

16.810

Engineering Design and Rapid Prototyping

IAP 2007

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Version 1.2

Deliverable A

Requirements and Interface Document

System: Weight Minimization

Component or Subsystem: Roller Assembly

Team Name: M5

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1. Component Description

The subsystem of the MIT Space Elevator Team's climber to be modified is the roller assembly (a CAD diagram of which appears on the right), the purpose of which is to move the climber assembly up the ribbon. It attaches to the rest of the climber via four polycarbonate support tubes. The purpose of the modifications is to reduce the weight of the roller assembly so as to increase our score and to decrease the amount of power that needs to be supplied in order for the climber to climb the ribbon. The primary goal of these changes is to minimize the weight and cost of the final roller assembly while maintaining structural integrity and function.

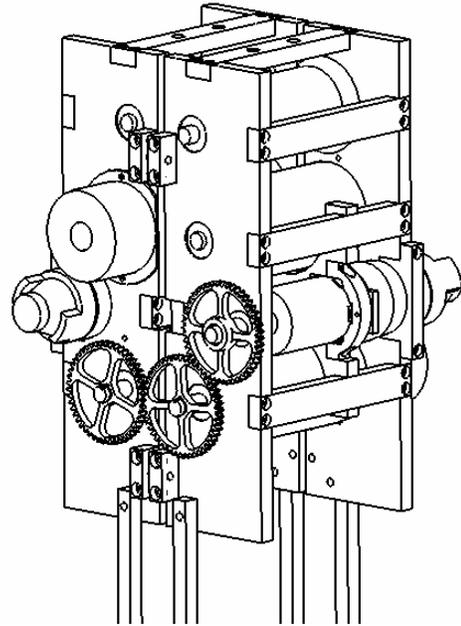


Figure 1: Full Roller Assembly

2. Functional Requirements

- 2.1 The weight of the climber should be minimized from the current 15kg. The lower weight maximizes the score during the competition and aids the power team by lower the power requirement.
- 2.2 The cost of the climber should be minimized. This allows the money to be used in other areas of the team.
- 2.3 The climber must be able to be attached to the ribbon in less than four minutes in order to allow enough time for all other parts of the competition assembly to occur.
- 2.4 A factor of safety of 2 should be maintained. This allows a guide in the type of materials to be used and that nothing too fragile is used.

3. Constraints

- 3.1 The climber must survive a 2meter drop test with no structural integrity failures.
- 3.2 The climber must lift its own weight.
- 3.3 The average speed of the climber must be maintained at 2 m/s.
- 3.4 The material must not be damaged by 5.8 GHz microwave radiation.
- 3.5 In case of rain, the climber must be water resistant.
- 3.6 The climber must be able to resist 11.5mph winds.

4. Interface Definition

4.1 Mechanical Interfaces

4.1.1 The roller assembly must bolt to the four rectenna support rods such that it will be able to carry the power and payload modules up the ribbon with it.

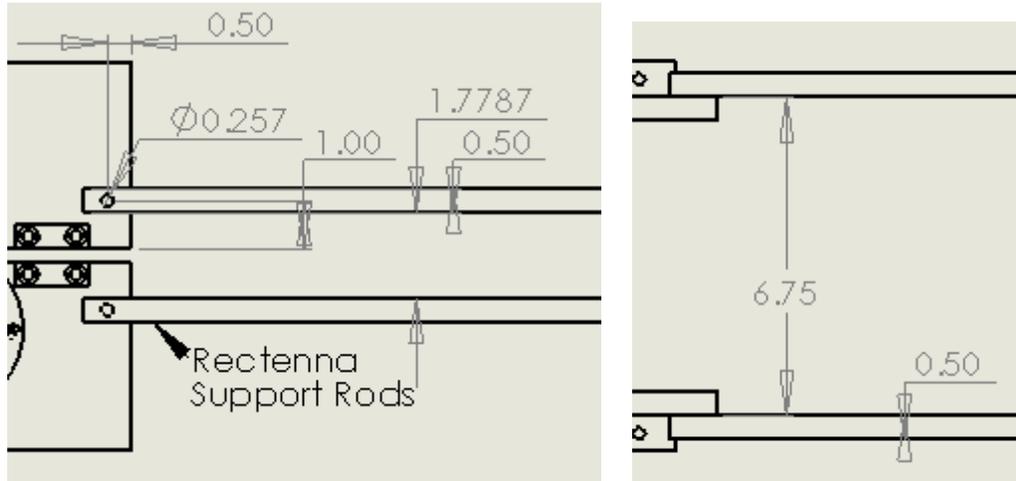


Figure 2: Rectenna Support Rods

4.1.2 The roller assembly must clamp onto the ribbon, which is a timing belt that is 2mm thick and 100-102mm wide.

4.1.3 The roller assembly must contain a rigid plate on the top and the bottom with a slit no wider than 7mm such that fingers cannot be ingested by the climber.

4.1.4 The roller assembly must fit around the envelope of the motor-gearbox assembly, which is taken as given.

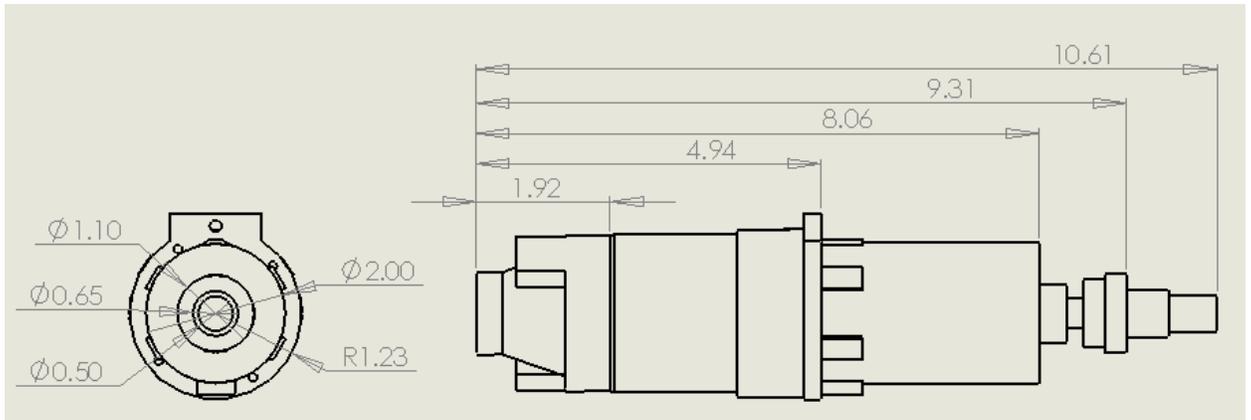


Figure 3: Motor Envelope

4.1.5 The roller assembly must have a device to grip onto an anti-rotation line 200-250cm from the ribbon.

4.1.6 The roller assembly must have a device to grip from the top and bottom of the assembly onto a belay wire loop that is 30-50cm from the ribbon.

4.1.7 The roller assembly must have a bump sensor to detect a 100mm x 250mm sliding strike target 1m from the top of the ribbon.

4.2 Electrical Interfaces

4.2.1 The roller assembly will send data down from the shaft encoders present on its axles to the control system.

4.2.2 The power system must send power to the brakes in the roller assembly.

4.2.3 The power system must send power to the motors in the roller assembly.

4.3 Software Interfaces

4.3.1 (None between the roller assembly and other climber systems)

5. Verification

5.1 For the testing of the clamping of the climber, the climber must be mounted by the team. The mounting will be timed as the team puts the climber on. In order to replicate the actual conditions of the competition, the ribbon will be shaken as this is done.

5.2 Structural integrity will be verified by “yank test.” The climber will be pulled down from ribbon from a height of 2 meters onto a soft landing surface. The climber will be tested for retaining structural integrity.

5.3 CAD verification regarding the weight of the climber will be tested with a scale.

5.4 The climber will run up the ribbon to make sure that it can lift its weight and reach 2 m/s.

5.5 The climber will be subjected to 5.8 GHz radiation to make sure that the components that can handle the radiation.

5.6 The climber will be hosed with water to simulate rain. The climber must be able to run, even if it is raining.

5.7 The entering and exiting location of ribbon will be measured with a ruler to make sure that the 7mm entrance is kept.

Signatures



Carolyn O'Brien