Abstract of PhD dissertation entitled:
Micro-chaos in digitally controlled mechanical systems
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In the past 50 years, with the appearance of digital electronic devices, a new challenge was introduced in the field of control engineering and computational science: dealing with the so-called *digital effects*.

The main digital effects are sampling, delay and quantization. Sampling arises from the fact, that processors operate in a periodic manner, they process one operation per cycle. Since the computation of control feedback takes time, processing delay between signal measurement and control effort output is unavoidable. Integer and floating-point numbers in computers are mostly represented in finite amount of bits, therefore they have a given precision, which leads to rounding (or with a more technical term, quantization) in calculations. Furthermore, many digital components like converters and filters can introduce one or more of these digital effects. For example, an analog-to-digital converter (ADC) can be treated as a composition of a quantizer and a sampler.

The term *micro-chaos* (or μ-chaos) was first introduced by G. Stépán in 1994, then examined by G. Haller and E. Enikov. They found that digital effects (sampling, rounding and delay) can lead to very small amplitude – hence the *micro* prefix – chaotic oscillations.

In works of G. Csernák, transient chaos is thoroughly examined when friction is added to the stick-slip model exhibiting micro-chaos. The escape rate and mean lifetime are estimated based on the fractal dimension of the repellor.

The PhD dissertation covers the following topics related to the analysis of micro-chaotic behaviour in digitally controlled systems:

Chapter 1 presents the past and current state of the corresponding research area which served as an entry point for the author's research.

Chapter 2 gives an overall picture about the 2D micro-chaos map corresponding to a digitally controlled 1-DoF mechanical oscillator. Various properties are shown and a simple classification of the possible cases is presented. Finally, certain results are generalized to multi-DoF systems.

Chapter 3 introduces an extension to the Simple Cell Mapping method, which allows adaptive expansion of the analysed state space region along with the opportunity of parallel execution.

Chapter 4 analyses the effect of twofold quantization: when both the input and output of the digital controller are affected by rounding.

Chapter 5 formulates the hybrid-switching micro-chaos map that describes the effect of dry friction on the motion of a 1-DoF digitally controlled oscillator. Besides the quantization-related switching events – that happen at the sampling instants – the friction-related switching events are also incorporated in the model that can be extended to the consideration of impact-like events, too.