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FUZZY-PID BASED CONTROLER FOR ACTIVE VIBRATION CONTROL OF NONLINEAR DYNAMIC SYSTEMS

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The light weight characteristic offered by flexible structures can be easily influenced to the excessive vibration and it also brings several problems including instability, fatigue, bending and low performance. Therefore, it is compulsory to suppress the undesired vibration of flexible structures due to sustain its performance. This paper presents the development of hybrid controller known as fuzzy-PID based controller for vibration suppression of the horizontal flexible plate structure. Initially, the experimental rig was designed and integrated with the instrumentation system for vibration data collection purpose. The vibration data obtained experimentally was used to model the dynamic system based on auto-regressive with exogenous input structure using evolutionary swarm algorithm. The model obtained in simulation environment was then used for the development of PID-Fuzzy based controller. The performance of proposed controller was validated by exerting two types of disturbances to the system for robustness verification. It was indicated that PID-fuzzy controller was achieved higher attenuation value at the first mode of vibration by achieving 32.14 dB attenuation in the system. The attenuation value has been reduced from 103.5 dB to 71.36 dB, equivalent to 31.05 % attenuation, after the introduction of vibration control. The mean squared error achieved by the controller is 0.0237, compared with 0.6655 before the activation of controller.

1. Introduction

Recently, it becomes a growing trend among the industries to reduce the weight of mechanical structures for minimizing the production cost and increasing the system effectiveness. Meanwhile, the characteristics offered by the flexible plate structure such as lightweight, faster response, less power consumption and less bulky design have received significant considerations by the industries to apply its advantages into their engineering applications. The flexible plate has been used in numerous industry applications such as aircraft body, automotive structure, robotic arm, electronic board design, bridge decks, and conveyor system [1].

Nevertheless, the vibration of the flexible plate structure is a critical problem faced by the industries, particularly in the airport baggage transport conveyor, micro hand surgery system and semiconductor manufacturing industry which have a light weight characteristic and relatively low damping for the fundamental and initial models. This drawback is often a limiting factor in the structure performance that can lead to the instability, fatigue and structural damages. Moreover, the frequency associated with this structure is commonly low which makes the nodes vibration control become an important issue for the light flexible structures [2, 3].

