Control system serpent: Scientists propose new model for automation

October 20 2016

In 360 BC, Plato wrote, "Whatever comes into existence always comes as a whole." In 2016, scientists are using the same philosophy to develop a new automation model for robotic systems.

"No phenomenon exists entirely alone. Each is a part of other phenomena," wrote Hua Chen, an associate professor at Hohai University, Chanzhou Campus, with YangQuan Chen, a professor at the School of Engineering, University of California, Merced.

In a paper published in *IEEE/CAA Journal of Automatica Sinica* (*JAS*), Chen and Chen proposed a new model for designing control systems used in automation. Traditionally, a control system consists of a machine directing or responding to another machine's behavior. Each piece is precisely defined as a cause and effect. The proposed model disregards such definitions.

The authors write of the ouroboros, an ancient symbol of a snake eating its own tail, as a representative example of their method. It's impossible to decipher how the snake came to bite itself, nor to clearly define where the head ends and the tail begins. The circle supports itself as a whole system.

"Different from the traditional control standpoint, the principle of the self-support idea treats the control inputs as an essential part of the control system dynamics itself," Hua Chen said. "In other words, in a closed-loop setting, control input signals and [the] system's behaviors are

interlaced, serving mutually a cause-and-effect pair—thus, a 'one-snake' picture."

By thinking of the whole instead of separate parts, it's possible to create a better system capable of goals with variable parameters, such as an autonomous vehicle tracking an unknown target. "Our suggested [generalized fractional-order principle of self-support] control strategy is an important method when considering the system with long-term memory, [as] our methods can be less model dependent or even model-free, yet with desirable robustness characteristics," said Hua Chen.

The mathematics supporting the proposed method rely on the inclusive attributes of fractional order calculus, in which a single equation may be used to describe several potential outcomes over a significant length of time. The results of such mathematics then inform the next step, so any miscalculations can be corrected on the fly within the system.

"Just as [with the snake circle]," Hua Chen said, "if we consider the control input as [part of] its inner dynamics—[meaning] the controller is not the reason of moving—it also can be looked [at] as the results of the tracking error feedback."

More information: Fractional-order Generalized Principle of Self-support (FOGPSS) in Control System Design: ieeexplore.ieee.org/stamp/stam … tp=&arnumber=7589490

Provided by Chinese Association of Automation