Impulsive Transport by Vibratory Feeders

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Abstract. Vibration conveyors are frequently used machines in various manufacturing plants of chemical and of mechanical engineering. They offer a cheap and effective possibility for the transportation of granular media of all sizes on the one and of small mechanical or electrical parts on the other side. Paper will consider theory and experiments for various configurations and models [2, 4].

Introduction

Figure 1 illustrates a typical configuration, its experimental setting, designed for tests, and some typical results. The transportation process is mainly governed by three parameters, the track angle α, the vibration angle β and the vibration amplitude. For layout an optimal combination of these parameters has to be evaluated, optimal with respect to transportation rate for example.

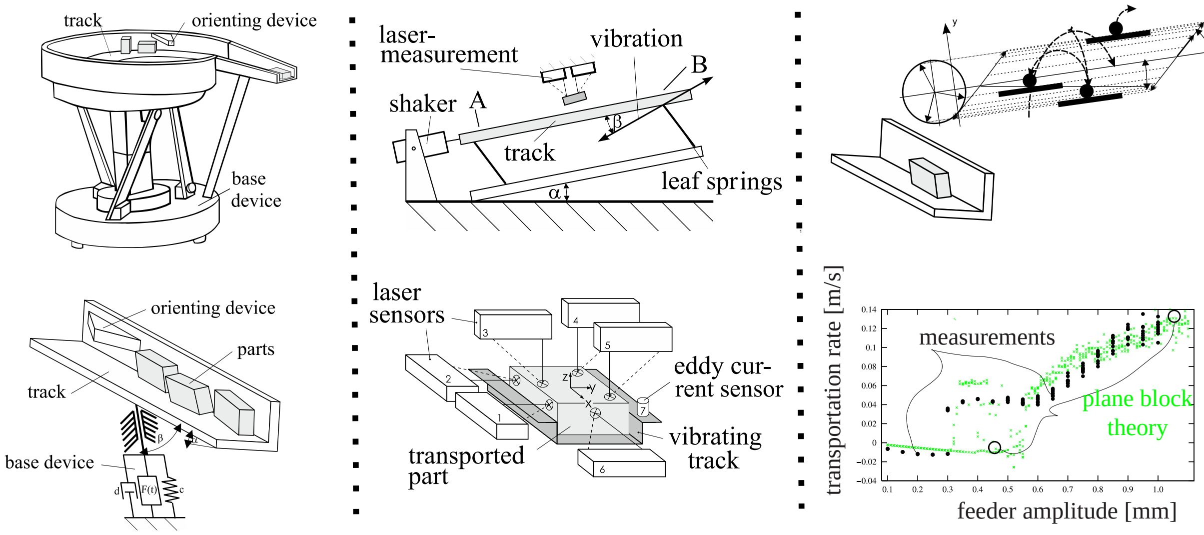

Figure 1: **left:** example vibration conveyor and principal arrangement near orienting device, **middle:** experimental setting and sensor arrangement, **right:** point mass/block mass models and comparisons [2, 4, 5]

Theory has been established for spatial, planar and point mass models, taking into account also the motion of a single block and of many contacting blocks. Mathematical model is based on well-known multibody theory with unilateral constraints using a set-theoretical prox-approach. It has the principal shape [1, 3]

$$\mathbf{M}(\mathbf{q},t)\ddot{\mathbf{q}}(t) + \mathbf{h}(\mathbf{q},\dot{\mathbf{q}},t) - \mathbf{W}\boldsymbol{\lambda} = \mathbf{0}, \qquad \ddot{\mathbf{g}} = \mathbf{W}^T\ddot{\mathbf{q}} + \bar{\mathbf{w}}, \qquad \boldsymbol{\lambda} = \text{prox}(\boldsymbol{\lambda} - r\ddot{\mathbf{g}}),$$

where the first expression is the equation of motion including all applied forces $\boldsymbol{h}$ and all constraint forces $\mathbf{W}\boldsymbol{\lambda}$, the second expression represents relative kinematics and the third one the unilateral constraints.

The model with block-masses are evaluated using the above equations together with some organization of moving and contacting multi-block-arrangements, and the point-mass model can be evaluated directly by explicit formulas. The right side of Figure 1 depicts some results. The comparison is very good considering the complexity of the problem, which is not only a nonlinear one but includes bifurcation behavior together with strange attractor structures.

All findings indicate, that for a first design of such conveyor machines the planar or the point mass models are already sufficient. They offer in addition a simple access to the physical understanding of the impact phenomena accompanying such transportation processes. The assessment of the three models with spatial, planar and point masses is governed by the idea of not loosing information of the dynamical behavior by any simplification.

References

[1] B. Brogliato, *Nonsmooth Mechanics*. Springer London 1999

[2] Z. Gazic, *Nichtlineare Dynamik von Vibrationsförderern*. Fortschritt-Berichte VDI, Reihe 13, Nr. 55, Düsseldorf 2009

[3] F. Pfeiffer, *Mechanical System Dynamics*. Springer Berlin Heidelberg, 2008

[4] P. Wolfsteiner, *Dynamik von Vibrationsförderern*. Fortschritt-Berichte VDI, Reihe 2, Nr. 511, VDI-Verlag Düsseldorf, 1999

[5] P. Wolfsteiner, F. Pfeiffer, *Modeling, Simulation and Verification of the Transportation Process in Vibratory Feeders*. ZAMM, Z.Angew.Math.Mech. **80** (2000) 1, 35-48