Fuzzy Computation of Solar Hybrid Electric Vehicle

Renbo Xu$^{1,2}$, Wanrong Zhang$^2$ and Zongsheng Nie$^2$

$^1$Physics and Microelectronics Institute, Central South University Changsha 410083 China
$^2$School of artificial intelligence, Nanchang Institute of Science and Technology Nanchang, 330108, China

*Corresponding author: 1310079631@qq.com

Abstract. Energy crisis and environment pollution are big problems today’s world faced, if we can combine the solar energy and traditional engine to be mixture type power E-vehicle, this will have important meanings to solve the faced energy crisis and environment pollution. This article briefly design the drive system of the solar energy mixture power E-vehicle, and process the key analyse it’s control strategy, propose one change structure vague control system, reach up to the related requirements.

Keywords: Electric car, Mixture power, Vague control, Drive system

1 Introduction
Since 1990s, century 20th, worldwide petroleum crisis and atmosphere pollution make the save energy and environment protection performance of vehicle more and more importance[1-3]. Especially to the big city with concentrated vehicle and congestion of traffic, frequently start-stop of vehicle caused change working situation of combustion engine (especially at low speed idling) running is the main reason which caused serious end gas discharge and high consumed oil. The high rising environment protection voice and pressure of increasingly short petroleum reserves forced people re-consider the problem of future vehicle. Example the clean, environment protection, save energy and renewable new energy vehicle already been the hot point of world vehicle industry development. Compare to the non-renewable energy resource like petroleum and natural gas, etc, the solar power already been the "Green" renewable energy which inexhaustible supply and be in endless supply[4,5]. This article designed solar power motor and the solar energy mixture power E-vehicle drive system which mixture driven by combustion engine, and analyse it’s control system.

2 The Algorithm of Multiple Tracking Vague Logic Network Control
According to the characteristic equation of system output, utilize the characteristic of solar power photovoltaic battery P-U curve similar to the para-curve, list out several commonly used the max power points tracking strategy, and analyse the principle, merits and faults, proposed out one innovate application of multiple tracking vague logic network control system. The principle of multiple tracking vague logic network control system shown as picture 1, the process of it realize the application is that logic controller firstly process the vague inference and vaguely make decision at the gathered control information through system language control rules, thus get the vague collection of control value, then get out the accurate value of output control through vague judgment, then acted on the controlled objects, finally make the controlled objects reach up to the expected control effect[6,8]
Fig 1. Principle picture of multiple tracking vague logic network control

a(n) in picture 1 means the actual value of difference of output power between time number n and time number n-1, A(n) means the value that a(n) corresponding to vague collection discourse domain, b(n) means the actual value of step length at time number n, B(n) means the value that b(n) corresponding to vague collection discourse domain, D(n) and D(n-1) means the duty ratio at time number n and time number n-1 respectively, Ke is the quantization factor, Ka is the scale factor. This structure start at each advantage search period, firstly calculate the power value P(n) at this time, then make the difference value a(n) between P(n) and last P(n-1) and step length b(n-1) of last time act on the input end of vague controller, change to be variable A(n) and B(n-1) in the vague collection discourse domain after go through quantization and vague handle, check the vague control regulation table and obtain the step length value B(n) of advantage research at this time, get the duty ratio increment b(n) after go through discourse domain inverse transformation, it added the duty ratio of latest time then get the duty ratio of next time, to adjust the output voltage of solar power battery, till next advantage search period start. The above process processing repeatedly till the output voltage adjusted to the max power point voltage of solar power battery.

3 Description of the Complete Vehicle Control System

The power system of solar energy mixture power E-vehicle is one double energy power assembly system, include multiple type parts like solar power battery, storage battery, solar power motor and combustion engine. Each part realize physic connection through the electric power bus line, change structure vague control system is the core of the whole control system[9,10]. The complete vehicle control system shown as picture 2.

Fig 2. The complete vehicle control system structure picture of mixture power E-vehicle

3.1 The Selection of Control Strategy

Because the characteristics of output of solar power battery, self discharge of storage battery and loading(motor) all are variable so difficult to build the accurate mathematical model. Vague control strategy is the real time control strategy which based on the regulations, it is not depend on the system’s accurate mathematical model, greatly
increased the freedom of control with very strong Robustness, very valid in the control of complex system so the control strategy select the vague control strategy.

3.2 Control Idea and form of Change Structure Control System

Generally, the vague control system strategy of vehicle under various working situation only utilize the deviation and deviation change ration of system, and in the complete control process, the discourse domain grade of each variable is fixed, control laws fixed so it not only unable to reduce the steady state deviation of the complete control system to be min limit, and more bad dynamic quality of system, if want to improve the control precision then require the control system able to select the corresponding control strategy according to the different conditions, means the design out the vague control system of change structure, make it able to max limit restrain the shake of system to improve the adjust precision of system and Robustness characteristics. Propose out one change structure vague control system which based on solar energy mixture power E-vehicle because of above ideas. It firstly according to the different measured value during the vehicle running process, make ensure the vehicle current running status, select the control strategy then confirm the running rules under the different running status according to the status parameters of system, use these suit to the process of vehicle running process and requirements of environment, in fact, this type change structure vague control system is one layering multiple rules collection vague control system. The control design idea of change structure control system shown as picture 3.

![Fig 3. Control drawing of change structure control system](image)

3.3 Principle Analyse of Judge Device

The working goal of judge device is according to the input parameters of vehicle: make decision which working mode running should by selected by vehicle. First obtain the driving speed of vehicle Vout through the speed sensor before do judgment, obtain the driver required torque PD(obtained through the driver intention calculating device) through throttle footstep and speed: obtain the max able to output power PMAX under the current status according to current energy storage status of storage battery and the limit power restrain which stipulated by supplier. The process chart of judge device shown as picture 4.

![Fig 4. The process chart of judge device](image)
4 Brief Summary
The solar power is the "Green" renewable energy which inexhaustible supply and be in endless supply, this article designed solar power motor and the solar energy mixture power E-vehicle drive system which mixture driven by combustion engine, and analyse it’s control system, this article designed solar power motor and the solar energy mixture power E-vehicle drive system which mixture driven by combustion engine, proposed out one innovative application of multiple tracking vague logic network control system and process the key analyse at it’s control strategy, utilize the equation which created during the calculating process and design the model parameter solve method, the process of realize the application is that logic controller firstly process the vague inference and vaguely make decision at the gathered control information through system language control rules, finally make the controlled objects reach up to the expected control effect, example the advantages at short charging time, small voltage wave and more higher transform efficiency of solar power.

Acknowledgments
This research was supported by key planning research projects of Hunan department of science and technology (Grant NO.2016GK2015) and reform project of jiangxi provincial department of education(Grant NO.JXJG-17-27-3).Education planning project of jiangxi province (Grant NO.17YB252 ).Scientific research start-up funding(Grant NO. NGRCZX-17-01).

References
[1] Nabil A A, Masafumi M.A novel maximum power point tracking for photovoltaic applications under partially shaded insolation conditions [J]. Electric Power Systems Research, 78(5):777-784. (2014).
[2] Aymen C, Rashad M K, Ken N.A novel multi-model neuro-fuzzy-based MPPT for three phase grid-connected photovoltaic system [J].Solar Energy,84(12):2219-2229.(2012).
[3] Liu F R, Duan S X, Liu B Y, et al. A variable step size INC MPPT method for PV systems [J].IEEE Transactions on Industrial Electronics, 55(7):2622-2628.(2013).
[4] M Dyble, Narendran N, Bierman A. Impact of dimming white LEDs: chromaticity shifts due to different dimming methods. Proc. SPIE, 55(4):1~9 (2013).
[5] YuanLei, Shen Jianqing, Xiao Fei. modeling and nonlinear phenomena simulation of current-mode controlled Buck-Boost converter[J].Journal of Central South University: Native Science Edition,43(3):972—979.(2014).
[6] Altas I H, Sharaf A M. A novel maximum power fuzzy logic controller for photovoltaic solar energy systems [J].Renewable Energy, 33(3):388-399. (2013).
[7] Hiren P, Vivek A. Maximum power point tracking scheme for PV systems operating under partially shaded conditions [J]. IEEE Transactions on Industrial Electronics, 55(4):1689-1698. (2015).
[8] Ersoy B, Birol A, Sabri C, et al. A grid-connected photovoltaic power conversion system with single-phase multilevel inverter [J].Solar Energy, 84(12):2056-2067.(2015).
[9] Cai Jihe, Sun Yuken, Huang Yonghong. Study on simulation model of PV module based on PSIM[J]. Modern Scientific Instruments, 12(6):65-69. (2015).
[10] H.-J. Chiu, Y.-K. Lo, J.-T. Chen. A high-Efficiency Dimmable LED Driver for Low-Power LightingApplications. IEEE Transactions on Industrial Electronics, 57(2): 735~743. (2015).