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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

Mohamed ABOHAMER, Jan AWREJCEWICZ, Tarek AMER	10
<i>ENERGY HARVESTING USING A PIEZOELECTRIC TRANSDUCER ON EXTERNALLY FORCED BUT DAMPED OSCILLATOR</i>	
Krzysztof AUGUSTYNEK, Andrzej URBAŚ, Jacek STADNICKI	12
<i>STUDY OF THE CLEARANCE EFFECT IN REVOLUTE AND PRISMATIC JOINTS ON THE DYNAMICS OF A SPATIAL MECHANISM WITH FLEXIBLE LINK</i>	
Samuel AYANKOSO, Pawel OLEJNIK, Jan AWREJCEWICZ	14
<i>IDENTIFICATION OF SELECTED ELECTROMECHANICAL SYSTEMS USING ACQUIRED TIME-SERIES DATA</i>	
Marek BARSKI, Adam STAWIARSKI, Małgorzata CHWAŁ, Marcin AUGUSTYN	16
<i>NUMERICAL SIMULATION OF FUNDAMENTAL ELASTIC WAVE MODES COUPLING IN COMPOSITE PLATES</i>	
Wojciech BATKO	18
<i>IDENTIFICATION OF ACOUSTIC PHENOMENA IN A NON-EUCLIDES METRIC SPACE</i>	
Hugo BÉCU, Claude-Henri LAMARQUE, Alireza TURE SAVADKOOHI	20
<i>TRANSLATION OF A CABLE WITH A SUSPENDED MASS: EFFECTS ON THE VIBRATION MODES</i>	
Piotr CZUBAK, Weronika ŻMUDA	22
<i>STUDY OF TRANSPORT POSSIBILITIES IN THE RESONANCE ZONE OF THE NEW VIBRATORY CONVEYOR EQUIPPED WITH THE SINGLE ELECTROVIBRATOR</i>	
Slawomir DUDA, Grzegorz GEMBALCZYK, Zygmunt KOWALIK, Pawel LIPSKI, Oskar KOZERA	24
<i>SUSPENSION SYSTEM WITH VARIABLE STIFFNESS FOR MOBILE ROBOTS</i>	
Jan FREUNDLICH, Radosław NOWAK	25
<i>VIBRATIONS OF A 3D-PRINTED FRACTIONAL CANTILEVER BEAM WITH A DOUBLE-QUICK-MOUNTS PIEZOELECTRIC TRANSDUCER</i>	
Pawel FRITZKOWSKI	27
<i>ANALYSIS OF VIBRO-IMPACT DYNAMICS BASED ON THE METHOD OF MULTIPLE SCALES</i>	
Michał HAĆ	29
<i>INFLUENCE OF MACHINING AND DESIGN PARAMETERS OF SHAFTS ON COOPERATION OF TOOTHED GEAR</i>	
Grzegorz ILEWICZ	30
<i>DYNAMICS OF RCM MECHANISM OF SURGICAL ROBOT FOR PERIODIC MOVEMENTS WITH CONSIDERATION OF BLDC ACTUATORS, FUZZY PID CONTROL AND GMS FRICTION MODEL</i>	
Grzegorz ILEWICZ	31
<i>DETERMINATION OF OPTIMAL SOLUTIONS FOR BALANCED RCM MECHANISM OF SURGICAL ROBOT DURING NATURAL VIBRATION, LINEAR BUCKLING AND SPHERICAL MOVEMENT TAKING INTO ACCOUNT INPUTS FROM IN VITRO EXPERIMENTS ON CARDIOVASCULAR TISSUE</i>	



Mateusz JAKUBOWSKI, Maciej MAJCHRZAK, Roman STAROSTA, Pawel FRITZKOWSKI	32
<i>FSI SIMULATION OF FLOATING WIND TURBINE BASED ON SPH METHOD</i>	
Anna JASKOT, Bogdan POSIADAŁA	34
<i>MODEL OF THE DYNAMICS OF MOTION OF A FOUR-WHEELED MOBILE PLATFORM WITH THE DYNAMIC INTERACTIONS OF DRIVE WHEEL SYSTEMS</i>	
Jarosław JEDRYSIAK	35
<i>VIBRATIONS OF AXIALLY FUNCTIONALLY GRADED BEAMS WITH AXIAL FORCE</i>	
Iryna KACHURA-ZHECHYTSKA, Błażej GABRYSZEWSKI, Martyna SOPA, Tomasz WALCZAK	37
<i>BIOMECHANICAL ANALYSIS OF THE JUMP SHOT IN BASKETBALL</i>	
Magda KAŻMIERCZAK-SOBIŃSKA	38
<i>THE LOWER FREE VIBRATIONS FREQUENCIES OF THIN PLATES WITH FUNCTIONALLY GRADED STRUCTURE</i>	
Lukasz KLODA, Stefano LENCI, Jerzy WARMINSKI, Zofia SZMIT	40
<i>NONLINEAR MODE COUPLING AND INTERNAL RESONANCES IN A PLANAR BEAM-SPRING SYSTEM</i>	
Krzysztof KOSAŁA	42
<i>COMPARATIVE ANALYSIS OF THE ACOUSTIC PROPERTIES OF GRANULAR MATERIALS</i>	
Tomasz KRAKOWSKI, Bartosz ZIEGLER, Witold STANKIEWICZ	43
<i>ANALYSIS OF DYNAMIC CHARACTERISTICS OF THE TURBINE SHAFT VIBRATION IN OXIDIZER TURBO-PUMP DEMONSTRATOR</i>	
Pavlo KROT, Hamid SHIRI, Radosław ZIMROZ	45
<i>USING THE NATURAL MODES OF TRANSIENT VIBRATIONS IN PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINES</i>	
Ewelina KUBACKA, Kamil WAWRZYŃIAK	47
<i>OPTIMIZATION ANALYSIS OF BAR STRUCTURE INCLUDING NATURAL FREQUENCY</i>	
Wojciech ŁAPKA	48
<i>ACOUSTICALLY IMPROVED POLISH PHARMACY ROBOT FABLOX</i>	
Magdalena ŁASECKA-PLURA, Jan BIAŁASIK, Mieczysław KUCZMA, Alireza TABRIZIKAHOU	49
<i>APPLICATION OF ISOGEOMETRIC APPROACH TO DYNAMICS OF CURVED BEAMS</i>	
Waldemar ŁATAS, Zygmunt DZIECHCIOWSKI	50
<i>LABORATORY STAND OF CHAIN CONVEYOR</i>	
Waldemar ŁATAS, Jerzy STOJEK	51
<i>OPTIMAL VIBROISOLATION OF MECHANICAL PRESS SUBJECTED TO POLYHARMONIC EXCITATION</i>	
Krzysztof MAGNUCKI, Joanna KUSTOSZ, Damian GOLIWAŚ	52
<i>FREE FLEXURAL VIBRATIONS OF AN EXPANDED-TAPERED SANDWICH BEAM</i>	



Krzysztof MAGNUCKI, Iwona WSTAWSKA, Piotr KĘDZIA	54
<i>FREE FLEXURAL VIBRATIONS OF A SANDWICH BEAM ON AN ELASTIC FOUNDATION WITH VARIABLE PROPERTIES</i>	
Leszek MAJKUT, Krzysztof KOSALA	56
<i>DETERMINATION OF SOUND INSULATION PROPERTIES OF HOMOGENEOUS BAFFLES USING FINITE ELEMENT METHOD</i>	
Mykhailo MARCHUK, Vira PAKOSH	57
<i>NATURAL FREQUENCIES HINGED ALONG THE LOWER RIBS OF THE TRANSVERSAL-ORTHOTROPIC PLATE-STRIP</i>	
Jakub MARCZAK	58
<i>TOLERANCE MODELLING OF VIBRATIONS OF A SANDWICH PLATE WITH A HONEYCOMB CORE</i>	
Jakub MICHALSKI, Tomasz STREK	60
<i>RESPONSE OF LATTICE STRUCTURES BASED ON THE TRIPLY PERIODIC MINIMAL SURFACES TO PROJECTILE IMPACT</i>	
Paweł OLEJNIK, Krzysztof PEPA, Godiya YAKUBU, Jan AWREJCEWICZ	61
<i>THE EXPERIMENTAL STAND FOR OBSERVATION AND CONTROL OF DYNAMICS OF AN EXTENDED ATWOOD'S MACHINE</i>	
Agnieszka OZGA, Marek SULEWSKI	62
<i>APPLICATION OF SUPERVISED LEARNING ALGORITHMS FOR ANALYSIS THE VIBRATIONS OF AN OSCILLATOR FORCED BY A RANDOM SERIES OF IMPULSES</i>	
Agnieszka OZGA, Marek SULEWSKI	63
<i>APPLICATION OF UNSUPERVISED LEARNING ALGORITHMS FOR ANALYSIS THE VIBRATIONS OF AN OSCILLATOR FORCED BY A RANDOM SERIES OF IMPULSES</i>	
Paulina PIETRUSIŃ, Piotr GIERLAK, Andrzej BURGHARDT	64
<i>MODEL OF THE MANIPULATOR WITH FLEXIBLE JOINTS</i>	
Pavel POLACH, Luboš SMOLÍK, Jan RENDL, Štěpán DYK, Miroslav BYRTUS, Michal HAJŽMAN	65
<i>AN OVERVIEW OF NONLINEAR VIBRATION PHENOMENA IN HYDRODYNAMIC JOURNAL BEARINGS</i>	
Volodymyr PUZYROV, Nataliya LOSEVA, Nina SAVCHENKO	67
<i>ON MITIGATION OF OSCILLATIONS OF A MECHANICAL SYSTEM WITH TWO DEGREES OF FREEDOM IN THE VICINITY OF EXTERNAL RESONANCES</i>	
Godwin SANI, Jan AWREJCEWICZ	68
<i>SYNCHRONIZATION AND ENERGY TRANSFER IN 4DOF FRICTION-INDUCED SELF- AND PARAMETRICALLY EXCITED OSCILLATORS</i>	
Filip SARBINOWSKI, Roman STAROSTA	70
<i>COMPREHENSIVE STUDY OF GALLOPING ENERGY HARVESTERS</i>	
Martyna SOPA, Grażyna SYPNIEWSKA-KAMIŃSKA, Tomasz WALCZAK	71
<i>TWO DIMENSIONAL MECHANICAL MODEL OF HUMAN STABILITY IN EXTERNAL FORCE-CAUSED FALL</i>	
Witold STANKIEWICZ	72
<i>REGISTRATION, MODAL DECOMPOSITION AND ANALYSIS OF HUMAN LEFT VENTRICLES</i>	



Stanislaw STRZELECKI	74
<i>DYNAMIC CHARACTERISTICS OF MULTILobe JOURNAL BEARINGS WITH THE LOBES OF DIFFERENT GEOMETRY</i>	
Anna SYGULSKA	75
<i>CINEMA HALL ADAPTED FOR OPERA SINGING – ACOUSTIC ASSESSMENT</i>	
Ryszard SYGULSKI	76
<i>STABILITY AND VIBRATIONS OF PLATES IN AXIAL FLUID FLOW</i>	
Janusz SZMIDLA, Anna JURCZYŃSKA	77
<i>CHANGE IN THE DYNAMIC PROPERTIES OF A COLUMN AS A RESULT OF A VARIABLE DISTRIBUTION OF BENDING STIFFNESS - NUMERICAL AND EXPERIMENTAL RESEARCH</i>	
Janusz SZMIDLA, Anna JURCZYŃSKA	78
<i>FREE VIBRATIONS OF A FLAT FRAME PARTIALLY RESTING ON A WINKLER ELASTIC FOUNDATION IN TERMS OF UNEVEN DISTRIBUTION OF FLEXURAL STIFFNESS</i>	
Zofia SZMIT, Lukasz KLODA, Marcin KOWALCZUK, Jerzy WARMINSKI	79
<i>EXPERIMENTAL DYNAMICS ANALYSIS OF THE THREE-BLADED ROTOR</i>	
Tomasz SZOLC	81
<i>STRUCTURAL HYBRID MODELLING APPLIED TO INVESTIGATE CURRENT PROBLEMS OF ROTOR DYNAMICS</i>	
Maria Teresa TEJEDOR SASTRE, Christian VANHILLE	83
<i>AMPLITUDE-DEPENDENT EFFECTS OF ULTRASOUND IN BUBBLY LIQUIDS</i>	
Andrzej URBAŚ, Krzysztof AUGUSTYNEK, Jacek STADNICKI	84
<i>KINETIC ENERGY BASED INDICATORS TO COMPARE DIFFERENT LOAD MODELS OF A MOBILE CRANE</i>	
Tomasz WALCZAK, Martyna SOPA, Martyna BIAŁECKA, Agata MROZEK, Jakub K. GRABSKI, Aleksander BŁAŻKIEWICZ	86
<i>LOAD ANALYSIS OF HYDROFOIL WINDSURFING ATHLETE</i>	
Tomasz WALCZAK, Martyna SOPA, Adam M. POGORZAŁA, Artur ROHDE	87
<i>GAIT SYMMETRY ASSESSMENT AFTER TWO-SIDE LOWER LIMB AMPUTATION</i>	
Ryszard WALENTYŃSKI, Agnieszka PADEWSKA-JURCZAK, Maciej WIŚNIEWSKI, Dawid CORNIK	88
<i>DYNAMIC ANALYSIS OF HIGH COOLING TOWERS</i>	
Hanna WEBER, Anna JABŁONKA, Radoslaw IWANKIEWICZ	90
<i>NON-LINEAR DYNAMIC RESPONSE OF A GUY LINE OF A GUYED TOWER TO THE STOCHASTIC WIND EXCITATION BY EQUIVALENT LINEARIZATION TECHNIQUE</i>	
Godiya YAKUBU, Pawel OLEJNIK, Jan AWREJCEWICZ	91
<i>A DOUBLE PENDULUM WITH FRICTION UNDER THE ELECTROMAGNETIC FORCING AND KINEMATIC EXCITATION: SIMULATION AND EXPERIMENTATION</i>	

IDENTIFICATION OF SELECTED ELECTROMECHANICAL SYSTEMS USING ACQUIRED TIME-SERIES DATA

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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

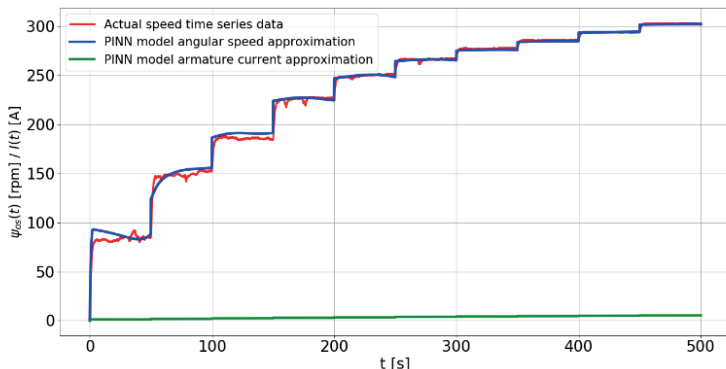


Fig. 1: The angular speed and armature current predictions of the geared DC motor PINN model after step-like increment of reference value

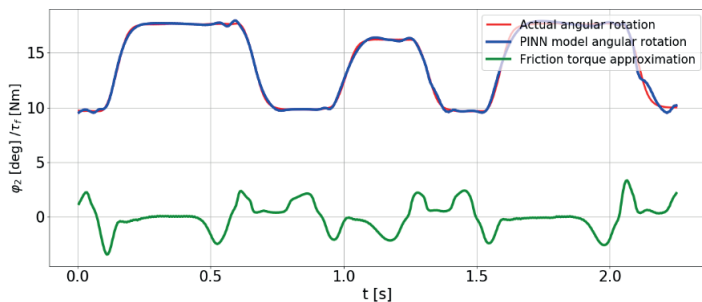


Fig. 2: The disk angular rotation and friction torque predictions of the double torsion pendulum PINN model

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