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*Editorial*

# Special Issue on Recent Advances in Nonlinear Vibration and Control

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The topics of nonlinear vibration and control have garnered much interest from scientists over the last few decades due to their widespread applications in various fields, such as physics and engineering.

The objective of this issue is to compile and present groundbreaking research on nonlinear vibration and control, including multi-loop control systems, under-actuated hovercraft, the stability of vibrating models and their behaviors, and the motion of rigid bodies, and it presents six articles on these subjects. In [1], two different types of simulated data are examined. The first incorporated noise with Gaussian distortion, and the second included distortion via both Gaussian noise and Cauchy disturbance. A sinusoidal signal was additionally added to the Cauchy disturbance to imitate known frequency loop oscillations and their propagation. Errors in regulation were demonstrated in the time series data. Due to the high computational complexity of the TE technique, the authors focused on creating causality graphs using the modified Transfer Entropy algorithm in combination with the obtained data. The acquired results enabled recommendations to be made regarding the selection of the probability function upon which the transfer entropy should be based. In [2], to track the desired trajectory for an under-actuated hovercraft, a nonlinear controller was used. It was a modification of a technique that has been documented in the literature, in which the considered control procedure differs from that of the previously discussed control technique in two significant ways. It first addresses a situation in which the geometric center and the center of mass do not line up, leading to extra forces and moments of force. The original trajectory tracking technique does not account for this because of the lack of symmetry, but the suggested strategy is a generalization of the established concept. The inertia matrix was diagonalized using a velocity transformation, allowing the symmetric matrix to be reduced to a diagonal form. Second, the modified quasi-velocity equations of motion provide some understanding of the dynamics of a moving object. The proposed method was tested numerically using a hovercraft model with three degrees of freedom and two desired trajectories. Without experimental confirmation, the presented strategy can be helpful in early simulation studies at the controller selection stage. The authors of [3] presented a formulation that incorporates the resonance frequency, the mass, the applied stress exerted by the product's application, and the utilized vibration profile. Following this, the associated reliability indices were predicted via two-parameter Weibull distribution using the vibration output data. This approach incorporates the specified stress as an acceleration response and a dynamic stress factor. The effectiveness of the fitted Weibull distribution in forecasting the reliability indices was addressed by utilizing its Weibull shape and scale characteristics; it is always possible to replicate the major vibration stress values. The accuracy of Hammerstein model identification was examined in [4],



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particularly where accurate identification in the time domain is important. The results of their analysis demonstrated a direct relationship between the frequency band of the estimated signals and the band of the impulse response of the matched filter that corresponded to the exponential swept-sine test signal used as the input during the identification phase. Both the filter matched to the input signal and the test signals supplied as inputs were characterized by constrained frequency bandwidths. This restriction was reflected in restrictions that might not be homogenous in the frequency bands of the calculated impulse signals. All of the authors' presented assumptions were supported by their results. Certain dynamic aspects of the star motion problem that are affected by the rotation of the galaxy were investigated in [5], which the authors modelled as a bisymmetric potential based on a two-dimensional harmonic oscillator with sextic perturbations. When specific circumstances were met, it was shown that the motion could not be integrated analytically. The Poincaré surface of a section was used to demonstrate the irregularity of the motion's behavior, confirming the analytical results for nonintegrability. It was demonstrated that the greatest equilibrium points are stabilized by the force produced by the rotating frame. Two significant contributions are presented in [6]. First, the authors determined whether it was feasible to incorporate suggested sample-and-hold inputs (SHIs) with a dual-loop control scheme into an extremely cheap microcontroller (Arduino) and improve the performance of a non-minimum-phase (NMP) mini-Segway (MS) system. Second, they investigated a dual-loop control tuning procedure to enhance the overall functionality of a closed-loop system. The results of their analytical investigation demonstrated that the chosen SHI is capable of reducing the viable sampling period from a 0.75 s zero-order hold (ZOH) to 0.1162 s (a reduction of 84.5%). According to their experimental findings, the average cart oscillation magnitude, which is mostly due to the system Coulomb friction, was decreased from 10.94 mm to 3.85 mm (a reduction of 64.8%).

Although submissions for this Special Issue are closed, more in-depth research is needed in the field of nonlinear vibrations in dynamic systems and methods of controlling them. In addition to the motions of rigid bodies, current challenges must be addressed, such as the vibration of structures due to earthquakes, the movement of giant tankers, and the treatment of vibrations in these systems in order to optimize them.

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## References

1. Falkowski, M.J.; Domański, P.D. Causality Analysis with Different Probabilistic Distributions Using Transfer Entropy. *Appl. Sci.* **2023**, *13*, 5849. [CrossRef]
2. Herman, P. Controller for an Asymmetric Underactuated Hovercraft in Terms of Quasi-Velocities. *Appl. Sci.* **2023**, *13*, 4965.
3. Barraza-Contreras, J.M.; Piña-Monarrez, M.R.; Torres-Villaseñor, R.C. Vibration Fatigue Life Reliability Cable Trough Assessment by Using Weibull Distribution. *Appl. Sci.* **2023**, *13*, 4403.
4. Burrascano, P. Parameter Optimization for an Accurate Swept-Sine Identification Procedure of Nonlinear Systems. *Appl. Sci.* **2023**, *13*, 1223. [CrossRef]
5. Alfadhli, M.; Elmandouh, A.; Al Nuwairan, M. Some Dynamic Aspects of a Sextic Galactic Potential in a Rotating Reference Frame. *Appl. Sci.* **2023**, *13*, 1123. [CrossRef]
6. Wang, Y.; Zhu, G. Performance Improvement of an NMP Mini Segway Using Sample and Hold Inputs. *Appl. Sci.* **2023**, *13*, 1070. [CrossRef]