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"Intelligent Control of Nonlinear Hysteretic Electric Throttle Using Brushless DC Motor"

by

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Venue: L105

ABSTRACT

The nonlinear hysteretic system (NHS) is very common in our physical systems, such as magnetized iron or the thermostat have this undesirable and yet inevitable property. The hysteresis is often used specifically to represent rate-independent state, as shown in Figure 1. A new intelligent control methodology, which is based on the fuzzy logic approach, will be proposed in this talk. In fact we will concentrate on the intelligent control of the nonlinear hysteretic electric throttle (ET) adopted in modern automobiles. **This control task is very important because it concerns lots of real human lives who are driving automobiles every day.** An electric throttle is a brushless-dc-motor-driven valve that regulates air inflow into the combustion system of the engine. The closed-loop throttle control system, as shown in Figure 2, should ensure fast and accurate reference tracking of the valve plate angle while preventing excessive wear of the throttle components by constraining physical variables to their normal-operation domains. These high quality control demands are hard to accomplish since the plant is burdened with strong nonlinear effects of friction, spring and limp-home nonlinearity. In this talk, the ET is treated as a Nonlinear Hysteresis System (NHS) with rate dependency and its property is shown in Figure 1. The NHS shown in Figure 1 is input/output bounded, i.e., $x_1 \le x(t) \le x_2$ and $y_1 \le y(t) \le y_2$. In Figure 1, when the input force $x(t)$ increases, i.e., $\Delta x(t)>0$, the ET will operate from close to open, which is $a \to b \to c$ in Figure 1. When $x(t)$ decreases, i.e., $\Delta x(t)<0$, the ET will operate from open to close, which is $c \to d \to a$ in Figure 1. Not only the theoretical aspects will be discussed, but also the real hardware implementation of our new methodology using advanced microcontrollers will be shown in this talk. For conclusion, we can say that the intelligent controller synthesis is performed in real time by solving an intelligent control problem of the electric throttle. The following Figure 3 shows the real-time implementation results.

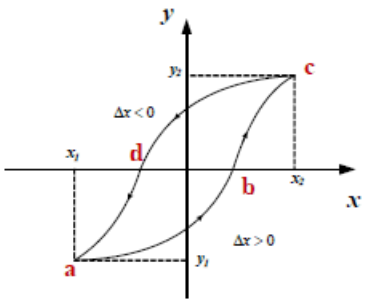


Figure 1. The Nonlinear Hysteresis System

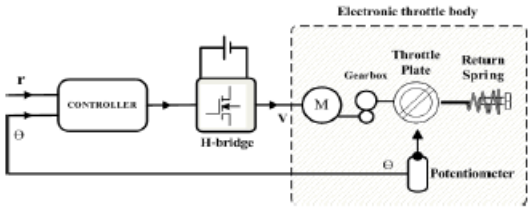
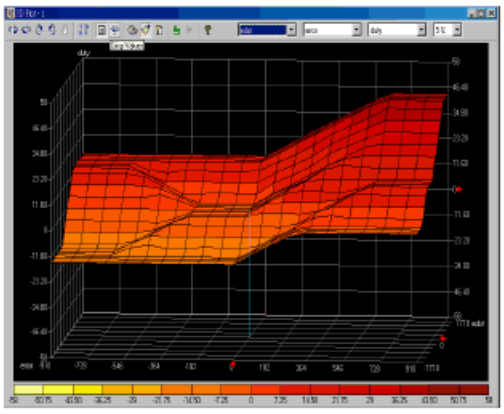


Figure 2. The closed-loop control of ET



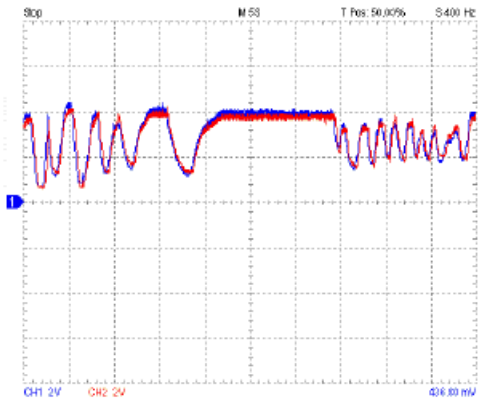


Figure 3. The 3D plot of Fuzzy Logic Controller with tracking performance

REFERENCE

Prof. *Chi-Hsu Wang* got his PhD. of Electrical and Computer Engineering at University of Wisconsin-Madison, U.S.A.in 1986. Currently, he is

an Distinguished Professor at Department of Electrical and Control Engineering of National Chiao-Tung University in Taiwan.

International Research Reputation:

1. IEEE Fellow.
2. Outstanding Contribution Award, 2006, IEEE Systems, Man, and Cybernetics Society.
3. Board of Governors (BOG), 2005 ~ 2007, IEEE Systems, Man, and Cybernetics Society.
4. Associate Editor, IEEE Transactions on Systems, Man, and Cybernetics, Part B, 2003 ~ present.
5. Webmaster, IEEE Systems, Man, and Cybernetics Society.
6. Program Co-Chair, 2006 IEEE International Conference on Network, Sensing and Control.
7. PC Member, 1998 ~ 2005 IEEE International Conference on Systems, Man & Cybernetics**.**
8. Tutorial Chair, 2006 IEEE International Conference on Systems, Man, & Cybernetics, Grand Hotel, Taipei, Taiwan.

ALL ARE WELCOME!