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Deterministic Chaos Machine: Experimental vs Numerical Investigations

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Deterministic chaos machine consisting of the triple pendulum as well as of driving and measurement subsystems is presented and studied (see [1], [2], [3]). The triple physical pendulum is designed as a system of two symmetrically joint pendulums to eliminate stress caused by torques and/or forces out of the pendulum's plane dynamics. It possesses a module-like structure and a stand being symmetrical steel welded construction. The pendulum-driving subsystem consists of two engines of slow alternating currents and optoelectronic commutation. The engine stator has been designed in such a way that the current intensity in the windings is linearly dependent on the engine torque owing to the removal of the ferromagnetic cores. The LabView software environment is applied. Namely, blocks are linked by lines of various colors and patterns in the environment and represent some predefined application procedures (reading and writing to channel inputs and outputs, numerical analysis, etc.) A series of measured data is stored in the text files and shown in various wave form graphs. In addition, a mathematical model of the experimental rig is derived as a system of three second order strongly nonlinear ODEs. Mathematical modeling includes details, taking into account some characteristic features (for example, real characteristics of joints built by the use of roller bearings) as well as some imperfections (asymmetry of the forcing) of the real system. Parameters of the model are obtained by a combination of the estimation from experimental data and direct measurements of the system's geometric and physical parameters. A few versions of the model of resistance in the joints are tested in the identification process. Good agreement between both numerical simulation results and experimental measurements have been obtained and presented. Some novel features of our real system chaotic dynamics have been reported.

References

[1] Awrejcewicz J., Kudra G., Wasilewski G., Experimental and numerical investigation of chaotic regions in the triple physical pendulum, Special Issue of Nonlinear Dynamics, 50(4), 755-766, 2007.
[2] Awrejcewicz J., Supeł B., Lamarque C.-H., Kudra G., Wasilewski G., Olejnik P., Numerical and experimental study of regular and chaotic motion of triple physical pendulum, International Journal of Bifurcation and Chaos, 18(10), 2883-2915, 2008.
[3] Awrejcewicz J., Kudra G., Wasilewski G., Chaotic zones in triple pendulum dynamics observed experimentally and numerically, Applied Mechanics and Materials, 9, 1-17, 2008.