Abstract

The vibration problems are accomplished in many application areas, such as in automobiles, aircrafts, helicopters, machines...etc., vibration may cause systems failure or reduce their performance. The passive (conventional) dampers are used for vibration reduction, designed for specific conditions, and thus cannot provide a good vibration reduction at different operation conditions. Therefore, the tuned (variable) dampers are effective way to provide optimal vibration reduction at different conditions.

Semi-active tuned damper was manufactured based on variable piston area (through closing and opening orifices of damper piston) and implemented in the test rig. The experimental work was carried out on a single degree of freedom rig system, which mainly composes of beam, harmonic excitation source (exciter), passive spring and tuned damper. The rig was provided by electronics system to acquire the sensors signal and to drive the damper according to control algorithm.

Due to the complex model of the manufactured damper, the neural network system identification (NNSI) was utilized to identify overall system components as one model based on the input - output data that collected from the experiment. The suitable architecture of the neural network that obtained by training was a one hidden layer of eight neurons with log-sigmoid activation function and one output layer of linear function. In addition, the mathematical model of the system was derived and used with experimental damping ratio at different damper disc angles (0-60°) to verify the experimental results.

The implemented controller is a model predictive controller (MPC), which was designed based on NNSI in MATLAB Toolbox to control the system vibration, and the MPC explicitly handled the measurable disturbance (excitation frequency) into account in the predictive model.

The results showed that the model predictive controller with a semi-active tuned damper is effectively reduced the root mean square (RMS) of the acceleration from 22 m/s^2 to 0.4 m/s^2 at resonance frequency, in which the maximum time of vibration reduction from higher RMS to minimum level is 1.39 second. The results depicted a good agreement between the mathematical model and experimental work, in which the RMS of experimental and theoretical is relatively converge, and the total range of percentage error between the experimental and theoretical RMS of acceleration at resonance is (4.9-10) %, which is acceptable.