Università Politecnica delle Marche

Dipartimento di Ingegneria Civile, Edile e Architettura
Prof. Stefano Lenci

Report of the PhD thesis "**Modelling friction for the analysis of different dynamical systems**," by **Krzysztof Jankowski**
Lodz University of Technology, Faculty of Mechanical Engineering, Division of Dynamics
Supervisor: Prof. Andrzej Stefański,
Subsidiary Supervisor: Dr. Asesh Saha

The thesis deals with the nonlinear dynamics of frictions oscillators.

In Section 2 an accurate summary of the main physical effects observed in experiments, and related to friction, is reported. A literature survey of the phenomenological oriented papers is given, and the main phenomena are illustrated in a clear and concise manner.

In Section 3 three different models of contact mechanics, from the simplest and classical models of Hertz to more sophisticated models, are summarized. The motivation of this section relies in the fact that some results summarized herein are used in the following part of the thesis.

In Section 4, which constitutes the core of the background of the thesis, various friction models are illustrated, starting from the simplest Coulomb model to the static Stribeck model up to dynamic models. A lot of attention is dedicate to the so-called physical based models, and also an hybrid model is summarized.
In Sect. 4.5 it is develop "a novel friction model by incorporating drooping friction characteristics (Stribeck effect) in the modified Maxwell slip model … it … can describe many friction characteristic including the hysteretic effects of friction in the presliding as well as in the pure sliding regimes."
From a modeling point of view, this is the innovative contribution of this thesis. Although the modification may appear minimal from a mathematical point of view, it is important from an engineering point of view. In developing this model, the candidate demonstrates a deep knowledge of the friction of model, and the ability of elaborating on them.

In Sect. 5 three single-degree-of-freedom systems are illustrated: the friction oscillator, the friction induced system and the stick-slip system. The latter is a special case of the first.

In Sect. 6 various friction law summarized in Sect. 4 are applied to the models of Sect. 5. The whole analysis is based on numerical simulations of the different ordinary differential equations. Many dynamical phenomena have been addressed, and it is shown how the considered friction laws permit to highlight these phenomena in the friction oscillators. The dynamical outcome of various models is considered, and the results are illustrated by means of time histories and phase portraits.
In this part the candidate show to able to deals with all the friction laws, and thus prove that he has a deep knowledge of the investigated matter.

Overall, the literature survey is adequate. The thesis is well written and clear. The objective are relevant from an engineering point of view, since permits to increase knowledge in the field of nonlinear dynamics of frictional oscillators, and the obtained results are interesting.

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The candidate has published one paper on international scientific journals related to the thesis subject.

I appreciated the work done by the candidate, the methodological approach and the obtained results. I consider positive the developed scientific work, I consider scientifically mature the candidate, and I support the award of the PhD title to Dr. Jankowski.

Stefano Lenci

Ancona, 2 July 2016

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