Scientists create a neural network for adaptive shock absorbers

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Scientists at South Ural State University have proposed an effective low-level controller based on an artificial neural network with a time delay for an adaptive shock absorber. Yuri Rozhdestvensky, DSc, and his

research team described the use of an active shock absorber control algorithm based on an artificial neural network. Their article, titled "Active Shock Absorber Control Based on Time-Delay Neural Network," is published in a special issue of *Energies* dedicated to intelligent transport systems.

Increasingly, motorists are choosing an adjustable suspension that adapts to any type of road surface. The SUSU scientists sought to improve the quality of the adaptive shock absorbers in an adjustable car suspension using an artificial neural network.

Such adaptive shock absorbers can significantly increase smoothness, comfort, handling, stability and contribute to improved traffic safety. Adaptive shock absorbers have an energy source, which makes it possible to completely eliminate unwanted vertical movements when the vehicle is moving.

"An active shock absorber is a complex technical system with substantially nonlinear performance characteristics that have the property of hysteresis, a 'late response,' to changing conditions. The difficulty in controlling active shock absorbers lies in the fact that the same required values of forces can be achieved by actuators of various nature. So the shock absorber considered in the article has electromagnetic valves and a hydraulic pump, characterized by long response time. But with hydraulic pump control errors, the resulting system error can be significantly lower than with solenoid valves," says Yuri Rozhdestvensky.

The current designs of adaptive shock absorber control systems use simplified control algorithms based on idealized mathematical models.

The scientists have proposed an active shock absorber control algorithm based on an artificial neural network. Neural networks can accurately

approximate any continuous function of many variables depending on the choice of the network structure and its training, which allows them to be used in a wide variety of fields, including control systems.

"The training of the neural network was carried out using a large amount of experimental data, covering various modes of shock absorber operation. The structure of the neural network with time delay was chosen, which allowed it to remember the sequence of input signals, and thus take into account the hysteresis property. In the proposed algorithm, the neural network is combined with proportional-integral-differential regulators, which are tuned by modern evolutionary algorithms. The results of the algorithm when performing typical and extreme operating modes of the shock absorber, as well as part of an integrated adaptive suspension control system, show the high efficiency of the proposed solution," says engineer Alexander Alyukov, a member of the research team.

Active shock absorbers have high energy consumption, so the researchers believe that their use in the suspension of electric and hybrid cars seems to be the most promising. Currently, the scientists continue to study adaptive vehicle suspensions in cooperation with colleagues from leading world research laboratories and universities in the U.S., Germany, and Spain.

More information: Alexander Alyukov et al. Active Shock Absorber Control Based on Time-Delay Neural Network, *Energies* (2020). DOI: 10.3390/en13051091

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