

Week IX Report

Advisor(s): Gary Tuttle

Client: NASA Marshall Space Flight Center

Members (Roles): Isaac Johns-Team Communicator, Ryan Bissett-Team Communicator, Tom Henry-Webmaster, Luke Dahlman-Team Leader, Anh Ho-Key Concept Holder, Dustin Pierce-Key Concept Holder, Antjuan Buffett

Project Title: Remote Deployment Circuit and Mechanism for Lightweight CubeSat Solar Panels

Weekly Summary

Being that the Design Document Version 1 was due on Tuesday (10/28) we made our final edits and put all individual group members' portions together. Our phone meeting with John Carr that was originally set for Monday (10/27) had been moved to Thursday (10/30) due to John's time constraints. In this phone meeting there was one major takeaway. It was been confirmed that we now only have 1 U (10x10x11 cm) or rack unit to work with. With these new dimension specifications we decided that our previous boom design is no longer feasible. However they would still like a deployable/retractable solar array of 4-9ft.² to fit in that same small space. These new dimensions change a lot for us in terms of boom design. The PLC logic for the most part will stay the same with foreseeable additions to be added. The whole boom needs to be redesigned and the torque needed is going to change thus changing the motors needed. The interfacing with the PLC to the motors will remain the same. The change in motors will not be dramatic either. The boom design will ultimately decide the torque, motor(s), and how we will arrange the motor to drive the boom. We just have a much smaller volume and need to be even more creative than before.

Meeting Notes

From our weekly meetings:

- From the meeting on Thursday with John Carr we received news of a dramatic change in specifications. In the meeting he clarified the dimensions for us and asked that we used 1 U as our storage volume.
- We had also discussed with John the size of the solar arrays to give us an idea on how to fold the arrays. He directly told us, "it is cheaper to go with a standard size. Typical sizes range from 1cm² to 20cm² in a square or rectangular shape. One promising candidate is about 6.1cm by 3cm and another is 1cm by 1cm. Generally, the larger the solar cell the better 'packing' you get as far as filling the usable space on the substrate.... But since we will be folding and rolling the substrate, smaller may be key in order to get the proper folds in there."

- We're planning to go with the smaller solar cell size, because it seems we will need to be doing a lot of folding to achieve the goal of $4\text{-}9\text{ft.}^2$. We have been given free range in our choice of solar cell size just as long as it is square or rectangular.
- John is sending us a sample of the substrate to give us an exact idea of the bending radius of the material, so Gary Tuttle will be on the lookout for its arrival. With the substrate we can use tinfoil to mimic the solar panel itself in our mock-up of the solar arrays to give a realistic representation.
- The bending radius is important to us due to the need to store the solar arrays. We want to be able to fold the arrays into a compact area that we can deploy from and retract into without any snags or breaks in the array structure. The smallest radius the substrate can survive while rolled is 2.5cm.
- The widths of the substrate and solar cells were discussed. For the substrate the width is approximately 5-10 μm and for the solar cells the width is about 20-40 μm , so John advised us to shoot for a maximum width of 50 μm . These widths will need to be considered for our total volume needing to be stored. With more folds comes more width taking up more volume.
- We were also given the density of both the substrate and solar cells. The substrate has a density of 15 g/m^2 and the solar cells have a density of 250 g/m^2 . The given densities allows us to get an idea of the amount of weight we'll be needing to support with our boom design. It will also be affecting the amount of torque needed to deploy and retract.
- We had a Monday (11/3) meeting where we started discussing the new boom design.
- A wooden box of 1 U (10x10x11cm) dimensions was built to visually appreciate what cubic volume we're working with. When visually seeing the 1 U wooden box it becomes very apparent that the task at hand has become more difficult than previously thought.
- Scrapping the scissor jack design we began looking into umbrella-like designs.
- The basic mechanics of an umbrella has been found and we briefly discussed the mechanics of umbrellas.
- An umbrella of 41" canopy arc and folded width of 1.5" is the best deployed to retracted ratio we have found yet.
- To achieve the 9ft.^2 calculated $A=\pi r^2$ so $r = \sqrt{\frac{A}{\pi}} = \sqrt{\frac{9}{\pi}} = 1.69 \text{ ft.}$. So with a 41" canopy arc the approximate radius is 1.71 ft. which nicely matches our needed radius. Crunching these numbers we decided that as of right now we will try to achieve just the minimum 4ft.^2 with $r = 1.13 \text{ ft.}$.
- With the smaller dimensions the way we fold and store our system becomes dramatically more important.
- However, considering the bending radius and the fact that umbrellas can tightly fold up and our design cannot it seems that umbrella design will not work as well.
- With that, a hand silk fan design is our most current option for boom design/structure.
- In our meeting we watched video on ATK's new MegaFlex Solar Array that they had built for NASA. ATK's design is similar to that of a silk fan in the way that it is folded and unfolded.
- We plan to either use the silk fan idea or to simply stack the cells on each other and find a way to unfold it from the flat stacks

11/3/2014 Group Meeting to Decide Course of Action and Discuss New Requirements

Duration: 1hr **Members Present:** Isaac Johns, Ryan Bissett, Tom Henry, Luke Dahlman, Anh Ho, Dustin Pierce, Antjuan Buffet

Purpose and Goals:

The purpose of today's meeting was to figure out a new boom design. We brainstormed with Professor Tuttle the feasibility of new designs given the new constraints. We talked about maintaining the core circuitry of our project while encompassing the new boom design. To start crunching number on feasibility.

10/30/2014 Group Meeting to Talk with John Carr

Duration: 1hr **Members Present:** Ryan Bissett, Tom Henry, Luke Dahlman, Anh Ho, Dustin Pierce

Purpose and Goals:

The purpose of Thursday's meeting was to cipher the email from John Carr sent to us on Tuesday (10/28). In the email he told us that he would be meeting with his team and that new constraints may be given. We clarified the change in the dimensions that had been previously given to us. We also clarified the bending radius, density, and width of the entire solar array/substrate.

Achievements

Our major achievement for the week was to come to a clear understanding of the new design constraints provided by our client. This included considering the system as a whole and to ask specific questions that would have a major effect on the new system design. We were also able to overcome the obstacle of a major design change this late in the semester and start developing a plan to achieve the desired outcomes.

Pending Issues

- Need to come up a new boom design that fits the desired criteria
- Determine if the 10 x 10 x 10 cm stored area constraint can be achieved in a perfect cube or if a more rectangular design will be needed
- Ensure the solar arrays on the substrate will have minimum area of 4ft³

Plans for Next Week

There are currently no individual plans. We are meeting this Wednesday at 4 pm to discuss moving forward and assigning individual tasks. Professor Tuttle requested that we determine the feasibility of these new design constraints before we jump right into a new design, because he has doubts on achieving the desired square area of the solar array from the 1 U.

Individual Contributions This Week

- Luke: Complied/Edited design document, spent time discussing design changes with client, & brainstormed/worked through concepts to achieve new design constraints.
- Isaac: Writing group report, building 1 U wooden box, brainstorming and researching new boom designs, & meeting
- Ryan: Weekly meetings, independent research over the weekend
- Tom: Website update and putting on ECE server, researching deployment options, & meetings and brainstorming
- Dustin: Meetings and boom design
- Anh: Project plan & coming up new ideas.
- Antjuan: Project plan & brainstorming ways around 1U cube

Total Contributions for this Project

2 – 1 hour meetings

- Luke: 8 hrs
- Isaac: 9 hrs
- Ryan: 5 hrs
- Tom: 7.5 hrs
- Dustin: 3.5 hrs
- Anh: 4 hrs
- Antjuan: 3.5 hrs