# Modified Multi-Verse Optimizer for Nonlinear System Identification of a Double Pendulum Overhead Crane

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**ABSTRACT**
This paper presents the identification of double pendulum overhead crane (DPOC) plant based on the hybrid Multi-Verse Optimizer with Sine Cosine Algorithm (HMVOSCA) using the continuous-time Hammerstein model. In the HMVOSCA algorithm, the new position updating mechanism of the traditional MVO method is modified based on the sine function and cosine function which is taken from the Sine Cosine Algorithm (SCA). Moreover, an average position is chosen by computing the mean between the current position and the current best position obtained so far. These modifications are mainly for balancing exploration and exploitation and escaping from local optima and expected better identification accuracy of the DPOC plant. In the Hammerstein model identification, a continuous-time linear subsystem is used, which is more suitable for representing any real plant. The HMVOSCA algorithm is used to tune the linear and nonlinear parameters to reduce the gap between the estimated results and the actual results. The efficiency of the proposed HMVOSCA algorithm is evaluated using the convergence curve, parameter estimation error, bode plot, function plot, and Wilcoxon's test method. The experimental findings illustrate that the HMVOSCA algorithm can identify a Hammerstein model that generates an estimated output like the actual DPOC system output. Moreover, the identified results also show that the HMVOSCA algorithm outperforms other existing metaheuristics algorithms.

**KEYWORDS**
Hammerstein system; Double pendulum overhead crane; Multi-verse optimizer; Sine cosine algorithm; System identification; Metaheuristics

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