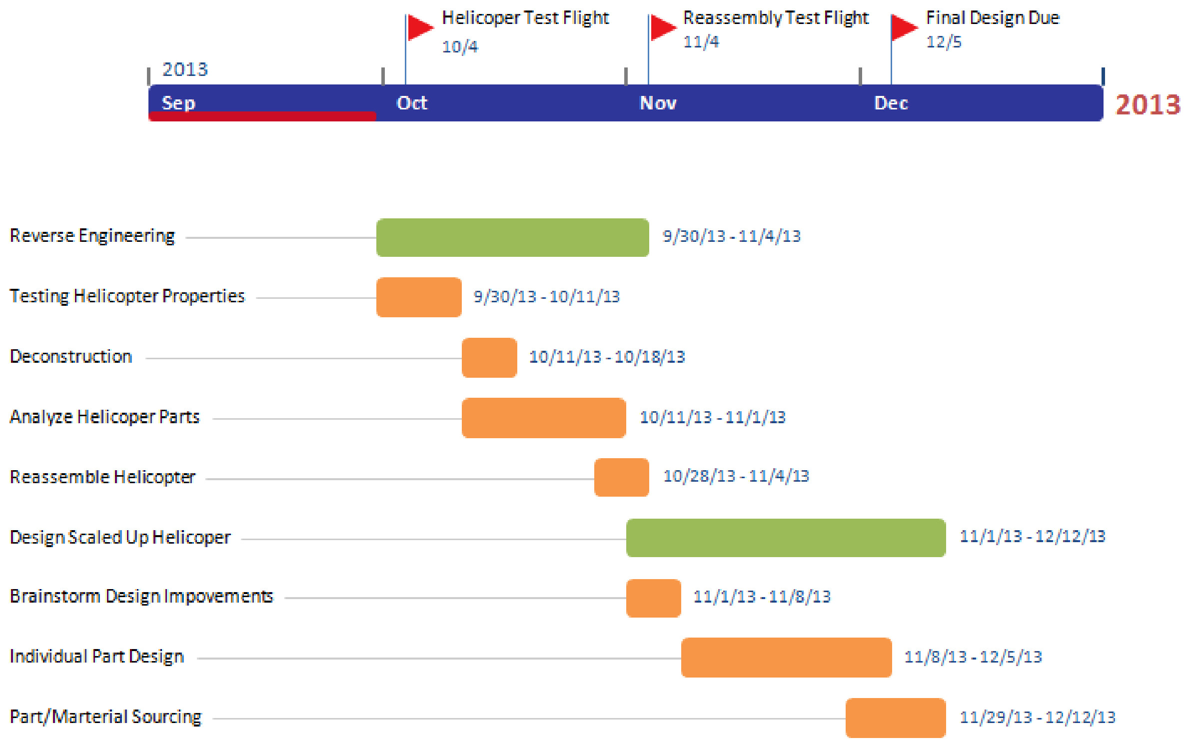
Table 1: QFD

		Engineering Requirements				
		Yield Strength	Weight	Power	Length	Lift
Customer Requirements	Scale Ratio to 1.5		X		X	X
	Perfomance	X				X
	Durability	X				
	Flight Duration			X		
	Attachments		X	X		
	Units	psi	lb	ft-lb/s	in	lbf
		Engineering Targets				

Gantt Chart

Our next steps in continuing this project, includes, breaking the team up into sub-groups to back engineer, research, and design the up scaled helicopter. In these sub-groups, there will be three groups of two to ensure everyone stays on track and all work is done correctly. In order to maintain the deadline of December 5th, 2013 for all design work the Team has made a schedule, which can be seen as Table2. The schedule is broken into two main tasks, which can be seen in green and the minor tasks in orange. These are the reverse engineering of the helicopter and the design of a scaled up helicopter. During the reverse engineering of the helicopter the Team must test the helicopter's properties such as weight, lift, and the RPM of the blades. Also under this task is the testing of the helicopter's flight characteristics which will begin on the first milestone on October 4th, 2013. Upon successful completion of testing the helicopter will be deconstructed and analyzed. Both of these tasks are started at the same time on the schedule so that once a section of helicopter is taken out other Team members may begin to analyze the components. Once pieces have been cataloged and analyzed they can begin to be put back together with the rest of the helicopter. Once all components of the helicopter have been analyzed the second main task can begin. This is scheduled to begin on November 1st, 2013. At this point in time the helicopter may not be fully assembled yet so a few more days are allotted to reassembly. Upon reassembly November 4th, 2013 is scheduled to be an official test flight of the reassembled helicopter. The first minor task of Design involves a week of brainstorming design improvements. The Team then has almost four weeks of part design, which will end on December 5th, 2013 when a final design is due. Once certain parts have been designed the Team can begin to source parts and materials. Sourcing parts will end on December 12th, 2013.

Table 2: Gantt Chart



Where We Are Headed

The team will begin work once again on January 13th, 2013. By this time most parts and materials have been received. The Team will then begin to assemble the scaled up helicopter. Certain components like the rotor assemblies will be assembled first to enable the Team to be able to test its properties and calibrate the motors before full integration into the system. While one part of the Team is involved in the rotor assemblies other members will be working on other subsystems. Once all main subsystems are assembled and calibrated the entire helicopter can be built and assembled. A fully built helicopter will then need to be tested extensively to ensure that the motion controls are perfectly calibrated. Once the basic flight controls are working further testing will be done to ensure all subsystems work together while still maintaining basic flight control. With flight controls ready the helicopter properties can be fine-tuned to extract the maximum performance from the motors.

Conclusion

To wrap things up, our team talked about our client and what tasks needs to be done in the next few weeks of the semester. We also discussed what are needs and goals are. The needs is to create an upscale helicopter that has live action camera features. The goal is to successfully create an upscale helicopter 1.5x the normal size that has removable attachments. Objectives were also discussed in order to meet specific engineering requirements and constraints. Our main objective is to have live camera feed that can record on flight. Constraints were also discussed based on its size, durability, range, battery life, and on board video. In our quality function deployment matrix, we discussed the engineering requirements and customer requirements. These were all based on the customer weights and constraints. Lastly, our project plan is to split up our team into multiple sub-groups. Each sub-group needs to be able to design and reverse engineer the remote control helicopter into CAD drawings in the future.