Research on Wheel-Legged Designs

Pranav Joshi, 2081830

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Link to This SSA

https://www.overleaf.com/read/tnshctrdqcqg#40b494

Goals

To research on wheel-legged designs

Summary

It is concluded that a tank-like climber 4 or a 6-wheeled climber 1 is applicable to the multiped challenge of this project.

1 Elaboration

1.1 Scouring Through Youtube

The first step that was taken in this research assignment was to look through Youtube and find robots (that used wheels and/or legs) that could climb equally heightened or higher stairs than the height of the robot itself. From this process, four designs were found that fit the bill. Below, they are elaborated in detail along with their pros and cons

1.2 6-Wheeled Climber

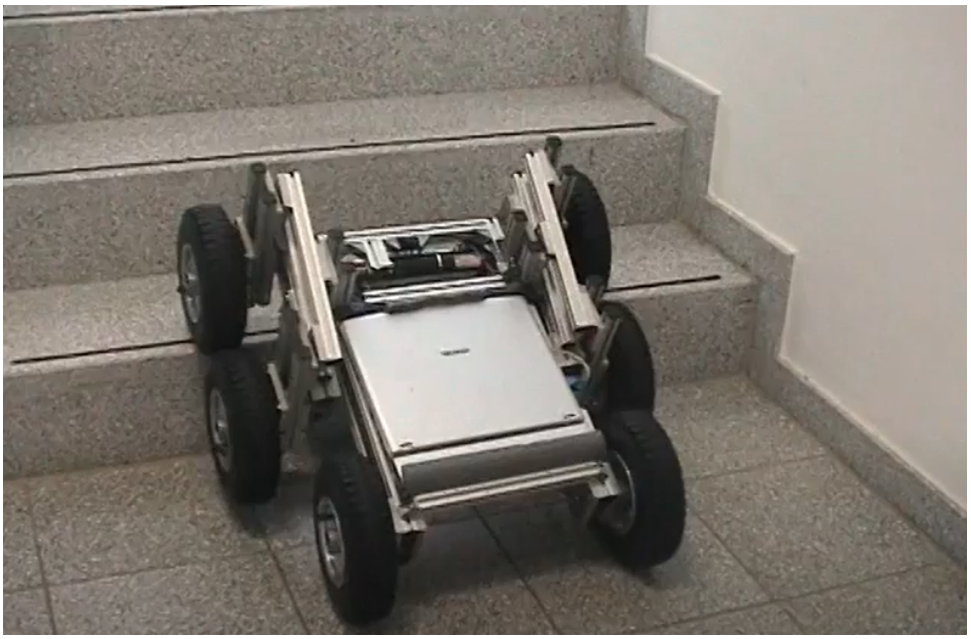

Figure 1: 6-Wheeled Climber [2]

Concept

The concept of the 6-wheeled climber is to mimic the shape of the stairs as it ascends, the lateral pair of wheels is used to pull the robot up, the middle pair of wheels are used to push the front wheels far enough to the top of the staircase so that the front wheels have enough leverage to pull the front body. Finally, the back wheels prevent any balance-related issues that are caused by the sharp slope of a staircase, ie; they prevent the robot from toppling backward as it climbs.

Advantages

- It is quite straightforward to determine the dimensions of the robot since it is directly dependent on the geometry of the stairs and the geometric constraints of the clear box.
- The robot has a behavior that can be predicted with ease
- It can cross both checkpoints if designed correctly
- The varied shape of the two stairs will not be a problem for this design

Disadvantages

- The robot could be very slow
- This design demands a good amount of material usage which may not be ideal

1.3 4-Wheeled Climber

Figure 2: 4-Wheeled Climber [1]

Concept

This four wheeled climber uses a unique shape of wheels that help the robot to find traction easily. The wheels in the front initiate the climbing process when they come in contact with a stair and the wheels in the back help push the robot body upwards. This design has been used here to climb fairly low-hight stairs, however the concept shows potential, given that the wheels can be oriented in such a manner that they lie on their longer side when beginning the race-course.

Advantages

- The design is based on a simple rotatory-repetitive motion, which makes it easier to determine and tweak around
- The design can be made to be fairly lightweight but sturdy.

Disadvantages

- The concept might not work as fluently with the given racecourse due to the height of the tallest stair being 12cm, while the robot itself can only be 15cm tall and 30cm wide, limiting the size of the wheels from becoming too long or tall.
- The design heavily depends on the geometry and functioning of the wheels which could pose a challenge if it's not executed properly
- The design could be very slow

1.4 Wheeled-Leg Dog Climber

Figure 3: Wheel-Legged Dog Climber

Concept

This design uses the anatomy of a dog with addition of wheels on each leg to mobilize itself and traverse objstacles that are bigger than itself. The legs in the front roll up to the top of the obstacle, extending the the elbows as required, followed by using the wheels and elbows to pull itself up. Meanwhile the back-legs and wheels provide the necessary balance so that the robot doesn't topple over.

Advantages

- If designed correctly, the robot could easily fit within the geometric constraints of the clear box
- The robot can be used to traverse any height obstacle with ease
- The robot can easily cross both checkpoints

Disadvantages

- The design is quite complex may demand a higher workload on the programming part as well
- Performing calculations may prove to be a difficult task for a complex system like this
- The design will be very slow given the number of moving parts that need to be adjusted uniquely to each step
- The system is complex to determine and may be out of the scope for this project

1.5 Tank-Like Climber

Figure 4: Adjustable Tank-like Climber

Concept

Tanks are known for their ability to traverse difficult terrain, this design uses a similar belt transmission/wheel concept to climb stairs. The angle of attack of the front section can be adjusted as required, and when paired with the traction provided by the belt, the system is able to climb stairs. This can be thought as a modified version of the very first design discussed in this SSA, however this design is able to produce significantly more traction due to the larger surface area of a belt, when compared to wheels.

Advantages

- The design can easily be fit into the geometric constraints (of the clear box)
- The belt provides a significant amount of traction which comes in handy when dealing with higher stairs
- The robot can cross both checkpoints easily
- The angle of attack of the front legs can be adjusted as per the height of the stair to maximize efficiency
- The system can execute a higher rate of predictable behavior

Disadvantages

- The design can be prone to failure due to improper balance, causing it to topple back if it is not weighted or operated correctly
- Using belts and creating the transmission may be complex and possibly not allowed
- The robot will be quite slow, since it needs to adjust its angle of attack for each stair
- The working of the concept is heavily based on the proper functioning of the belts, if the belt fails, the whole design will fail

1.6 Conclusions

In conclusion, after comparing all these designs for their pros and cons, it is recommended that a tank-like climber or a 6-wheeled climber is investigated further, since they are promising concepts with scope to be optimized for speed. They are both very similar concepts, and after further discussion perhaps one concept can be chosen and designed so that it fits the RPCs of this project.

References

[1] *Senior Design Project;Stair Climber*. URL: https://www.youtube.com/watch?v=46qEgN3eqkA. (accessed: 15.02.2024).

[2] *Stair Climbing Robot*. URL: https://www.youtube.com/watch?v=-YKtUWb8-GE. (accessed: 15.02.2024).