Restated Project Scope and Project Plan

EML 4552C – Senior Design – Spring 2012 Deliverable #1

Team # 5

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Project Scope

Problem Statement

The challenge of this project is to develop a two-step hub mechanism that allows for the deployment of segmented solid reflector panels. This involves creating a CAD model, dynamic simulation, and ultimately a working prototype to show its ability to facilitate the folding process.

Objective

The Goal of the project is to design the two-step hub mechanism. This includes a complete CAD model, full kinematic and dynamic analysis, and working scale prototype. The final prototype should demonstrate that the mechanism capable of deploying the solid reflector could be operated in an effective and efficient manner.

Justification and Background

Since the beginning of telecommunications, it has been a priority to develop transportable reflectors that maintain their efficiency while being deployed. Reflectors that focus electromagnetic energy are used in applications such as radio-frequency (RF) antennae, solar collectors, cameras, and other optical devices. The reflectors used in these applications are typically shaped to focus electromagnetic energy at a particular point or area. In the case of an antenna feed mounted on or proximate to the reflector, the reflector is shaped to have a parabolic surface to focus the electromagnetic energy in a particular direction.

Reflectors have been configured in two types: solid or mesh configurations. Solid reflectors usually provide higher performance than mesh reflectors. This is because the mesh reflectors generally have a loss in the electromagnetic energy being focused upon it. A solid reflector does not tend to have a very big loss in the focused electromagnetic energy. Also, the mesh of a mesh reflector sometimes requires individual positional or cord adjustments at hundreds or thousands of locations during its assembly and after deployment to achieve its required performance level. A mesh reflector requires a surface roughness deviation from an ideal surface profile of less than 0.010-inch. Even though these required adjustments than could be done to a mesh reflector, it is sometimes very difficult to achieve with the needed precision. In addition, the mesh reflector cannot be used to focus high-frequency RF signals such as Ka and Ku-band transmissions. This is why a solid reflector is more commonly used.

The reason mesh reflectors are used, however, is because they are very dynamic in their ability to be stored. Mesh reflectors can be folded into a compact configuration, allowing them to be stowed in relatively small volumes. A solid reflector cannot typically be stowed in a folded configuration, resulting in a larger ratio of stowed-to-deployed volume than a mesh reflector of comparable size. In applications that are space-based, the sizes of the fairings in which the reflectors are stowed prior to deployment are limited in size. As a result, the reflectors used in space-based applications or any airborne or mobile applications are normally mesh reflectors.

Methodology

The first task was to read and understand all preliminary information received from Harris Corporation and to research existing and previous hub deployment designs. This not only allowed for additional understanding of previous designs, but also ensured that the new design is unique and will withstand testing that caused previous designs to fail. This research will reveal to us important parameters that need to be considered while in the construction stage. Harris Corporation has provided detailed drawings, videos, and explanations of past designs; therefore, it is our duty to take them, refine them, and turn them into a tangible, working Hub Deployment Mechanism.

After extensive research and brainstorming, our team came up with a ball screw/synchronizer idea to achieve the rotary and linear motions independently. This idea has changed since our last presentation in the fall semester. The reason behind the change is that our method of rotating then retracting the panels would not have worked for a large scale application. Because this prototype needs to be a scaled down version of a working hub mechanism, our sponsor wanted us to find another way of implementing the two required motions.

The design includes all desired measurements and implements all limiting factors and all important parameters in order to ensure avoidance of possible modes of failure. After the design was optimized and refined, materials were chosen for each component of the hub.

Following selection of optimal design and materials, CAD drawings of all parts are being produced in Pro/ENGINEER. A 3-D model of the hub mechanism is being produced within Pro/ENGINEER so that a working, moving hub can be virtually seen. This is allowing us to get an idea of how each component of the hub deployment mechanism will move. Since the interface between the hub deployment mechanism and the interlocking panels is important, it is hoped that a 3-D model of the whole system can be produced to ensure that there are no problems between the two.

After the CAD drawings are complete, construction on the components of the hub deployment mechanism will begin. Since a full-sized deployable solid reflector can span up to 30 feet in diameter, a much smaller replica will be built for the purposes of this project. The parts will be machined in local shops or bought from online sources.

The last stage in this project will be to test our hub deployment mechanism. This will be done by first attaching the interlocking panels Team 6 will construct and then analyzing the deployment and retracting process. If the system is in working order and is problem free, then the project is complete. Time will be accounted for and allotted at the end of this stage just in case there is a problem.

Expected Results

Our overall goal in this project is to create a working prototype of the hub assembly system for solid reflector deployment. Our prototype will prove the functionality of the hub assembly and will interface with the panel prototype of the other Harris senior design team. The prototype will rotate all the panels with respect to one another and then pull the panels axially to interlock them to one another and form the solid parabolic surface. The working prototype will first be created as a CAD model and will be simulated to make sure it performs as described by the patent documents. The minimum torque requirements will be met in both the simulated prototype and the built prototype. Working together with the other Harris senior design group, we expect a fully functional working prototype of a high surface accuracy tangential deployable solid reflector for space and ground applications to be built.

Project Schedule

January

All materials needed for the hub mechanism were ordered at the beginning of January, and will be received by the end of the month. During this time, we will finalize the Pro/E CAD model by implementing any updates made to the design of the hub deployment mechanism. If time allows after the design has been finalized, the 3D printer will be used to create a replica of the hub mechanism to prove the design's functionality.

February

Since the team anticipates receiving all materials by the end of January, the first 2 weeks of February will be spent machining all the parts. We have allotted 2 weeks for this step to give the machinists the maximum possible amount of time as to ensure that the parts are correct and accurate. After machining is complete, the team will spend the next week constructing the hub mechanism and ensuring that all parts are fitting correctly together. If some of the components need to be additionally machined, they will be sent back to the shop. The last week of February, we will send the rings with attached connection tabs and the synchronizer to a shop so they can be anodized. This will be done to ensure that the rings are strong enough to withstand the forces and stresses induced by the weight of the panels and to reduce ring-to-ring friction.

March

After the rings and synchronizer return from being anodized, the hub mechanism will again be constructed. Since construction never goes as planned, we will more than likely spend the rest of the month tweaking and fine polishing the hub mechanism by further machining the components if needed. We will be working with Team 6 (the Interlocking Panel Team) during this step by adding the reflector panels to the hub mechanism. Testing of the system as a whole will then ensue for the remainder of the month of March.

April

The majority of the month of April will be spent analyzing and testing the hub deployment mechanism. The final report for the spring semester will be written as we accomplish each step in completing this project. Bi-monthly video conferences will be scheduled with our team's sponsor, Mr. Gustavo Toledo from Harris Corporation. We will update him on the progress of the project and ensure that we remain within the customer's needs.

Project Schedule					
	Duration	January	February	March	April
Finalize Pro/E Model	3 weeks				
Order Parts	3-4 weeks				
Receive Parts	1 day				
Machine Parts	2 weeks				
Preliminary Build	1 week				
Anodizing/Extra Machining	1 week				
Final Build	4 weeks				
Testing and Analyzing	3 weeks				
Write Report	All				