Engineering Risk Analysis Group
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MSc thesis

# Stochastic Analysis of Fractional Hysteretic Behaviour

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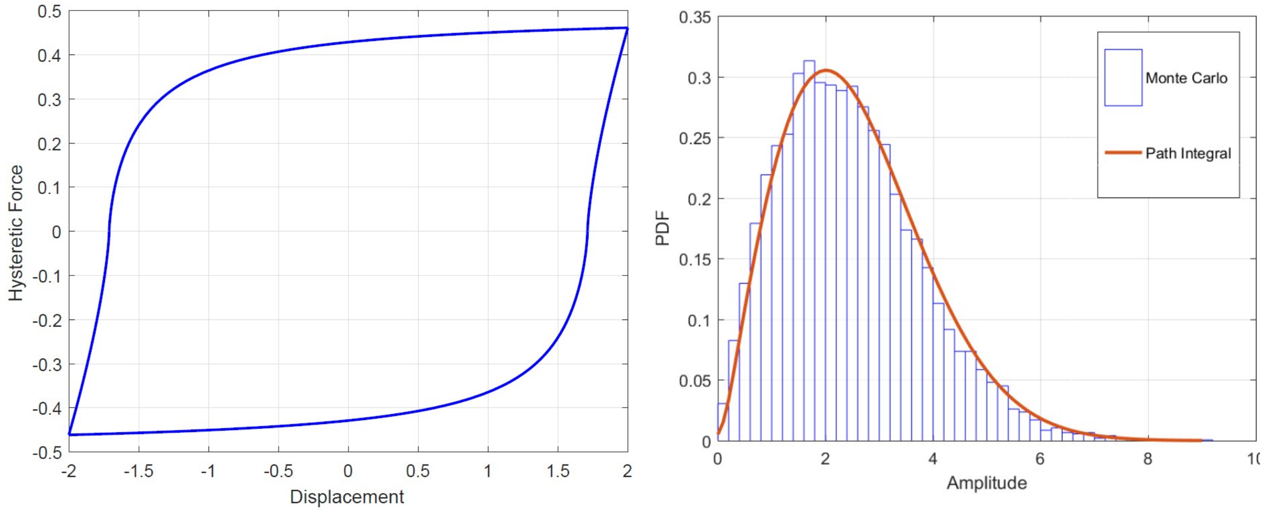
## Background

Random loads play a key role in many engineering applications. Therefore, uncertainty quantification is an important topic to predict for instance the displacements due to earthquakes or wind.
In case of a hysteretic material behaviour this is even more difficult as a hysteretic force does not only depend on the displacement or velocity but also on the time. The three most popular hysteretic models, the bilinear model, the Bouc-Wen model and the Preisach model as well as a new fractional order hysteretic model were analyzed within this work.




*Fractional Hysteresis Curve; PDF of the stochastic analysis in comparison with MC data*

## Methodology

To perform a stochastic analysis of hysteretic systems, the nonlinear hysteretic systems were subjected to statistical linearization to create quasi-linear surrogate systems. Stochastic averaging was applied to the surrogate systems to produce one-dimensional Markov diffusion processes in terms of the displacement amplitude, which were solved by a numerical path integral approach.
Additionally, the Bouc-Wen model was enhanced by exploiting the possibilities of the fractional calculus and the newly defined fractional model was analyzed by the proposed workflow.

## Results

The results of the stochastic analysis were compared with Monte Carlo simulations. The simulations showed a good agreement in case of lightly damped systems, whereas in case of highly damped systems the results showed a deviation as statistical linearization and stochastic averaging assume a lightly damped system. Moreover, the stochastic analysis framework is very efficient as only an one-dimensional process has to be calculated.
The new fractional model could be useful considering the fitting possibilities of experimental data.

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