System identification for communication channels and nonlinear signal sampling circuits

Technology #m11-036

Many technologies are currently designed for data acquisition converting physical data like sound and images into a digital or analog signal. However, there is a need for technologies which can identify the parameters of these data acquisition systems, especially in fields like biology. This technology is an algorithm that transmits a sufficient number of test signals through the sampling circuit or system under consideration and records the generated time sequences. These time sequences effectively measure projections of the system's filter onto a suitable space of signals (e.g., bandlimited signals); given a sufficient number of such measurements, the algorithm can accurately reconstruct the coefficients that represent the filter characterizing the circuit.

By taking advantage of time encoding, the algorithm can identify unknown parameters of a wide range of electronic and biological systems with nonlinear filters

Time encoding machines (TEM) are a class of circuits that can encode analog signals as time sequences without loss of information; they comprise a wide range of well-known electronic circuits, oscillators, and biological neuron models such as asynchronous sigma-delta modulators (ASDM), van der Pool oscillators, and the Hodgkin-Huxley neuron model, respectively. Since time encoding is invertible under suitable conditions, it is possible to recover an encoded signal given knowledge of the encoding circuit via time decoding algorithms. Using this invertibility and the conditional duality between time encoding and parameter identification enables one to treat the projection of the system's filter as the input to a time encoding machine with an impulse response described by a test signals. Hence, the algorithm can reconstruct the filter projection and the filter itself.

Lead Inventor:

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Applications:

- Design of brain-machine interfaces (BMI) and neural prostheses for treating conditions such as motor paralysis, blindness due to retinal damage, and hearing loss due to inner ear damage.
- Identification of the signal processing performed by neural circuits in the brain.
- Modeling of dynamical systems.
- Reverse engineering of circuits of unknown provenance.

Advantages:

- Identifies parameters of time encoded machines or asynchronous circuits
- Can identify parameters of biological as well as electronic circuits.
- Can effectively identify parameters of noisy systems.

Patent Information:

Patent Pending (US 20120084040)

Tech Ventures Reference: IR M11-036

Related Publications:


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