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LINEAR OPERATORS FOR THE ANALYSIS OF NONLINEAR SYSTEMS

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The digital revolution of the 20th century was strongly motivated by the need to simulate nonlinear differential equations which, at the time, remained outside the scope of analogue simulators, [1]. While classical digital computation remains the mainstay of science, it is now frequently suggested that it may have run its course and the future will bring computation based on different physical principles. Most prominently this is the motivator for the current rise of research in quantum computing. As regards the specific problem of simulation of nonlinear differential equations further progress may well be enabled by nanotechnology, particularly the inherently nonlinear memristive nano-circuits, [2-3]. If such breakthroughs indeed pan out they will affect rather profoundly our capabilities of simulation of nanosystems and biological systems, perhaps leading to further mathematization of biology. We are already seeing progress in that direction, e.g. researchers have applied memristive circuits to simulation of neural synapses and biological memories, [4].

From the moment of its inception the concept of memristance stimulated the developments of new methods in applied mathematics, especially those that put emphasis on nonlinearity, e.g. the celebrated chaotic circuits of L. Chua. More recently analysis of memristive oscillators has endowed new perspectives on the problem of constructing bases in separable Hilbert spaces, [5-6] and resulted in the discovery of a new type of fast transform, [8] with good analytic properties, [9]. It is an interesting characteristic of these new methods that they commingle the concepts of Functional Analysis with those traditionally encountered only in the Analytic Number Theory, [10]. Also, these purely mathematical results have already paid back to applications by enabling new perspectives at the analysis of nano-circuits as well as analysis of signals, [7].

In my talk I will outline the theoretical principles pertaining to the aforementioned transforms and discuss applications of these methods with special emphasis on nanosystem modeling, simulation, and signal analysis.

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