Measuring dynamic systems in the presence of nonlinear distortions and time varying behavior: Going beyond the Linear Time-Invariant framework in instrumentation and measurement.

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Abstract:
Many real life measurement problems boil down to the characterization of a dynamical system. In most instruments, for example, dynamic signal analyzers, the linear time-invariant (LTI) paradigm is used to model these systems. However, nowadays the linear and the time invariance behavior are more and more challenged. The ever increasing demand for higher performance and efficiency pushes the systems in a nonlinear operation mode so that nonlinear models are required for their design and control. Also the time invariance assumption does no longer hold in many biomedical applications. For that reason it becomes very urgent to extend the successful LTI approach to address these new challenges. The model quality and the model building cost are becoming limiting factors for further technological developments, and a new generation of instruments is needed to provide the basic information in the engineering labs.

In this tutorial, we offer a systematic approach to deal with nonlinear and time-varying systems. We will learn
- how to recognize the presence of nonlinearities and time-variations
- how to quantify the level of these effects
- how to include these effects in mathematical models
- many real life examples will be given, amongst others:
    - detection and analysis of nonlinear vibrations on a ground vibration test of an F-16 fighter
    - characterization of a micro-wave power amplifier
    - cell impedance measurements on a beating hart
    - study of pit corrosion of metals

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