Abstract

In power systems, classification and parameter estimation of the power quality (PQ) signals play an important. Without significant improvements in *state-of-the-art* methods, tracking of PQ signals, mainly transients, and harmonics are not feasible. In the time-domain, due to the Shannon/Nyquist sampling principle, PQ analysis requires massive data storage place. Besides, the overall process is complex. Therefore, two different domain-based algorithms are constructed in the thesis. In the time-domain analysis, the major concentration is given on the modifications of the tracking algorithms for transient and harmonic signatures. On the other hand, in the compressed sensing (CS) domain, the thesis focuses on the development of a new framework for sparse signals classification and parameters estimation.

The Kalman filter (KF) is the elegant set of robust equations that is extensively used for real-world signal tracking. The cubature KF (CKF) and its square-root version, i.e., square-root CKF (SCKF) are applied throughout the thesis for their superior performances in the high dimensional state-space model with improved numerical stability. To this end, the suitable model structures for transient and harmonic signals are formulated, and comparative analyses using variants of KF are performed to select the most convenient filter module. Then, a novel algorithm based on a symmetric-strong-tracking (SST) framework for the SCKF is developed where state constraints are imposed using the logarithmic barrier function to estimate the parameters of a transient signal. The proposed scheme is validated in real-time by flashing codes in the ARM Cortex-M7 core-based microcontroller. Next, a two-stage adaptive SCKF algorithm is formulated that simultaneously estimates the harmonic/interharmonic parameters of a signal and statistical characteristics of the noise. The algorithm employs a high-resolution subspace-based Root-MUSIC that estimates the unknown frequencies *a priori*. The proposed two-step module follows IEEE/IEC 60255-118-1-2018 Standard with class M thresholds. The remarkable achievement is obtained when compared with *state-of-the-art*

methods in real-time using the ARM-based microcontroller. Later, we moved our research work towards the sparse representation of a power signal using the orthogonal matching pursuit (OMP) and K-singular value decomposition (K-SVD). Here, the sparse power system domain-based CKF (SPSD-CKF) algorithm is developed. Later, CS embedded SCKF and a deep convolution network architecture have been implemented for classification and parameters estimation of the sparse PQ signals.

Keywords: Compressed sensing, convolution neural network (CNN), cubature Kalman filter (CKF), Kalman filter (KF), K-SVD, orthogonal matching pursuit (OMP), Root-MUSIC, sparse representation.