Escuela Superior Politécnica del Litoral

PARES & NONES
Un break científico

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Stable rotational orbits of based-excited pendula system

PROBLEM

The dynamics of the practical application of energy harvesting from rotatory motions requires more in-depth analysis to understand its behaviour. Such dynamics can be studied through the rotational orbits of a harmonically base-excited two pendula system.

GENERAL OBJETIVE

Identify system parameter ranges for which pendulum rotations exist.

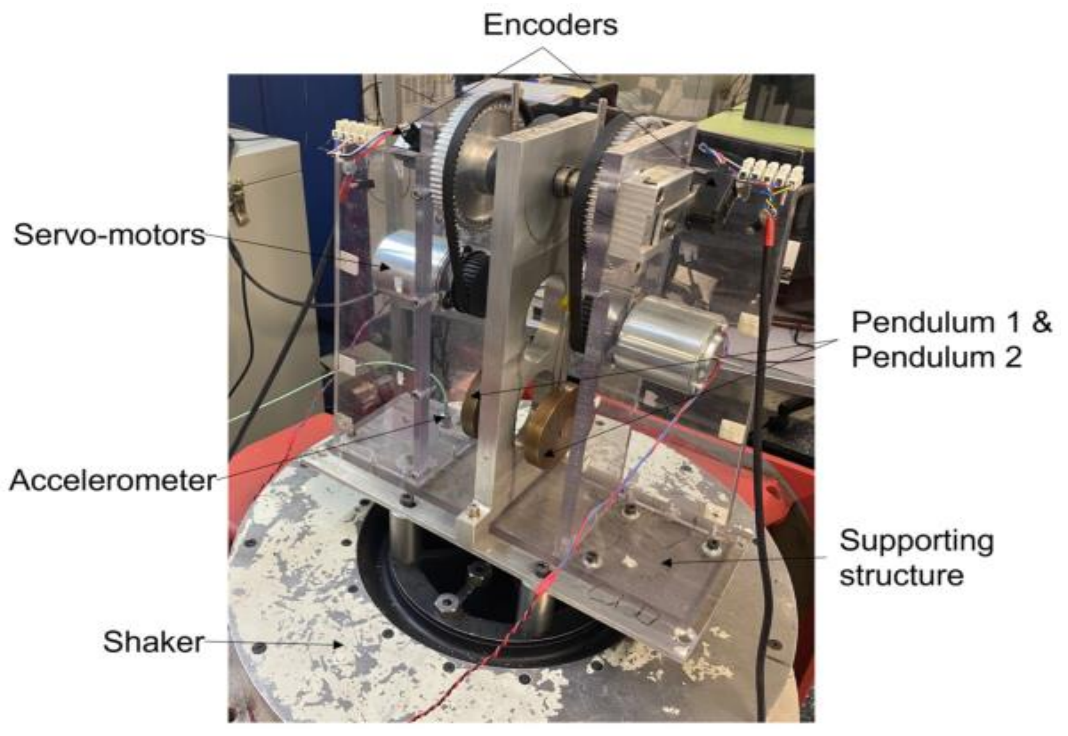

Fig. 1. Two-pendula experimental rig

PROPOSAL

Carry out the identification of the ranges by undertaking bifurcation analysis with the three more appropriate system parameters as control parameters, namely, the external harmonic excitation amplitude, the external harmonic excitation frequency, and the difference in pendulums lengths.

RESULTS

Bifurcation analysis has been performed for the identification of values beyond which rotations exist, and the study of corresponding bifurcation points has been conducted with the computational tool ABESPOL, developed at the centre for applied dynamics research (CADR) of the University of Aberdeen. Direct simulations and one-parameter continuation analysis were performed with ABESPOL. One-parameter continuation results showed complex bifurcation scenarios for antiphase rotatory motions. Further, results showed that pendulum rotations, in phase and antiphase, co-exist with oscillatory motions. Finally, basins of attraction have been computed, enabling attractors to be identified.

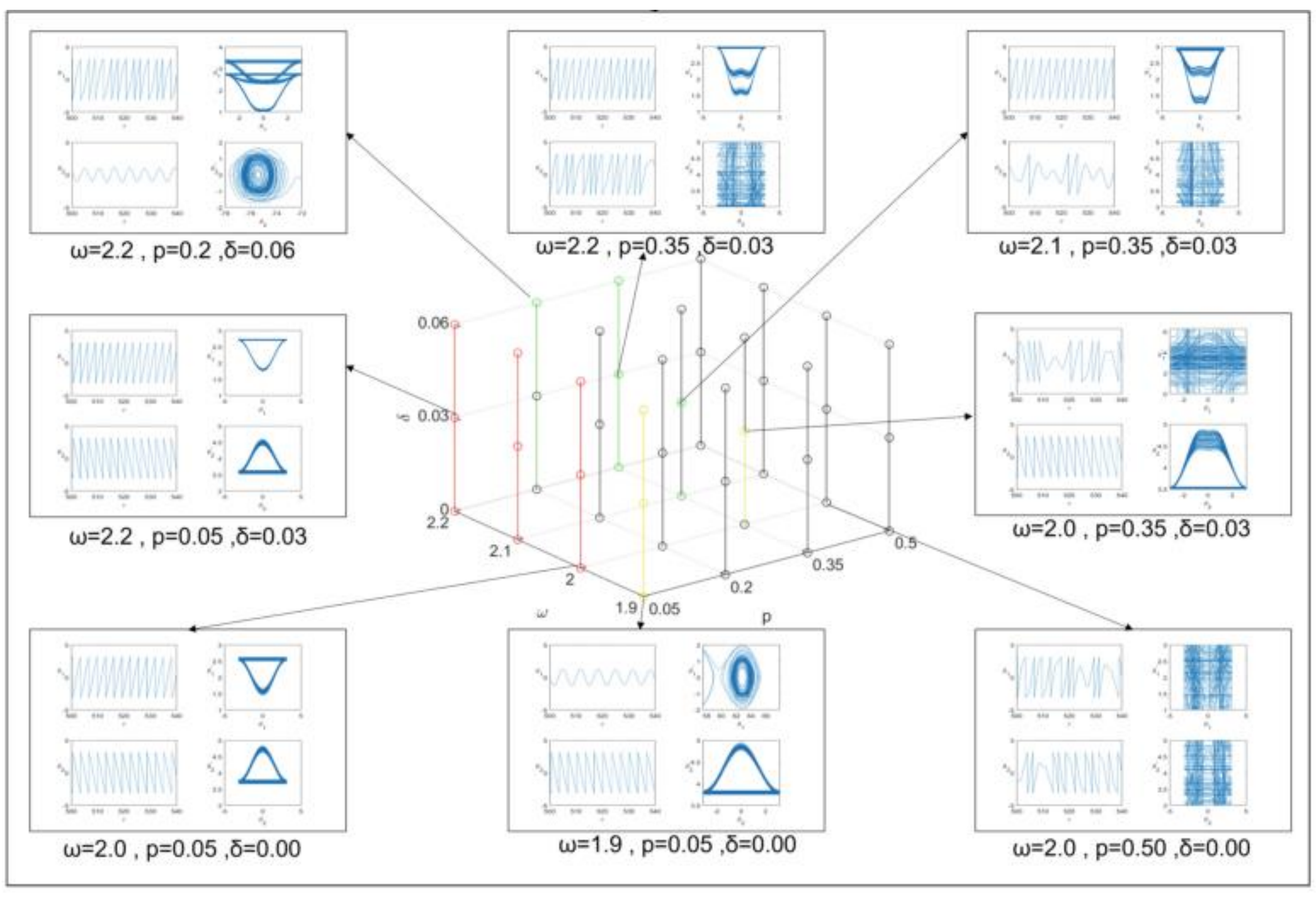

Fig. 2. System qualitative responses for the three analysed system parameters

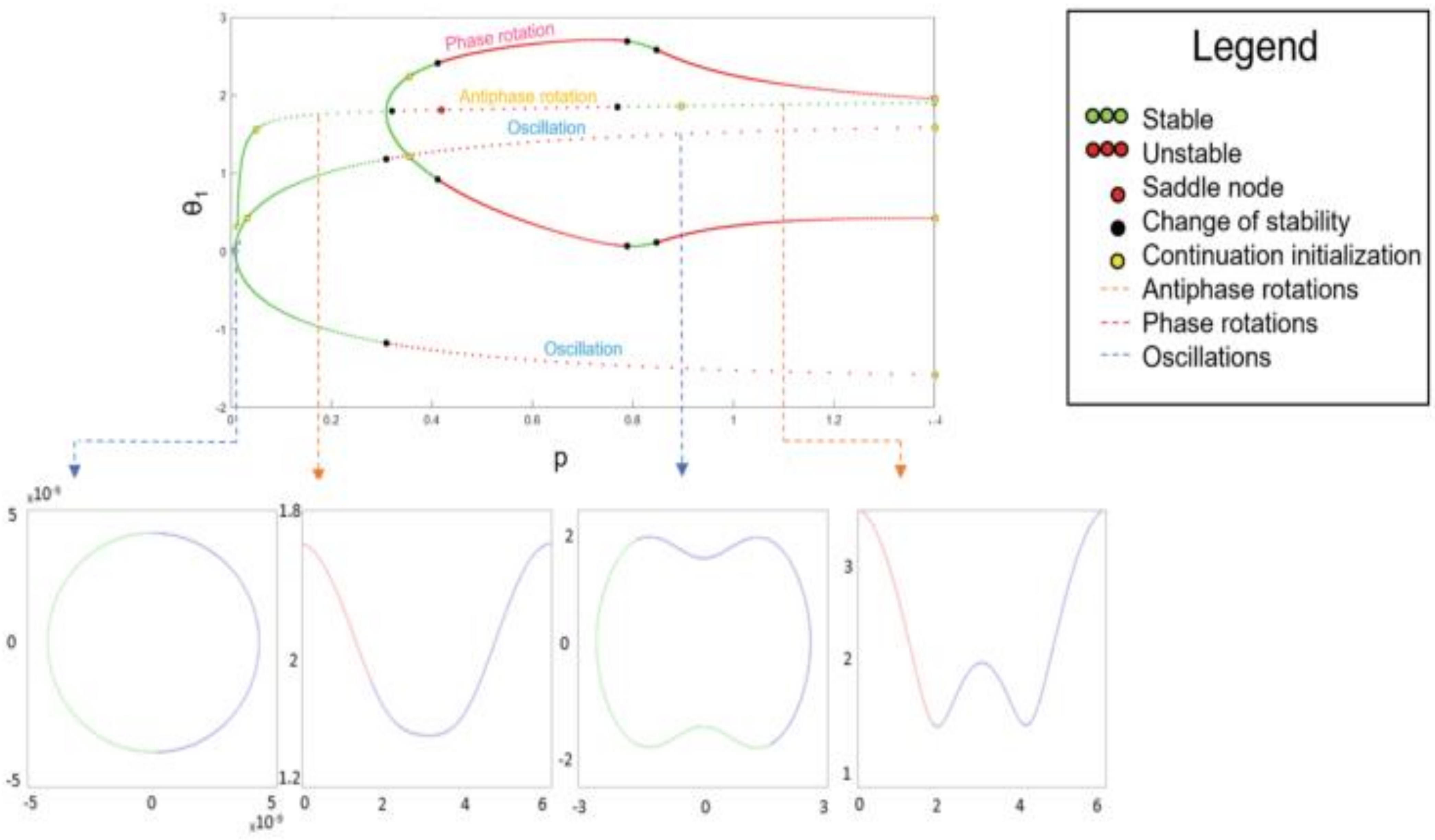

Fig. 3. Bifurcation analysis for the pendulum 1

CONCLUSIONS

- This work studied a two-coupled parametric pendulum system excited in a vertical direction so as to identify ranges of system parameters for which pendulums rotate stably, to be applied to wave energy harvesting in a novel concept.
- Direct numerical integration of the system equations and numerical continuation using the computational tool ABESPOL have been performed. With this, ranges for rotational motion of both pendula have been determined, using three system parameters as control parameters. Moreover, bifurcations such as saddle-node and period-doubling have been located, and co-existence of oscillations and rotations of the pendula has been found.