Scientists simplify model for human behavior in automation

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Human unpredictability is a problem in the automated human-machine systems people use every day. Scientists from Nanjing Institute of Technology's School of Automation in China and the University of California, Merced's School of Engineering partnered to find a programming solution for erratic human behavior.

"In a human-machine control system, the human operator participates in the control process," said Jiacai Huang, a professor at the Nanjing Institute of Technology's School of Automation and the study's lead author. Human operator behavior includes not only skilled control tasks, but also instinctive and emotional reactions. "[An] accurate mathematical model of human operator behavior provides criteria to the controller design and systems analysis."

The scientists published the theory and experimental evidence for a new human behavior prediction method in the IEEE/CAA *Journal of Automatica Sinica*.

Control systems, such as a car's cruise control feature, are based on specific parameters with limited variables. On a hill, the cruise control will automatically accelerate to maintain speed against gravity. For most other variables, such as another car slowing unexpectedly, the system depends on the driver to apply the brakes.

The system doesn't make decisions; it simply reacts to the input. Yet the inability to perfectly predict human operator behavior hinders advanced

system design. Researchers have analyzed how best to describe human behavior in machine systems since the mid-1940s. Currently, scientists use several equations to account for every potential outcome.

The researchers' proposed model is based on fractional order calculus, in which multiple outcomes can be considered within the same equation.

"[Our] model for human operator behavior has many advantages, such as simple structure with few parameters, [all] with clear physical meaning," said Huang. "More importantly, the proposed new model gives a unified, formalized description for the human operator behavior."

The human operator is modeled as a part of the system rather than an addition to the system, as traditional modeling does. To experimentally test this idea, the scientists created a closed-loop system in which a person followed a target on the screen with a steering wheel. Compared to traditional mathematical models, the proposed method was a better fit for how the human operator actually behaved. "The human operator is a complex system, and many aspects of the human brain and behavior have the characteristics of a fractional order system," Huang said.

The researchers plan to study how their human operator model could improve advanced systems, such as autopilot in planes or for robotic use in surgeries.

More information: Fractional order modeling of human operator behavior with second order controlled plant and experiment research, DOI: 10.1109/JAS.2016.7508802 , ieeexplore.ieee.org/document/7508802/

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