TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

NOTATIONS

a_x	longitudinal car acceleration
b	setpoint weighting of proportional term in PID control
B	magnetic flux density
c	setpoint weighting of derivative term in PID control
C_{BL}	damping coefficient from release bearing to ball and socket joint
C_c	damping coefficient of virtual spring on worm gear collision
C_{CP}	damping coefficient of clutch disc
C_{DM}	damping coefficient of identity shaft
C_{eng}	damping coefficient of engine
C_G	damping coefficient of worm gear
C_{IG}	damping coefficients on input shaft
C_{OG}	damping coefficients on output shaft of gear box
C_{RG}	damping coefficients on inverse shaft
C_{ss}	damping coefficient of stage springs
C_{SP}	damping coefficient of assist spring
C_{wh}	identity damping coefficient on wheels
C_{WS}	damping coefficient of worm shaft
d_G	pitch diameter of worm gear

d_W	pitch diameter of worm shaft
D_A	aerodynamic drag force
D_{out}	clutch actuator travel
f_r	rolling resistance coefficient
F	force caused by current and magnetism
F_x	longitudinal forward force on car
g	gravity
i	current in conductor
I_{CP}	inertia moment of clutch disc
I_{DM}	identity inertia moment of final shafts
I_{eng}	inertia moment of engine
I_G	inertia moment of worm gear
I_{IG}	inertia moments of input shaft
I_L	inertia moment of linkage arm at mass center
I_{OG}	inertia moments of output shaft of gear box
I_{RG}	inertia moments of inverse shaft
I_{ss}	inertia moment of stage springs
I_{WS}	inertia of worm shaft
J_m	inertia of motor rotor

K	proportional integer in PID controller
K_c	spring coefficient of virtual spring on worm gear collision
Ke	EMF (electromotive force) constant
K_{ss}	stiffness coefficient of stage springs
K_{SP}	stiffness of assist spring
Kt	torque constant on DC motor
l	length of conductor
I_{wh}	identity inertia moment of the total wheels
La	inductance of armature
m_{BL}	simplified mass of release bearing and clutch lever
m_G	mass of worm gear
M_{car}	car mass
M_{SP}	mass of assist spring and fix plate
N	derivative limit constant in PID control
N_w	thread number of worm shaft
p_x	axial pitch of worm shaft
r_{GG}	distance from mass center to axle on worm gear
Ra	resistance of armature
R_{DM}	final gear ratio

R_G	gear box transmission ratio
R_{hx}	hitch forces
Ri	inner radius of clutch disc
Ro	outter radius of clutch disc
R_r	clutch lever ratio
R_x	rolling resistance forces
s_{ins}	pre-deformation of assist spring
S_{LC}	motion of ball and socket joint in X direction
S_{Lx}	displacement of mass center of the linkage arm in x-direction
S_{Ly}	displacement of mass center of the linkage arm in y-direction
T	torque caused by current and magnetism
T_{cf}	torque able to be transfer from clutch
T_d	derivative integer in PID controller
T_{DM}	torque transmitted to the drive wheels
T_{engR}	engine output torque
T_{GD}	torque from output shaft of gear box to output shaft of differential mechanism
T_{Gf}	torque caused by friction on the axle of worm gear
T_i	integral integer in PID controller

T_{IG}	torque transmitted from clutch
T_{IR}	torque transmitted to inverse shaft in gear box
Tl	extra torque loading on motor
T_{LCf}	friction torque on ball and socket joint
T_{LGf}	torque caused by friction on the joint of worm gear
T_{OR}	reacting torque from output shaft to the inverse shaft in gear box
T_{OG}	torque transmitted to differential mechanism
T_{RG}	torque from inverse shaft to output shaft in gear box
T_{syn}	torque generated by synchronizer
v_a	supplied voltage on armature
W	force exerted from worm gear to worm shaft
W_c	reacting force of clutch
W_{car}	car force
W_{Ga}	axial force on worm gear
W_{Gr}	radial force on worm gear
W_{Gt}	tangential force on worm gear
W_{Gx}	axle force in X direction on worm gear
W_{Gy}	axle force in Y direction on worm gear

W_{LCx}	force on ball and socket joint in x-direction
W_{LCy}	force on ball and socket joint in y-direction
W_{LF}	force of assist spring
W_{LGx}	force from linkage to worm gear on x-direction
W_{LGy}	force from linkage to worm gear on y-direction
W_{Wa}	axial force on worm shaft
W_{Wtf}	tangential friction force on worm shaft
W_{Wr}	radial force on worm shaft
W_{Wt}	tangential force on worm shaft
η_{eng}	transmission efficiency of powertrain
θ_c	overtaking angle of lower or upper limit on worm gear
θ_{DM}	rotation angle of identity shaft
θ_{eng}	engine rotation angle
θ_G	rotation angle of worm gear
θ_{IG}	rotation angle of input shaft
θ_L	rotation angle of linkage arm
θ_m	rotation angle of rotor
θ_{OG}	rotation angle of output shaft of gear box

θ_{RG}	rotation angle of inverse shaft
θ_{ws}	rotation angle of worm shaft
λ	lead angle of worm gear
μ	friction coefficient between worm shaft and worm gear
μ_{clutch}	clutch disc friction coefficient
μ_{Ga}	friction coefficient on axle of worm gear
μ_{Gj}	friction coefficient on joint of worm gear
μ_{LC}	friction coefficient of ball and socket joint
ξ	damping ratio in control function
ρ	air density
ϕ_n	pressure angle of worm shaft