Fast Frequency Estimator (FFE)

Tech ID: 24871 / UC Case 2013-548-0

BACKGROUND

The problem of estimating and tracking the frequency of a weak sinusoidal signal occurs in many areas of signal processing. There are a variety of approaches to estimate the frequency of a harmonic signal. The most common approach is to directly measure the time difference between zero crossings and the number of cycles per second. However, this approach is very sensitive to signal noise. Solutions to overcome this problem have been proposed, such as the Fourier transform technique, correlation, the least square error technique, recursive algorithms, chirp Z transform (CZT), adaptive notch filters, and Kalman filtering that estimates instantaneous frequency of the signal. The Kalman filter is a recursive stochastic technique that gives an optimal estimation of state variables of given linear dynamic system from noisy measures. Moreover, the filter must always deal with the inherent nonlinearity and with extreme noise levels. Coincidentally, the Kalman filter also gives a time-varying gain, which is not amendable to frequency domain analysis.

TECHNOLOGY DESCRIPTION

UC Santa Cruz researchers have proposed a clock and date recovery circuit that can serve as a replacement for Phase Locked Loops (PLLs) in many applications. The novel circuit design is based on high level speed analog implementation of a modified extended Kalman Filter Frequency Estimator (EKFFE). High levels of functionality and stability has been verified using MATLAB and SPICE simulations. Greatly superior performance in acquisition time and range compared to PLLs has been demonstrated. The invention, known as a Fast Frequency Estimator (FFE), has proven success, showing very fast convergence. Moreover, the scalable FFE displays infinite pull-in range with no forgetting factor, optimal noise rejection, and has flexibility in many communication, computer, and other applications that would otherwise use a PLL.

APPLICATIONS

- Circuit design for computer and other applications that can use PLL

ADVANTAGES

- Fast convergence
- Infinite pull-in range with no forgetting factor
- Optimal noise rejection
- Great flexibility for many communications

INTELLECTUAL PROPERTY INFORMATION

Country	Type	Number	Dated	Case
Japan	Issued Patent	6424202	10/26/2018	2013-548
United States Of America	Issued Patent	9,325,333	04/26/2016	2013-548

Additional Patent Pending

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OTHER INFORMATION

KEYWORDS

Phase Locked Loop, PLL, data recovery, Kalman filter, frequency estimator, Extended Kalman Filter Frequency Estimator, EKFFE, Fast Frequency Estimator, FFE, MATLAB, SPICE, circuit design, computer, communications, Cat3

CATEGORIZED AS

- **Communications**
  - Other
- **Computer**
  - Hardware
  - Other
  - Software
- **Semiconductors**
  - Design and Fabrication

RELATED CASES

2013-548-0

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