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Construction and 3D model of stand for investigating a non-ideal forcing in a nonlinear chain dynamics of self-excited oscillators with friction

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Abstract: The research involves application and research on a non-ideal forcing to modelling and identification of vibrating systems with friction. It is still an innovative approach in the numerical analysis of vibrations of mechatronic machines and devices. This will allow to make a much real numerical modelling and more efficient identification of nonlinear dynamic phenomena observed in vibrating systems with friction, and thus, a better modelling of such phenomena in computer programs. To obtain the goal, initial 3D model of the mechanical stand was made in the CAD software. Based on the 3D model, real stand will be built, and experiments will be held to obtain data that will be necessary to ensure correctness of the mathematical model, which also will be studied and developed.

Keywords: friction, dynamics, oscillators, non-ideal power source, CAD software

1. Introduction

In order to obtain experimental data, that would be compared to a results from a mathematical model, real stand needs to be built. Main idea was to make it as much modular and universal as it is possible. Such a conception will allow to make even dozens of different experiments using only one machine, by doing only few changes in the construction. Because of using two different linear actuators, comparison of how they can affect the stick-slip motion of the investigating bodies will be able to observe. It was discovered that when the rotor speed of the motor was close to resonance, an increment of the input power produced only a very slight increase of the rotor speed, while the oscillation amplitude increased considerably. It is one of the aspects of investigating the non-ideal forcing and it is also known as Sommerfeld effect [1], that may be observed during the experiments with proper parameters. Also, stage of complicity of the mathematical model of the system including non-deal energy source coupled with additional element, sometimes can give much different results [2], so different ways of approach will be investigated to give as much similar results as it is possible in comparison to obtained experimental data.

2. Results and Discussion

Prepared 3D model of the stand consists of few key components. First one is a base (1), to which aluminium strut profiles will be used. They give a lot of possibilities to make the stand universal and modular, because of additional elements that give a chance to connect them mount additional components in various ways and. Next components are linear actuators. One of them is lead screw (2) and the second is belt driven (3), but they could be easily changed into another one if necessary for some additional experiments. On top of the carriage of the actuators are placed handles for treadmills (4),

on which investigated bodies (5) are placed. They have one degree of freedom because of the guide roller (6). More than one body can be placed on each treadmill to make a chain of oscillators, between which springs (7) can be placed. First step will be to investigate the behaviour of the system with DC motors with low vibrations they generate and can transfer to the construction, but also investigation with stepper motors (8) will be able to do to check if the vibrations affect the friction coefficient between bodies and the treadmills. To make measurements, high speed camera will be used with proper postprocessing.

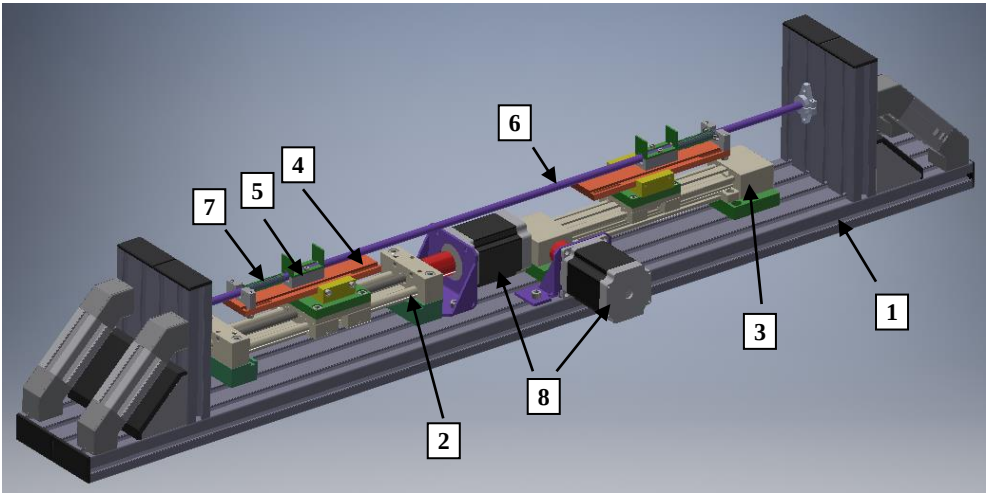

Fig. 1. 3D CAD model of the stand.

3. Concluding Remarks

3D model of the stand was made. Current construction will provide possibility of carrying out various experiments concerning non-deal forcing and chain dynamics of self-excited oscillators with friction. Different degrees of freedom system, caused by number of investigated bodies, will be able to create with various stiffness of the springs, such as many materials of the bodies and treadmills. Creating 3D model is an iterative task, therefore still some improvements are applying.

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References

[1] GONZÁLEZ-CARBAJAL, JAVIER; DOMÍNGUEZ, JAIME. NON-LINEAR VIBRATING SYSTEMS EXCITED BY A NONIDEAL ENERGY SOURCE WITH A LARGE SLOPE CHARACTERISTIC. MECHANICAL SYSTEMS AND SIGNAL PROCESSING, 2017, 96: 366-384.

[2] SGHAIER, EMNA, ET AL. COUPLED BENDING TORSIONAL VIBRATIONS OF NON-IDEAL ENERGY SOURCE ROTORS UNDER NON-STATIONARY OPERATING CONDITIONS. INTERNATIONAL JOURNAL OF MECHANICAL SCIENCES, 2019, 163: 105155.