Design and analysis of a specialized rover to overcome various unpredictable obstacles

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Abstract. The paper presents the steps made modelling marsrover structure in software SolidWorks and its analysis on certain aspects. The importance of structure and its mechanical capabilities is related to its compatibility with the environment. When the environment is unpredictable and unexplored the chance of stable functioning falls into the abyss. However, being prepared for various obstacles and challenges increases the chance of the mechanism performing what it was intended to do. Therefore, the structure build in this work will be analyses with different amendments to understand it potential in an environment that promises only challenges. This work provides brief introduction on the history of marsrover landing and its importance in context of exploration. All the steps of the structure modelling are illustrated, and the analysis of structure capabilities is presented.

1 Introduction

As we delve into the development of technology and new methodic, we can see their numerous applications in various fields. Each decade new revolution occurs and every year there is new technological breakthrough. Although, lately the period is shortening due to the exponential progress. One technology improvement can influence the development of others and this circle of progression is accelerating putting some of scientists and commons to question the necessity of the further advancement. Nonetheless the progress will keep it pace and influence our existence at each its leap.

The advancement of technology allowed us to change not just the world we leave but also to start journey on other nearby planets. Due to technological progress and human accumulated knowledge, we are able to visualize and analyses some of the nears planets using the latest technologies. One of the missions that included first landing on the Moon was Apollo 11 In 1969. Although there was other mission to the Moon but never did landing. This marked the great journey that led to the landing a mars rover to the mars. On July 4 in 1997 the Mars rover landed to the mars. From this moment there were other missions that included other improved rovers landing on the Mars [1, 2].

The work will look into designing Marsrover with the use of SolidWorks to illustrate its main components.

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2 Materials and methods

There are different rovers invented to scope the challenges of a certain environment of our planet. The difference of marsrover is its functionality to grasp in the environment of planet Mars. There have been few rovers that ended being in the surface of the mars. The followings were once collecting the data and two are still functioning: Sojourner (1997), Spirit (2004–2010), Opportunity (2004–2018), Curiosity (2012–present), and Perseverance (2021–present) [3, 4]. The following rover were exploring the mars since These rovers are primarily used to gather information on the surface of Mars about past water activity and other useful data. Therefore, the ability to overcome an unknown set of obstacles and how its function in different scenarios is vital. The figure one illustrates the rover that is used at the moment in the Martian mission. The structure build in this work will be similar to this one, but as idealized version. The whole mission of this machinery is depending on its ability to wonder around and collect the data. If it is stack or can't move the usefulness of the rover fall to almost zero. Hence, it is important to model a rover that will pass any obstacle without losing it balance and being unable to overcome challenges [5, 6].

To build the structure software SolidWorks was used. This tool is well utilized in engineering world and can be served as a standard for other tools. SolidWorks is capable of various tasks including modelling separate parts, assembly of parts, analysis in various fields and many more [7]. In this work the tool was used to build the structure of 10 separate parts. Then these parts were connected to a one structure in the assembly section using appropriate mate functions. As the structure was finished all the necessary boundary conditions were applied and analyzed.

3 Results and discussion

From the following figure 1 can see each individual part of the structure of marsrover. As it was mentioned previously the structure consists of 10 parts build separately. All ten parts are numbered and other parts that are in the image are duplicates of them.

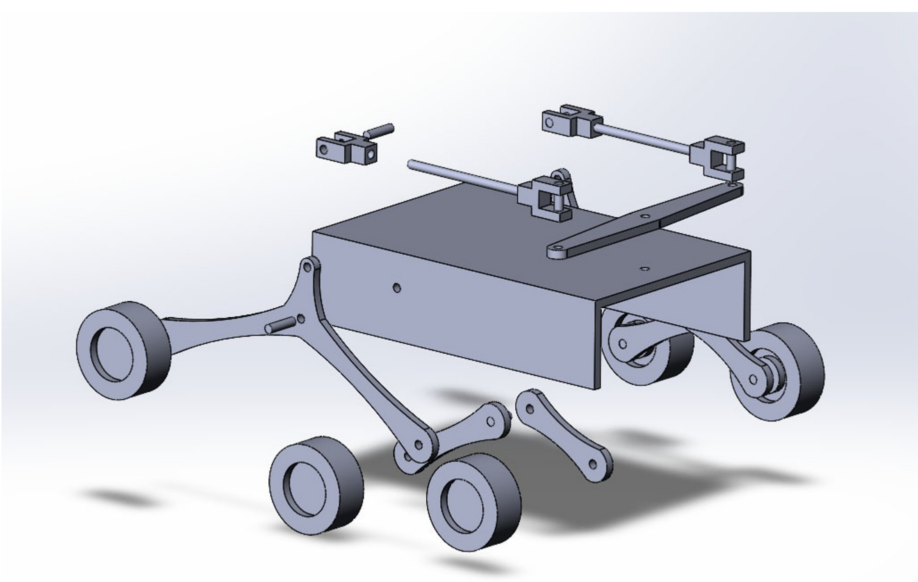

Fig. 1. Expanded view of the structure.

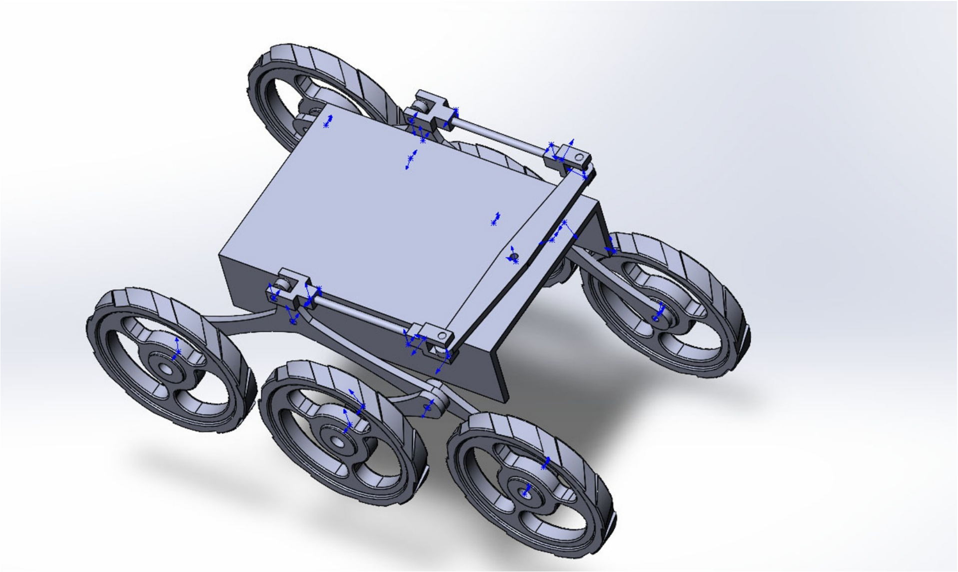

Fig. 2. Assembled part of the rover.

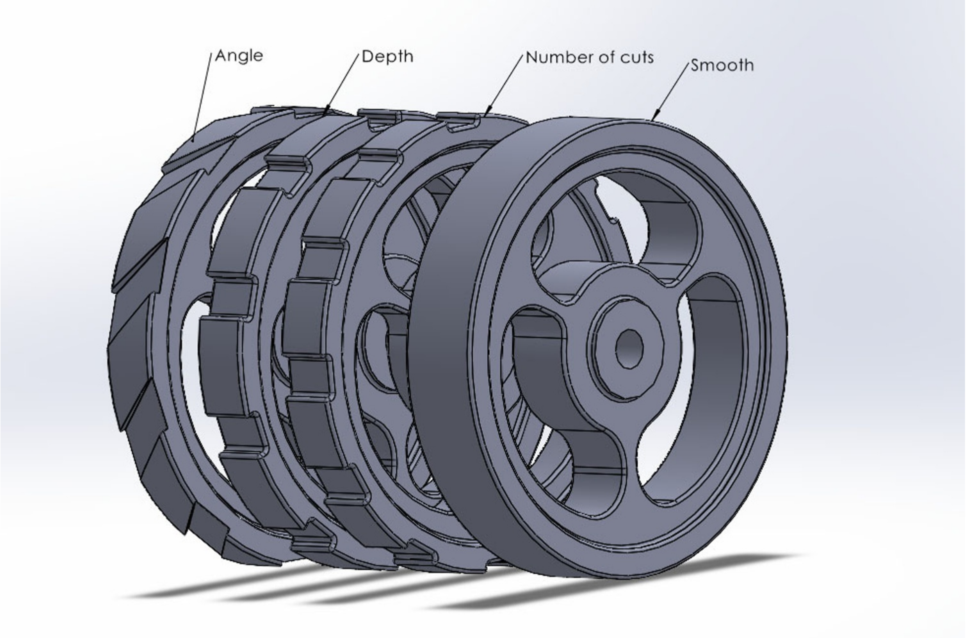

Fig. 3. Variation of wheel design.

Figure 2 illustrates assembled structure of marsrover. It is obvious that real marsrover appears to have completely different look. Although, the idea of this work is to build idealized version of marsrover and test it with the minimum effort applied due to complexity. The results gathered from the structure can be easily applicable for the real ones as it represents the tendency.

Variation of wheels were created to test which of the design will overcome the challenges better than others. Figure 3 presents various finishes on the wheel.

Four different designs of wheels are presented: Angel – where degree to the cut are introduced, depth – where the values of cut's depth are changed, numbers of cut – where the numbers of cuts in the wheel are varied, smooth – where no additional changes were introduced. By changing these wheel results will be gathered.

In the first four scenarios, the number of tire cuts varied. With five cuts, the system failed to overcome any obstacle. With 8, 10, and 14 cuts, it could pass the first obstacle but not the second. Next, the tire of the third stage was modified with cuts at 45, 55, and 60-degree inclinations. At 45 and 55 degrees, the system overcame both obstacles, but at 60 degrees, only the first. Increasing the depth of 45-degree cuts on the 10-cut rim enabled the system to pass both obstacles by reducing the front and rear motor torques. Additional tests determined the maximum obstacle diameter the system could overcome, achieving a 135 mm obstacle (120% of the wheel diameter).

Table 1. Number of tests with the parameters and results.

Number of tests	Design 1 (angle)	Design 2 (depth)	Design 3 (number of cuts)	End distance of the given platform with obstacles
5	45	10	10	Arrive
6	55	10	10	Arrive
7	60	10	10	Didn't arrive
8	45	20	10	Arrive
1	0	10	5	Didn't arrive
2	0	10	8	Didn't arrive
3	0	10	10	Didn't arrive
4	0	10	14	Didn't arrive

4 Conclusion

To conclude, the work was done to model and analysis the marsrover. Design and the analysis were done by the software SolidWorks. The software was capable of preforming the given tasks. The marsrover structure was build and analyzed to understand it capabilities to overcome the given challenges. By changing the wheels design the structure was given the environment to pass. With the changing values of angle, depth and numbers results were gathered. The most effective design of wheels was found to be with the number of cut equal to 10 and with the angle of 45 degree. These findings concluded that the not just the structure design is important when overcoming the challenges of the given environment but also the finish in the wheels.

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