

AN INTRODUCTION TO PRISM SIGNAL PROCESSING

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The Internet of Things (IoT) [1] and Industrie 4.0 [2] propose substantial increases in the deployment of sensors into a diverse range of environments. The challenges are considerable: local computational power must be efficiently and flexibly deployed both to perform current metrological tasks and to reconfigure/redesign the signal processing flow as monitoring requirements evolve over time.

This paper introduces the Prism (precise, repeat integral, signal monitor), a new type of signal processing block, as a contribution towards to the challenges of 21st Century metrology. The Prism acts as a fully recursive, dual output, FIR filter: the computational burden is low and independent of data window length. Prism design is trivial, so that networks of Prisms can be assembled, whether at design time or autonomously in real time, to carry out a wide range of metrological tasks. Prism-based trackers for the frequency, phase and/or amplitude of a sinusoid perform close to the Cramer-Rao Lower Bound (CRLB) for SNRs down to 0 dB.

Prism signal processing has been used in the development of a next-generation Coriolis mass flow meter transmitter, resulting in substantial improvements in metering capability. Whereas the current commercial technology typically generates measurement updates typically at up to 100 Hz, the new prototype provides updates at 48 kHz, and can further control and monitor the flowtube in two modes of vibration simultaneously, thus providing independent measurements of mass flow and density (both at up to 48 kHz). The Coriolis dual mode capability has applications in measurement validation, flowtube design, and multiphase flow. New Prism structures are generated in real time to enable optimal tracking of the measurements as the frequency of oscillation varies over time. The fast dynamic response of the new transmitter has been applied to the monitoring of diesel fuel injection in an automotive test engine: short flow pulses of 1 ms duration can be tracked at engine speeds of 1000 rpm.

References

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2. B. Vogel-Heuser, D. Hess. *IEEE Transactions on Automation Science and Engineering*. 2016. Vol 14, issue 2.