

Proposal for a bachelor thesis project

August 28, 2014



1 Title

The Woodpecker: Autonomous oscillations in a discontinuous dynamical system

2 Background

Mechanical systems of rigid bodies are often modelled by differential-algebraic systems. The woodpecker is a curious toy which features contact discontinuities. In practice one can observe that this toy leads to periodic oscillations. With this project, we try to model this behavior.

<https://www.youtube.com/watch?v=2ImYyadjjVM>

<https://www.youtube.com/watch?v=47cYVq5ijpU>

3 General Task

Your task will be to develop a mathematical model and the corresponding numerical methods for simulating the woodpecker. In particular, you will show that stable oscillations exist and find the oscillation frequency.

4 Steps

- Development of the mathematical model
- Investigation of numerical methods for DAEs with discontinuities (state switching)

- Development and implementation of numerical models for the woodpecker.
- Comparison to measurements.

5 References

- Claus Führer, Edda Eick-Soellner: Numerical methods in mltibody dynamics. Teubner 1998 (electronic edition: Springer 2014?)
- RI Leine, Ch Glockner, DH van Campen: Nonlinear dynamics of the woodpecker toy. Proc DECT'01, Pittsburgh, PA, Sept 9–12, 2001
- F Pfeiffer: Mechanische Systeme mit un stetigen Übergängen. Ingenieurarchiv 54(1984), 232–240