Theme for a Diplomarbeit

Modeling, analysis, and experimental realization of a ferromagnetic inductor

in collaboration with Dr. Richard Stanley Williams , Dr. Suhas Kumar, and Dr. John Paul Strachan
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Abstract: Recently, scientists at Hewlett Packard Labs (Dr. R.S. Williams and Dr. S. Kumar) have fabricated and modelled a ferromagnetic inductor [1], and showed how it falls into the class of memory elements [2]. In the experiments carried out at Hewlett Packard Labs, the flux- and temperature-dependent inverse differential inductance of the ferromagnetic inductor was found to exhibit a negative sign under suitable conditions, indicating the capability of the device to feature locally-active dynamics [3]. Since complex behavior, including amplification of infinitesimal fluctuations of energy, may emerge in a system if and only if the latter may undergo locally-active dynamics [4], the aforementioned discovery is of major interest to the electronic engineering community.

In this Diplomarbeit the model of the ferromagnetic inductor presented in [1] shall be thoroughly investigated to gain a deeper insight into the mechanisms at the origin of the device nonlinear dynamics. Particularly, system-theoretic methodologies [5] shall be applied to the model to derive a rigorous proof for the possible emergence of local activity in the device. Later on, studies shall be devoted to the design of novel dynamical circuits capable to amplify small signals by leveraging the capability of the ferromagnetic inductor to display a negative differential inductance under suitable conditions. By comparing the results of these investigations with those reported elsewhere on memory resistors (memristors for short) [3], this research is expected to lead to the introduction of new fundamental notions and/or to the clarification and generalization of known concepts in circuit and system theories.

In parallel to the theoretical work, the ferromagnetic inductor and its dynamical circuits shall be fabricated and electrically characterized through laboratory experiments in order to validate the model predictions.

This project is part of a long-term collaboration [6] between the Institute of Fundamentals of Electrical Engineering (Prof. R. Tetzlaff, Dr. A. Ascoli), and Hewlett Packard Labs (Dr. R.S. Williams, Dr. S. Kumar, and Dr. J.P. Strachan).

References

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[5] L.O. Chua, "CNN: A Paradigm for Complexity," World Scientific Series on Nonlinear Science, Series A, vol. 31, Series ed. L.O. Chua, 1998

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Announcement: Students with strong interest in nonlinear system theory, mathematics, and computer programming are best suited to engage in this Diplomarbeit.

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