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List of Symbols and Abbreviations

a.c	Alternating current
ρ_j^1	Membership grade for *x* and *y*
$\overline{p_i}$	Firing strength
a_0	Battery terminal voltage when SoC = 0%
a_1	Battery terminal voltage when SoC = 100%.
A_1, A_2, B_1 and B_2	Linguistic variables
ABS	Antilock braking system
ADVISOR	Advanced vehicle simulator
A-ECMS	Adaptive equivalent consumption minimization strategy
AFEMS	An adaptive fuzzy logic-based EMS
a_i, b_i and c_i	Premise parameters
ANFIS	An adaptive network-based fuzzy inference system
ANN	Artificial neural network
ASCI	Auto-Sequential Commutated mode single-phase inverter
BEVs	Battery driven electric vehicle
BLDC	Brushless DC motor
BMEP	Brake mean effective pressure
BMS	Battery management system
BP	Back propagation
BWS	Battery working state
C_1	Capacitor of the branch R_1C_1
C_2	Capacitor of the branch R_2C_2
C_3	Capacitor of the branch R_3C_3
CC	Coulomb counting
CD	Charge depletion
CDFIM	Cascaded-DFIM
CF-qZSI	Current-fed quasi-ZSI
CHIL	Controller hardware-in-Loop
CMPPT	Centralized-MPPT
C_p	Battery capacity in Ah

CS	charge sustaining
CSI	Current source inverter
CS-PMSM	Compound-structure PMSM
CVT	Continuous variable transmission
d.c	Direct current
DDP	Deterministic Dynamic Programming
DEKF	Dual extended Kalman filter
DFIM	Doubly fed induction motor
DP	Dynamic programming
DRM	Double rotor machines
DSO	Digital storage oscilloscope
E_a	Activation energy
ECMS	Equivalent consumption minimization strategy
e-CVT	Electronic continuous variable transmission
EKF	Extended Kalman filter
EM	Electric motor
EMS	Energy management system
ESS	Energy storage system
EV	Electric vehicle
FC	Fuel cell
FC	Fuzzy control
FCEVs	Fuel cell vehicles
FEM	Finite element method
FIS	Fuzzy inference system.
FL	Fuzzy logic
FLC	Fuzzy logic control
FOC	Field oriented control
FPGA	Field-programmable gate array
f_r	Rolling resistance coefficient
g	Acceleration constant
GA	Genetic algorithm
GT	Game theory
HESS	Hybrid energy storage system

HEV	Hybrid electric vehicle
HIL	Hardware-in-Loop
I	Current flowing in the circuit
I&C	Incremental conductance
I_A	Armature current
I_{bat}	Current of battery
ICE	Internal combustion engine
ICV	Internal combustion vehicle
IEMA	Intelligent energy management agent
IM	Induction motors
IMCCR	Induction motor with compound cage rotor
IPMSM	Interior permanent magnet synchronous motor
I_{sc}	Incremental short circuit current
IWO	Invasive weed optimization
J_{rot}	The inertia of rotational components.
K_0	Reaction constant
KF	Kalman filter
KKT	Karush–Kuhn–Tucker
LC	Inductor capacitor
LP	Linear programming
M	Vehicle Mass
MF	Membership function
MFM-BDRM	Magnetic-field-modulated brushless double-rotor machine
mg	Motor generator
MHE	Moving horizon estimation
MPC	Model predictive controller
MPG	Miles per gallon
mpgge	Miles per gallon gasoline equivalent
MPP	Maximum power point
MPPT	Maximum power point trackers
MRAC	Model reference adaptive controller
M-SRM	Modular- Switched reluctance motors
NEDC	New European driving cycle

NN	Neural network
NPC	Neutral point clamped
OCV	Open circuit voltage
ω_e	Speed of engine
ω_{mg1}	Speed of motor-generator set 1
ω_{mg2}	Speed of motor-generator set 1
ω_{req}	Requested speed
P&O	Perturb & Observe
PAM	Pulse amplitude modulation
P_{bat}	Battery power
P_{bat}	Battery power
PGS	Planetary gear set
PHEV	Plug-in HEV
PI	Proportional integral
p_i, q_i, r_i	Consequent parameters
PM	Permanent magnet
PMBLDC	Permanent magnet BLDC
PMP	Pontryagin's minimum principle
PMSM	Permanent magnet synchronous motors
PSO	Particle swarm optimization
PV	Photovoltaic
PV-HEV	Solar driven-HEV
PWM	Pulse width modulation
Q_b	Battery capacity
R	Gas constant
R_0	Internal resistance of battery
R_1	Resistance across C_1
R_1	Resistance across C_2
R3	Resistance across C_3
R_b	The internal resistance of the battery
RC	Resistance capacitator
r_{dyn}	Dynamic radius of the tyre
rpm	Revolutions per minute

SA	Simulated annealing
SBP	Synergetic battery pack
SDP	Stochastic dynamic programing
SoC	State of charge
SoC*	Rate of change of state of charge
SoE	State of energy
SoF	State of function
SoH	State of health
SRM	Switched reluctance motors
STA	Super twisting algorithm
T_1 , T_2 and T	Various time instant of the waveform
TCO	Total costs of ownership
T_d	The torque developed by the motor
T_e	Torque of ICE
T_{em}	Operating temperature
T_{mg}	The torque of the motor-generator
T_{mg1}	The torque of the motor-generator set 1
T_{mg2}	The torque of the motor-generator set 2
T_o T_0^- and T_0^+	Initial condition
T_{req}	Requested torque
TTR	Through-the-road
UC	Ultra-capacitor
UDDS	Urban Dynamometer Driving Schedule
UKF	Unscented Kalman filter
V	Vehicle speed
V_0	Voltage across R_0
V_1	Voltage across R_1
V_{1zero}, V_{2zero} and V_{3zero}	Zero input response of voltages V_1,V_2 and V_3
V_2	Voltage across R_2
V2G	Vehicle to grid
V_3	Voltage across R_3
VF-ZSI	Variable frequency- Impedance source inverter
V_H	High-speed region

V_L	Low-speed region
V_{mot}	Voltage across motor
V_{oc}	Open circuit voltage
V_{oc}	Open circuit voltage
VSI	Voltage source inverter
V_{ter}	Voltage across terminal of battery
x and *y*	Crisp inputs
XEVs	(BEVs, HEVs & PHEVs)
XHEVs	Full HEVs and PHEVs
ZSI	Impedance source inverter
α	Road angle
δ	Mass factor
η_{mg}	The efficiency of the motor-generator set
$\Sigma F_{resistance}$	Total resistive force
ΣF_t	Total tractive force
τ_1	Time constant of the branch R_1C_1
τ_2	Time constant of the branch R_2C_2
τ_3	Time constant of the branch R_3C_3
ω_{mg}	The angular speed of the motor-generator set
V	Vehicle speed in m/s
g	Gear ratio
i_g	The gear ratio of the transmission,
i_{mw}	Gear ratio of traction motor to the driven wheels
i_{rw}	Gear ratio of the ring gear to drive train wheels
n_{e_max}	Maximum allowable RPM of ICE
n_{e_min}	Minimum allowable speed
$n_{m/g}$	Speed of motor-generator set
n_{tm}	EM speed
r_w	wheel radius