The Research on Obstacle Crossing Ability of Tracked Wheel Vehicle

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Abstract. The Tracked wheel vehicles which have the similarity with wheeled vehicle in nature are derived from wheeled vehicle, but tracked wheel vehicles greatly improves the vehicles' obstacle crossing ability. This paper establishes the mathematics model of the tracked wheel vehicles, the simulation model is set up based on SIMULINK, the tracked wheel vehicles' obstacle crossing ability is mainly studied.The results show that the tracked wheel vehicles' obstacle crossing ability raises at least more than two times in contrast to wheeled vehicles.

Introduction

Tracked wheel is a new kind of walking system, While driving on the off-road, obstacles like aditches and barriers need to be crossed, and due to its low speed at this time,so the statics balance equation can be used to solve the relationship between obstacles and the vehicles parameters[1-2].Ordinary off-road wheeled vehicle obstacle crossing ability can be achieved by its maximum height and diameter of the wheel h_w / D. In order to facilitate comparison, tracked wheel vehicles' obstacle crossing ability can refer wheeled vehicles, by the ratio of obstacles' height and the distance of the propelled wheel center to ground $h_w / 2h$ [3-7]

For the tracked wheel vehicles, the front axle's obstacle crossing ability is different from the rear axle's obstacle crossing ability. This paper respectively analyzes the obstacle crossing ability of the front axle and the rear axle.

Nonlinear mathmatical Model

While crossing the obstacle,The caterpillar force of the tracked wheel vehicle's front axle is shown in figure 1.

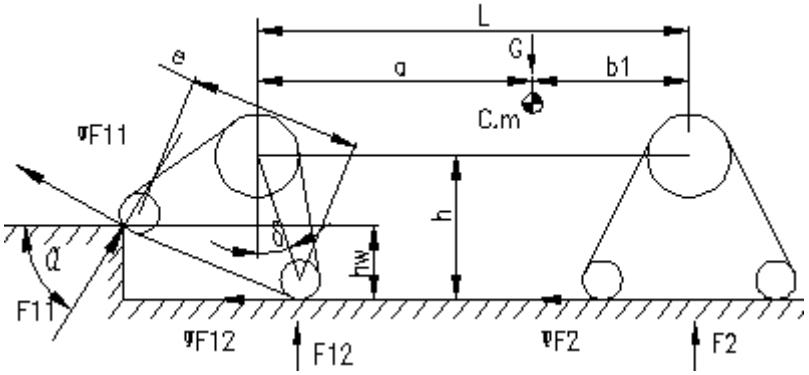

Fig.1 Front axle force schematic of tracked wheel vehicle

The following equation of front axle force schematic of tracked wheel vehicle can be obtained:

$$F_{11}\cos\alpha-\varphi F_{11}\sin\alpha-F_{12}\varphi-F_2\varphi=0$$

$$F_{11}\sin\alpha+F_2+F_{12}-G+\varphi F_{11}\cos\alpha=0$$

$$-F_{11}\varphi\frac{e}{2}+F_2L-Ga-(\varphi F_2+\varphi F_{12})\frac{\sqrt{2}}{2}e\cos\delta+F_{12}\frac{\sqrt{2}}{2}e\sin\delta-F_{11}\frac{e}{2}=0$$

$$F_2\left(L-\frac{\sqrt{2}}{2}e\sin\delta\right)-F_{11}e-G\left(a-\frac{\sqrt{2}}{2}e\sin\delta\right)=0 \tag{1}$$

$$\cos\alpha=h_w/e$$

$$\sin\alpha=\sqrt{1-\left(\frac{h_w}{e}\right)^2}$$

Equation (1): ψ – adhesion coefficient; a – the distance between vehicle's gravity and front axle; b – the distance between vehicle's gravity and rear axle; h_w – obstacle height; L – the distance between two axle; G – gross vehicle gravity; F_{11}、F_{12}—obstacle's counter force on the front wheel; F_2 – rear axle payload; α – the angle between counter force of front axle and ground; e – the grounding length of track; δ – the angle.

Similarly, the rear axle force schematic of tracked wheel vehicle can be obtained:

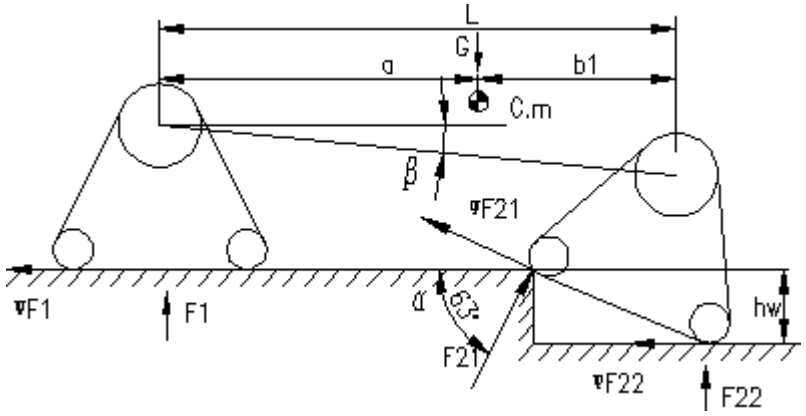

Fig.2 Rear axle force schematic of tracked wheel vehicle

$$F_{21}\cos\alpha-\varphi F_{22}-\varphi F_{21}\sin\alpha-\varphi F_1=0$$

$$F_{21}\sin\alpha+\varphi F_{21}\cos\alpha+F_{22}+F_1-G=0$$

$$\varphi F_{21}\frac{1}{2}e+(\varphi F_{22}+\varphi F_1)\frac{\sqrt{2}}{2}e\cos\delta+F_1L+F_{21}\frac{e}{2}-Gb1-F_{22}\frac{\sqrt{2}}{2}e\sin\delta=0$$

$$F_1\left(L+\frac{\sqrt{2}}{2}e\sin\delta\right)+F_{21}e-G\left(b1+\frac{\sqrt{2}}{2}e\sin\delta\right)=0 \tag{2}$$

$$\cos\alpha=h_w/e$$

$$\sin\alpha=\sqrt{1-\left(\frac{h_w}{e}\right)^2}$$

Equation (2): the parameters as described above.

The Instance Simulation Analysis

With a tracked wheel vehicle as the research object to study the obstacle crossing ability, and the study result is analyzed in contrast to the wheeled vehicle obstacle ability.The tracked wheel vehicle and wheeled vehicle technology parameters shown in table 1, taking the technical parameters into the above mathematical model and the simulation results can be achieved.

Table 1 Related Technical Parameters of Tracked and Wheeled Vehicle

	a/m	b/m	L/m	$D(h)/m$	φ	h_0/m	e/m
Wheeled	1.82	0.98	2.8	0.7	0.7	0.4	-
Tracked	1.82	0.98	2.8	0.35	0.7	0.4	0.5

Figure 3 shows that with the increase of the ratio a/L, the front axle obstacle crossing ability of tracked wheel improved significantly.

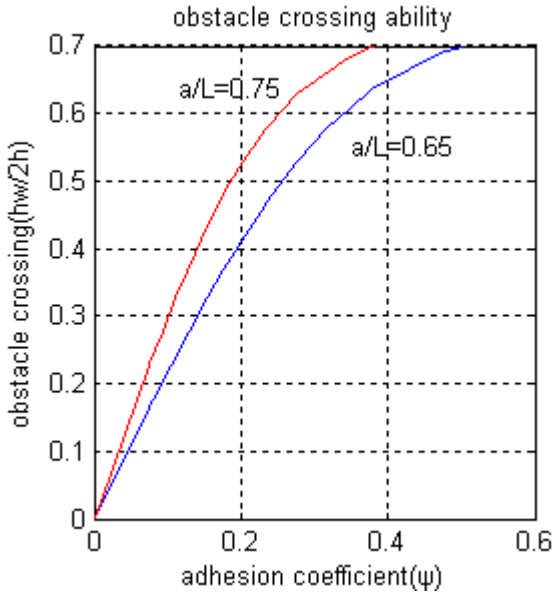

Fig.3 Front axle obstacle crossing ability

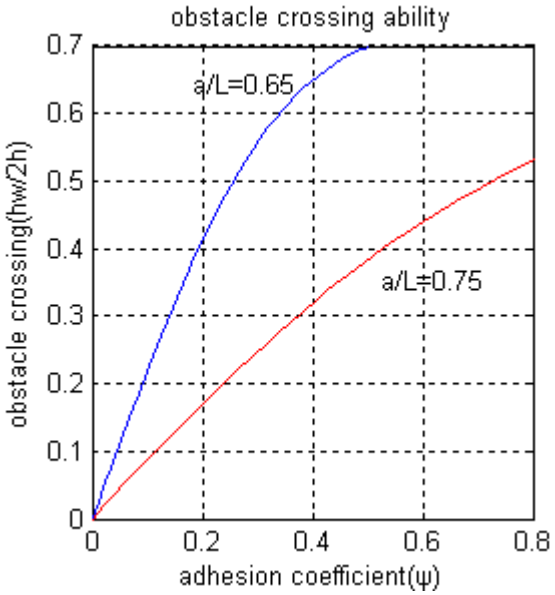

Fig.4 Rear axle obstacle crossing ability

Obtained from Fig.4: with with the increase of the ratio a/L, the rear axle obstacle crossing ability of tracked wheel decreases insteadly.

Obtained from Fig.5:on the same conditons, the front wheel obstacle crossing ability of wheeled vehicle is much higher than the rear wheel obstacle crossing ability, namely the rear wheel is the main limiting factor on obstacle crossing.

Learned from the above analysis, both wheeled vehicles and the tracked wheel vehicles, the rear axle is the main factors restricting the vehicle obstacle crossing ability.

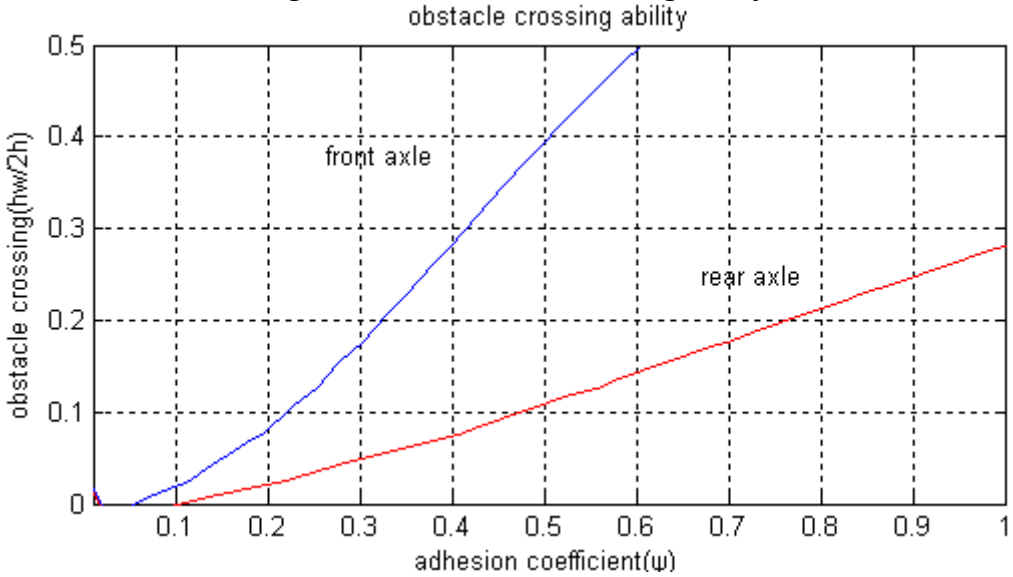

Fig.5 Wheeled vehicle obstacle crossing ability

After comparing the obstacle crossing ability of common wheeled off-road vehicles and tracked wheel vehicle, the comparison result is shown in figure 6.

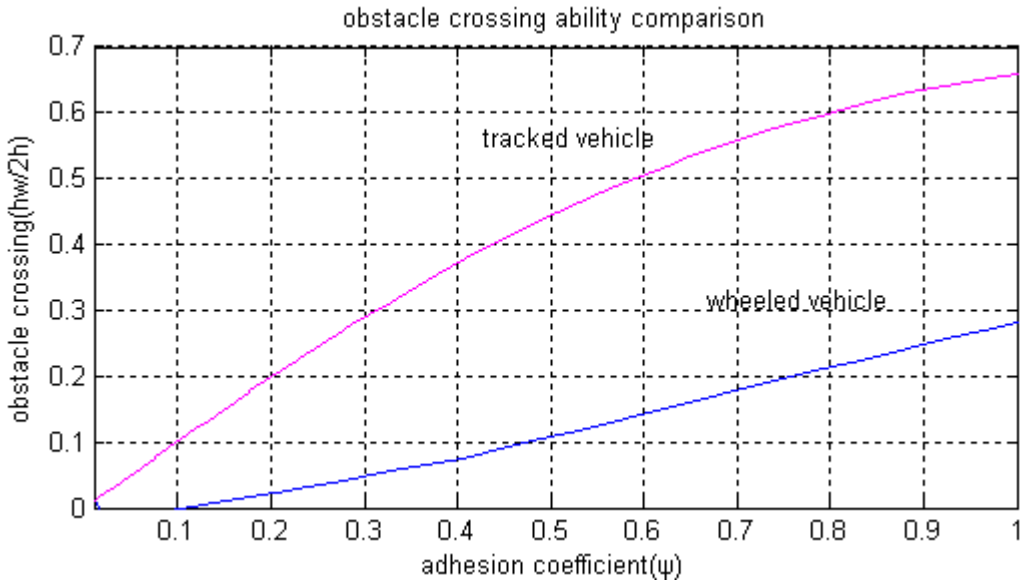

Fig.6 Obstacle crossing ability comparison

Obtained from figure 6:with the increasement of adhesion coefficient, the vehicles' obstacle crossing ability increases, and on the same conditons, the tracked wheel vehicles obstacle crossing ability is at least 2 times of the wheeled vehicle.

Conclusion

This article compares the obstacle crossing ability of tracked wheel vehicle and wheeled vehicle.For both tracked wheel vehicle and wheeled vehicle, the rear wheel is the main factor limiting the vehicle obstacle crossing ability. The simulation results show that tracked wheel vehicle obstacle crossing ability increases by more than two times comparing to wheeled vehicles. The tracked wheel vehicle can be applied to the unmanned platform vehicles which require higher obstacle crossing ability.

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