THE PERFORMANCE OF LAMBDA LINKAGE ON TRAVERSING UNEVEN SURFACES

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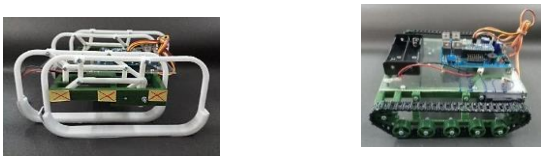
1. Introduction

The wheel, which is commonly used in transportation, has difficulty in traversing uneven surfaces, caused by its small ground contact area, forcing it to follow the surrounding contour, causing shaking of the vehicle. By increasing the ground contact area, this problem could be solved, for example with the tank track and large off-road wheels. However, the tank track has lots of moving parts and could be immobilized due to broken or clogged tracks and gears and large off-road wheels still could get stuck.

Here, a walking mechanism with large feet utilizing the Chebyshev Lambda linkage is proposed. The objective of this research is to apply the Lambda linkage as a transportation mechanism, and to study its performance in traversing uneven surfaces smoothly compared to other mechanism.

2. Research Methods

Three model vehicles were created, one with the Lambda linkage, called "the walker", the second with tank tracks, and the third with 3 cm radius large wheels. The walker dimensions are 18 cm length, 19.5 cm width, and 9.5 cm height with mass 476 g. The other models are created with similar sizes, shown in Fig. 1. The walker has 4 feet with a length of 18 cm each and each step spanning 16.5 cm with a maximum step height of 0.9 cm. By applying the Parallelogram Linkage, the movement of the linkage output is copied to another location to support a large foot. All models were built using a 3D printer and powered by a couple of servo motors.



[a] [b]

Figure 1. The models of the vehicle:
[a] The walker [b] the tank

The models were tested on various obstacle courses, which included smooth surface, a 0.8 cm height step, a 10 cm width x 0.8 cm deep hole, and 1 cm radius semicircular bumps. The movement of the vehicles was recorded by video camera and measured with the Tracker software to obtain the acceleration, which showed how much the vehicle body shook during travel. The less the body shakes, the smoother the vehicle travels.

To help design improvement of the walker, a computer simulation was made with the Open Dynamic Engine library. By tuning simulation parameters to match experiment data, this would prove the simulation to be reliable, allowing more effective design to be tested without physically altering the vehicle. To find the efficiency of the vehicle models, the energy output and input were measured and compared.

3. Results

The Lambda Mechanism is applicable as a walking mechanism, although it lacks the ability to travel smoothly on flat surfaces due to its foot slamming the ground. However, after a foot design modification, the walker could travel smoother than tank tracks on uneven surfaces. The best mechanism to use on uneven surfaces turned out to be the large wheels due to its large radius, while the tank tracks provides the best climbing capability because of the tracks teeth.

The analysis, shown in Fig. 2, shows that the wheels could travel most smoothly on uneven surfaces. However, the walker travels more smoothly over 3 obstacles compared to the tank. The loss of friction and hitting the obstacle caused the walker to shake more. On the other hand, the large ground contact area of the walker allows the vehicle to pass through small holes without going down the holes. The Lambda Linkage is less efficient compared to the tank track, while the most efficient is the large wheels.

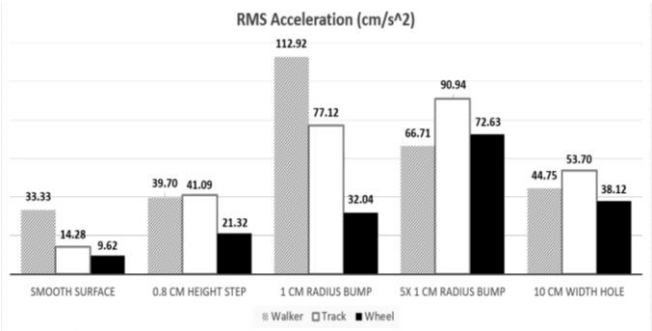


Figure 2. The RMS acceleration of the vehicle models.

4. Conclusion

The Lambda mechanism is successfully applied as a transporting mechanism. The lambda is proven to be more suitable for uneven terrain, when compared to tank tracks, but not as good as the large wheels. For further improvement, "smart" suspensions could be applied to the walker.

5. References

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