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All published papers received a positive opinion of the members of the Scientific Committees.

Prospective insight

The jubilee of the conference, similarly as the jubilee of every important event in our lives, invites us to reflect on the past and the future.

It was April 1960 when prof. Edmund Karaśkiewicz as a chairman of the Poznan Department of the Polish Society of Theoretical and Applied Mechanics (PTMTS) organized and headed the first two-day symposium on linear and nonlinear vibrations. It took place in Poznan. The symposium became an event organized every two years. The chairmen of the conference changed, but all of them set themselves the goal of caring for high scientific level of the symposium. It resulted in obtaining by the conference a high reputation in the Polish scientific world.

More than 60 years have passed. At that time, we observed the rapid development of technology, which fundamentally affected the world, the life of societies and every single person. The development of new technologies was possible thanks to science. On the other hand, we see how much we can support the development of science through the use of modern technical solutions. Faced with the task of organizing the 30th edition of the VIBSYS conference, we asked ourselves a number of questions. First of all, which research topics are currently the most relevant and important from the scientific and application point of view. The second issue was to define an attractive way to exchange knowledge, popularize science and encourage young scientists to conduct research.

We decided to answer the first of these questions together with the conference participants who represent various modern trends in the broadly understood subject of vibrations in physical systems. The current and subsequent editions of VIBSYS will allow us to decide which of the topics are particularly worth considering during the conference. In terms of organization, we plan to maintain new ideas that turned out to be right during the conference in 2020. These include a hybrid form of participation both stationary face-to-face on the spot and remote via an online platform, a competition for young scientists on the best presentation of the research results, popularization of history and art through trips to interesting places in the Greater Poland region and the emission of short films encouraging to see, e.g., the exhibition of the National Museum in Poznan during breaks in the sessions.

The special moment during the 30 edition of VIBSYS will be a session dedicated to the memory of prof. Czesław Cempel. Prof. Cempel worked in the Institute of Applied Mechanics and organized the VIBSYS conference many times. He was a chairman and honorary member of the scientific committee. Employees of our Institute, co-authors and friends will present the profile of the professor and his scientific achievements.

At the end of this introduction, we wish the participants fruitful discussions and many pleasant moments during the VIBSYS conference at the Poznan University of Technology.

Chairs of the Conference

Table of Contents

IDENTIFICATION OF SELECTED ELECTROMECHANICAL SYSTEMS USING ACQUIRED TIME-SERIES DATA

Samuel AYANKOSO[1], Paweł OLEJNIK[1] , Jan AWREJCEWICZ[1]

[1] *Department of Automation, Biomechanics and Mechatronics, Faculty of Mechanical Engineering, Lodz University of Technology, 1/15 Stefanowski Str., 90-537, Lodz, Poland*
e-mail: samuel.ayankoso@dokt.p.lodz.pl, pawel.olejnik@p.lodz.pl, jan.awrejcewicz@p.lodz.pl

ABSTRACT

The mathematical model of simple electromechanical systems can be derived from fundamental physical laws relating to energy and momentum. But this modelling method is subject to high bias, and it is difficult to apply when dealing with complex electromechanical systems [1]. Over the last few years, there has been an increased interest in an alternative method of modelling, which is called data-driven modelling. In this method, a machine learning tool is used to learn the dynamic behaviour of a system directly from measured data. Beside the use of time-series data, this new modelling paradigm also relies on a model structure, and a training/learning algorithm. Some common machine learning tools for data-driven modelling or identification include neural networks, sparse identification of nonlinear dynamics, and symbolic regression.

Neural networks (NNs) such as multilayer perceptron (MLP) and recurrent neural networks have been used for diverse engineering applications; their success can be linked to advancements in sensors, computational platforms, and network architectures [2]. Nevertheless, NNs have a few challenges, which include model variance with new datasets, large and quality data required, and its structure lacks physical meaning. These problems can be handled by a physics-informed neural network (PINN) [3]. The basic concept of PINN is the use of physical laws described by ordinary or partial differential equations while training a neural network to solve supervised learning problems [4]. Essentially, a PINN gives the flexibility of estimating the unknown states or variables of a system like its frictional behaviour, and it can also be used in identifying the parameters of a mathematical model.

In this abstract, we present the identification of two electromechanical systems, a geared DC motor and a double torsion pendulum system using the PINN modelling approach.

In the identification of a geared DC motor, time-series data of the system voltage input and the angular speed output were obtained experimentally. Then, a PINN model consisting of two MLP networks was proposed to predict the motor angular speed and armature current. The model loss function was formulated with the mean squared error of the model prediction and the physics-based residuals of the system. The PINN model was trained, and the network weights and biases, including the physical parameters, were updated in the process. The identified physical parameters are shown in Table 1 and the prediction results of the model are shown in Fig. 1. The results indicate the proposed PINN model can be used to accurately predict the angular speed and armature current of a geared DC motor, while also identifying the associated physical parameters of the system.

Similarly, we acquired the column and disk pendulums' time-series angular rotation data from a double torsion pendulum system. The data was used with another PINN model to predict the angular rotation of the disk pendulum and the friction between the contact surface of the pendulums. Newton's second law of rotation and the model prediction error were employed in formulating the loss of the model, and we also used the known value of each pendulum moment of inertia in the algorithm. After training the model, the predicted angular rotation of the column pendulum and the estimated planar friction are shown in Fig. 2. The overall results demonstrate the input-output relation and the frictional behaviour of an electromechanical system can be estimated using experimental time-series data from the system and a robust neural network such as PINN.

Table 1: The estimated physical parameters of a geared DC Motor

Geared DC Motor Physics Parameters							
J_{rs}	J_{os}	B_{rs}	B_{os}	K_m	L	R	K_b
0.001	0.0379	1.2539	0.3532	0.6585	0.001	1.3798	0.3938

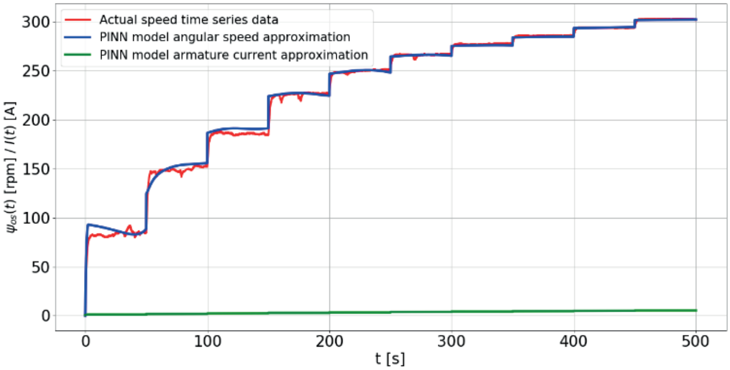

Fig. 1: The angular speed and armature current predictions of the geared DC motor PINN model after step-like increment of reference value

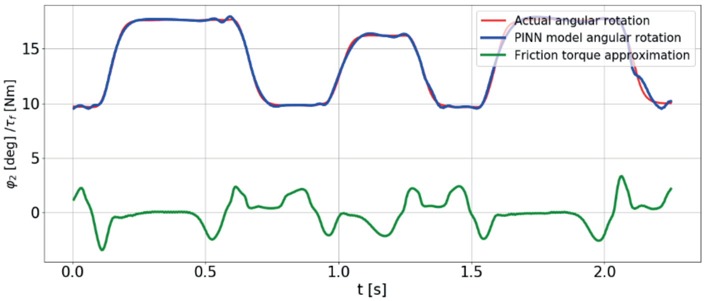

Fig. 2: The disk angular rotation and friction torque predictions of the double torsion pendulum PINN model

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