Liquid slosh suppression by implementing data-driven fractional order PID controller based on marine predators algorithm

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ABSTRACT
Traditionally, the control system development of liquid slosh problems usually employed a model-based approach which is difficult to utilize practically since the fluid motion in the container is very chaotic and hard to model perfectly. Thus, this research paper proposed the development of a data-driven fractional-order PID controller based on marine predators algorithm (MPA) for liquid slosh suppression system. The MPA is used as a data-driven tuning tool in finding the optimal FOPID controller parameters based on fitness function which consists of total norm of tracking error, total norm of slosh angle as well as total norm of control input. The motor-driven liquid container performing a horizontal movement is used as a mathematical modeling to justify the suggested data-driven control approach. The effectiveness of the FOPID controller tuning method based on MPA was assessed by evaluating the performance criteria in terms of convergence curve of the average fitness function, statistical results, and Wilcoxon's rank test. We have shown that the proposed datadriven tuning tool has a good ability in producing better results for the majority of the performance criteria as compared to other recent metaheuristic optimization algorithms.

KEYWORDS
Marine predators algorithm; Liquid slosh control; Metaheuristic optimization; Fractional order PID; Data-driven control