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The overall design of the unmanned electric logistics vehicle

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Introduction

Electric vehicle can be divided into two types, namely electric vehicles using pure batteries as power sources and electric vehicles with auxiliary power sources.

Overall design of electric vehicles

Environmental awareness system

The top of the car is equipped with a 16-line laser radar; the second layer of two RTK antennas, the middle binocular camera; the third layer is equipped with four cameras surrounding the body; the bottom layer is the ultrasonic sensor surrounding the body.

Decision planning system

Decision-making algorithm based on combination of rules and learning and GPS/DR combined positioning system.

Control execution system

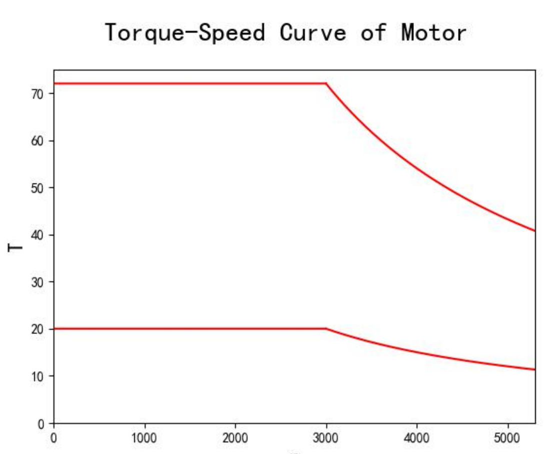
Gear mechanism and ball screw mechanism.

Motor parameter design

$$P_{mr} = \sum_{u_{amax}} P = \left(\frac{Mgf}{3600} u_{amax} + \frac{C_d A u_{amax}^3}{76140}\right) \Big/ \eta_t$$

$$\sum_i P = \left(\frac{Mgf}{3600} u_a + \frac{C_d A u_a^3}{76140} + \frac{Mgi}{3600} u_a\right) \Big/ \eta_t$$

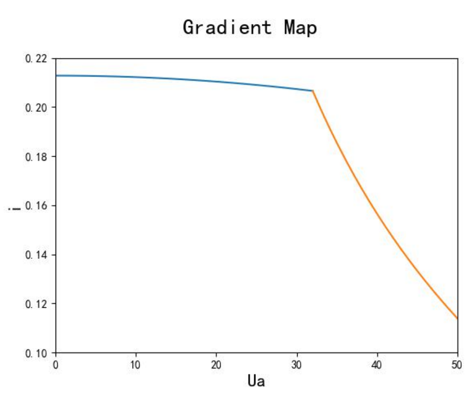
Motor selection

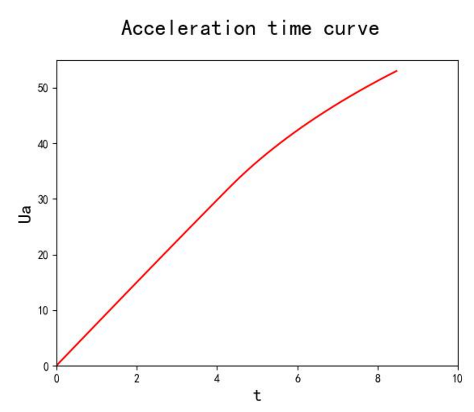


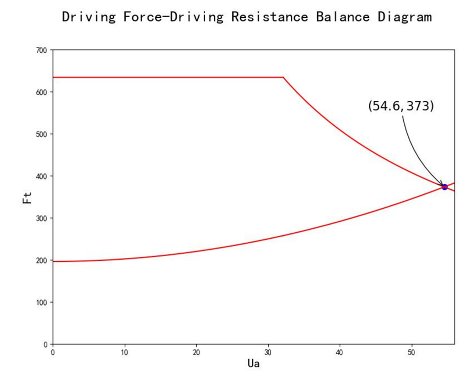
Driveline ratio

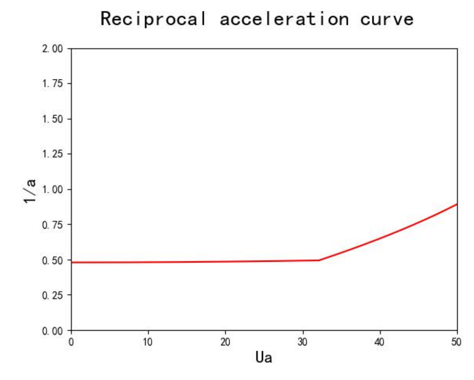
$$\sum i \le \frac{0.377 n_{max} r}{u_{amax}} \qquad \sum i \ge \frac{F_{uamax} r}{\eta_t T_{nmax}}$$

Check maximun grade,speed and acceleration performance









Battery pack capacity design

$$N = \frac{V}{V_0}$$

$$W = \frac{S \bullet P_{mr}}{u_a \bullet \eta_t \bullet \eta_m}$$

$$C \ge \frac{W}{N \bullet V_0 \bullet DOD \bullet \eta_b}$$

$$P_{sbmax} = V_s \bullet I_{smax}$$

Evaluation of brake performance

$$E_f = \frac{z}{\psi_f} = \frac{b}{L\beta - \psi_f h_g}$$

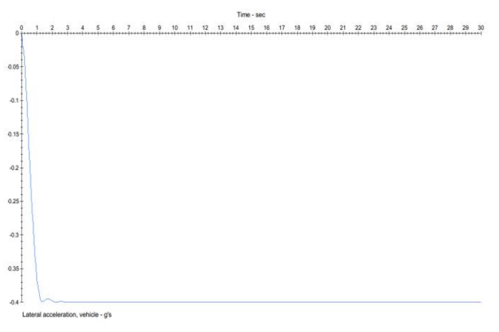
$$a_{max} = E_f \bullet \psi$$

$$S = \frac{1}{3.6}\left(\tau_2' + \frac{\tau_2''}{2}\right) u_a + \frac{u_a^2}{25.92 a_{max}}$$

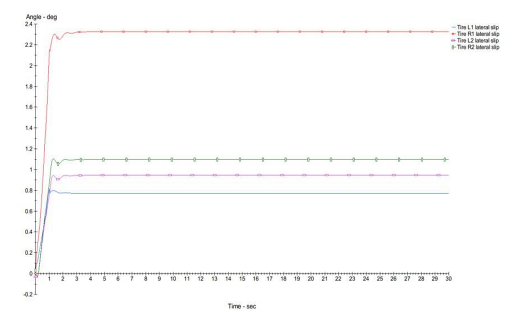
Evaluation of passability

Minimum ground clearance：200mm
Approach angle：42.86
Departure angle：37.97
Minimum turning diameter：6m
Longitudinal pass radius：2.2m

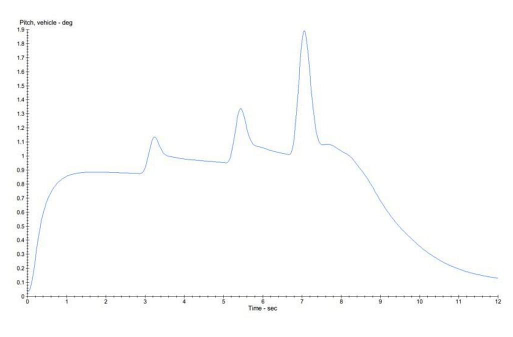
Simulation of Vehicle Handling Stability



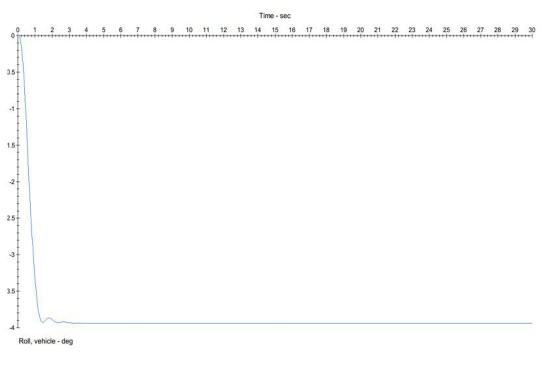
Centroidal Acceleration Diagram



Side Deflection Diagram of Wheel

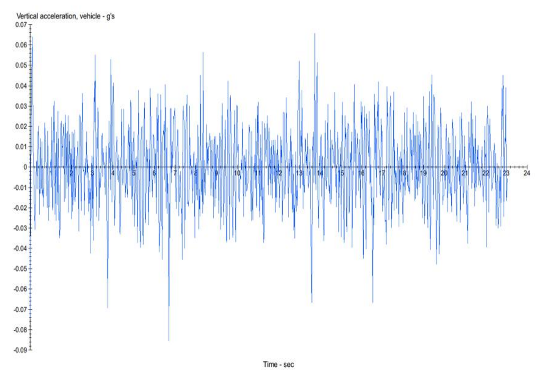


Front Bend Angle of Body

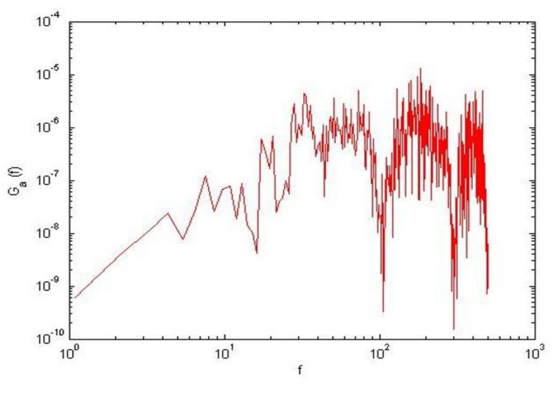


Body roll angle diagram

Automotive Ride Comfort Simulation



Vertical acceleration curve



Pavement excitation power spectral density

$$a_w = [\int_{0.5}^{80} W^2(f)\, G_a(f) df]^{\frac{1}{2}}$$

The relationship between L_{aw} and a_w and human subjective sensation

Weighted root mean square acceleration a_w/（m/s^2）	Weighted vibration level L_{aw}/dB	Subjective Feeling
<0.315	110	No discomfort
0.315-0.63	110-116	Some discomforts.
0.5-1.0	114-120	Quite uncomfortable
0.8-1.6	118-124	Discomfort
1.25-2.5	122-128	Great discomfort
>2.0	126	Extremely uncomfortable

Conclusions

Vehicle parameters

Basic parameters	
Energy type	Pure electric
Driving range	100km
Maximum speed	50km/h
Acceleration time（0-50km/h）	7.7s
Maximum gradient（%）	20
Curb weight（kg）	700
Full load total mass（kg）	1000
body	
Length / width / height（mm）	2500/1000/1800
Wheelbase（mm）	1730
Front wheel pitch（mm）	820
Rear wheel pitch（mm）	820
Minimum ground clearance（mm）	200
Frame type	Side girder frame
Motor	
Motor type	Permanent magnet synchronous motor
Rated voltage（V）	60
Rated power（kw）	6
Peak power（kw）	12
Rated speed（rpm）	3000
Peak speed（rpm）	5300
Rated torque（Nm）	20
Peak torque（Nm）	72
Number of driving motors	1
Motor layout	Front transverse
Battery	
Battery type	Ternary lithium battery
Core nominal capacity（Ah）	70
Nominal voltage（V）	3.65
Internal resistance（Ω）	≤ 0.001
Standard discharge current（A）	70
Retarder	
Number of gears	1
Type of reducer	Fixed Tooth Ratio Two-stage
Chassis and Steering	
Driving mode	Front-end precursor
Front suspension type	McPherson independent
Rear suspension type	Torsion beam type independent
Assistance type	Electric power assist
Car body structure	Unloaded body
Tire and Braking	
Type of front brake	Vented Disc
Type of rear brake	Drum type
Parking brake	Wheel brake drum parking brake
Front tire specification	115/70 R16
Rear tire specification	115/70 R16

Acknowledgments

I am used to admiring great men and celebrities, but I am more eager to dedicate my respect to no ordinary person than my teacher, Yu Houyu. I may not be your best student, but I have much respect for you. What impressed me the most was that you dedicated your time to answer all our question during this graduation project design period, which takes several hours and sometime affect your lunch time. For a small problem, you will think carefully and discuss it with us. This gives us a model for rigorous study.

References

[1]Tian Pengfei,Luo Yiping,Zhou Feng,et al.CATIA-Based Urban Mini EV Design[J].The Open Mechanical Engineering Journal,2015,9:346-350.