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REVIEW OF PARAMETER ESTIMATION USING ADAPTIVE FILTERING

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ABSTRACT: In this paper, a comparative study of different adaptive filter algorithm for channel parameter estimation is described. We presented different parameter estimation approaches of adaptive filtering. An extended Kalman filter is then applied as a near-optimal solution to the adaptive channel parameter estimation problem. Kalman filtering is applied for motion parameters resulting in optimal pose estimation. A parallel Kalman filter is applied for joint estimation of code delay, multipath gains and Doppler shift. In this paper, a complete review of parameter estimation using adaptive filtering is explained.

Keywords: Parameter Estimation, Adaptive filtering, Kalman filter, Extended Kalman Filter.

I.INTRODUCTION

The power efficiency provided by coherent detection in digital communication systems is only possible when the receiver is supplemented by carrier phase synchronization, or said generally, a multiplicative distortion estimation unit. Such a unit, which may or may not have access to modulation-free sections of the carrier, can optimally estimate the multiplicative distortion from the received signal by modelling the dynamics generating the multiplicative distortion[19].

A popular approach for carrier recovery[19] is the maximum likelihood (ML) method where an appropriate likelihood function of the carrier phase taken as unknown and essentially constant over an observation interval is maximized and no assumption about the a priori probability densities is made. For a simple additive white gaussian noise (AWGN) channel, other approaches which use some apriori knowledge about the carrier phase distribution yield similar results because the module-2 pi nature of phase effectively produces a uniform distribution.

In the manufacturing environment, low-cost camera systems are commonly used for many tasks. This kind of vision measurement includes significant noise due to the camera’s characteristics, image signal spatial quantization and amplitude discretization, lens distortion, sensor pixel level errors, etc. Even for high-cost camera systems, these error sources cannot be totally avoided. Noisy image can result in poor individual pose estimates [20]. To reduce the effect of image measurement noise on the pose estimates, a time based filter can be applied to filter out some of noise when a sequence of images are used for tracking control.

Spread-spectrum receiver to demodulate data, the timing offset between the receiver generated reference signal and the transmitted signal must be accurately tracked [21]. Any Doppler shift distortion present on the signal must also be taken into account. Here we will assume a pre-acquired coarse timing estimate. The remaining problem is thus to acquire coarse estimates of the Doppler shift, and to track the code delay, timing and complex-valued multipath coefficients. The problem of tracking timing and multipath coefficients jointly was first considered and solved using an EKF algorithm.

This paper is organized as follows: In Section II, Adaptive filtering is explained using Different configurations Adaptive system identification, Adaptive noise cancellation, Adaptive linear prediction and Adaptive inverse system. In section III linear channel estimation is explained. Then parameter estimation, state estimation and linear channel estimation is explained. In Section IV, shows the review of parameter estimation using Kalman filter, extended Kalman filter and parallel Kalman filter. Finally, a conclusion is made.

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II. ADAPTIVE FILTERING

From last few decades adaptive Filtering is gaining momentum in many Digital signal processing (DSP) applications. Digital signal processing (DSP) has been a major player in the current technical advancements such as noise filtering, system identification, and voice prediction. There are four major types of adaptive filtering configurations [2]; Adaptive system identification, Adaptive noise cancellation, Adaptive linear prediction and Adaptive inverse system. All of the above systems are similar in the implementation of the algorithm, but different in system configuration. All 4 systems have the same general parts; an input $x(n)$, a desired result $d(n)$, an output $y(n)$, an adaptive transfer function $w(n)$, and an error signal $e(n)$ which is the difference between the desired output $u(n)$ and the actual output $y(n)$. In addition to these parts, the system identification and the inverse system configurations have an unknown linear system u(n) that can receive an input and give a linear output to the given input.

A. Adaptive System Identification

The adaptive system identification is primarily responsible for determining a discrete estimation of the transfer function for an unknown digital or analog system. The same input $x(n)$ is applied to both the adaptive filter and the unknown system from which the outputs are compared(Fig 1).

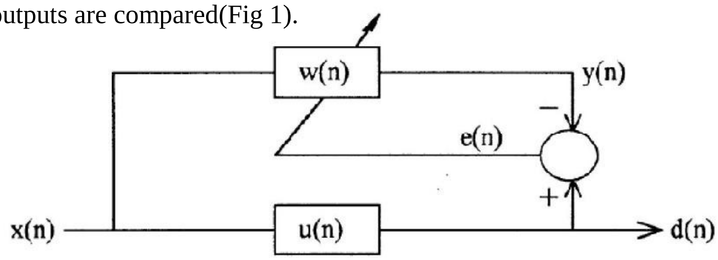

Fig. 1: Adaptive System Identification

B. Adaptive Noise Cancellation

Adaptive noise cancellation configuration [6] is shown in fig. 2. In this configuration the input $x(n)$, a noise source $N_1(n)$, is compared with a desired signal $d(n)$, which consists of a signal $s(n)$ corrupted by another noise $N_0(n)$. The adaptive filter coefficients adapt to cause the error signal to be a noiseless version of the signal $s(n)$.

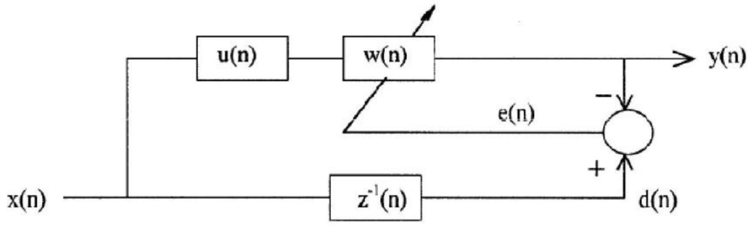

Fig. 2: Adaptive Noise Cancellation

C. Adaptive Linear Prediction

Adaptive linear prediction essentially performs two operations. The first operation, if the output is taken from the error signal $e(n)$, is linear prediction. The adaptive filter coefficients are being trained to predict, from the statistics of the input signal $x(n)$, what the next input signal will be. The second operation, if the output is taken from $y(n)$, is a noise filter similar to the adaptive noise cancellation.

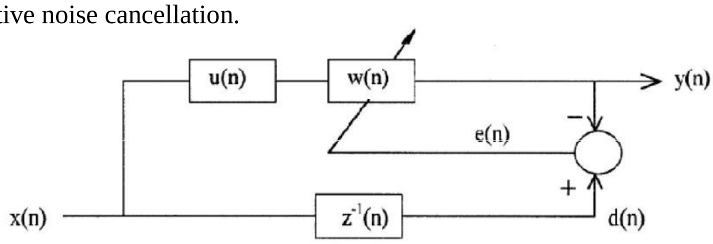

Fig. 3: Adaptive Linear Prediction

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D. Adaptive Inverse System

The goal of the adaptive filter here is to model the inverse of the unknown system $u(n)$. This is particularly useful in adaptive equalization where the goal of the filter is to eliminate any spectral changes that are caused by a prior system or transmission line. The way this filter works is as follows. The input $x(n)$ is sent through the unknown filter $u(n)$ and then through the adaptive filter resulting in an output $y(n)$. The input is also sent through a delay to attain $d(n)$. As the error signal is converging to zero, the adaptive filter coefficients $w(n)$ are converging to the inverse of the unknown system $u(n)$.

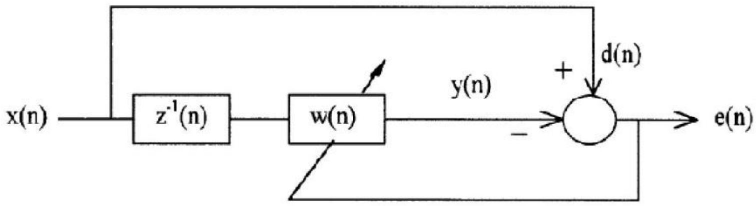

Fig. 4: Adaptive Inverse System

III. LINEAR CHANNAL ESTIMATION

The term estimator is related to the filtering. It is used to refer as a system i.e. designed to extract information about a prescribed quantity of interest from noisy data. The term channel estimation allows the receiver to approximate the effect of the channel on the signal. The channel is suffered from the two impairments: ISI and Noise [9].

A. Parameter Estimation

In the parameter estimation parameter does not change at all or changes slowly in time, whereas the state estimation continuously evolves in time. Parameter identification in many communication and control system some of the system parameters are not known with desired accuracy. The method of estimating these known parameter from observed data is called parameter identification. System identification the more general problem of developing a mathematical model of the system from observed data is called system identification[4].

B. State Estimation

State estimation is described by signal processing, filtering and smoothing. Three basic approaches used for estimation are least-squares, maximum-likelihood, and Bayesian. An estimator is defined as a function of the observations possessing certain desirable properties such as unbiasedness, consistency, and minimum variance. A Kalman filter provides estimates that are optimal in the least-squares, maximum-likelihood and Bayesian sense for a Gauss-Markov model. The stochastic process is Markov if, given its present state, its future is independent of its past [7].

C. Channel Estimation

The Channel estimation is defined as the process which characterizing the effect of the physical channel on the input sequence. The channel estimate, estimates of the impulse response of the system, if the channel assumed to be linear. It must be stressed once more that channel estimation is only a mathematical representation of what is truly happening. A good channel estimate is one where some sort of error minimization criteria is satisfied (e.g. Minimum Mean Square Error (MMSE) [12].

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IV. REVIEW OF PARAMETER ESTIMATION

Below table: shows the literature survey of the parameter estimation using adaptive filtering techniques:

Year of Publication	Author	Title	Techniques	Conclusion
1989	Aghamohammadi, A., Meyr, H. and Ascheid, G.	Adaptive synchronization and channel parameter estimation using an extended Kalman filter[19]	Extended Kalman filter	MD estimation for digital communications involves, in general, nonlinear models with additional unknown or randomly varying parameters
1992	Jiang Wang and William J. Wilson	3D Relative Position And Using Kalman Filter Orientation Estimation For Robot Control[20]	Kalman Filter	Kalman filter is used to reduce the effect of vision measurement noise and to provide optimal pose estimates.
1994	Alfred W. Fuxjaeger and Ronald A.	Adaptive Parameter Estimation using Parallel Kalman Filtering for Spread Spectrum Code and Doppler Tracking[21]	Parallel Kalman Filtering	Adaptive parameter estimation was used to implement an adaptive RAKE receiver operating in the presence of multipath.
2001	Schulz-Rittich, P., Baltersee, J. And Fock, G	Channel estimation for DS-CDMA with transmit diversity over frequency selective fading channels[15]	Transmit diversity	The effectiveness of these techniques is determined by the accuracy of the radio channel estimation system
2007	Linhai Li , Hong Li , HongYi Yu , Baiwei Yang and Hanying Hu	A New Algorithm for MIMO Channel Tracking Based on Kalman Filter[14]	Kalman Filter	Estimation of a time-varying fading channel in multiple-input multiple-output (MIMO) wireless systems is a difficult task for the receiver.
2006	Wang Ling, Liang Ting	Kalman Filter Channel Estimation Based on Comb-Type Pilot in Time-Varying Channel[13]	Kalman Filter	To compensate for this ICI, a kalman filter based on comb-type pilot signal is proposed for channel Estimation.
2010	Shanmugan, K.S., Sanchez, M.P., de Haro, L. and Calvo, M	Channel estimation for 3G wideband CDMA systems using the Kalman filtering algorithm[11]	Kalman filtering algorithm	In the receivers for 3G CDMA systems depends on accurate estimates of the multipath fading Channel.
2010	] Vilaipornsawai, U.	Joint Data Detection	Doppler	Doppler Adaptive

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	and Leib, H.	and Channel Estimation for Fading Unknown Time-Varying Doppler Environments Communications[18]	Adaptive Smoothed Data Detection and Kalman Estimation	Smoothed Data Detection and Kalman Estimation (DA-SDD-KE) that jointly detects data and estimates the channel as well as the time-varying Doppler.
2011	Zheng Du, Xuegui Song, Cheng, J. And Beaulieu, N.C	Maximum Likelihood Based Channel Estimation for Macrocellular OFDM Uplinks in Dispersive Time-Varying Channels[12]	Maximum Likelihood	Two iterative maximum likelihood (ML) based channel estimation Algorithms are proposed for OFDM uplinks in dispersive time-varying channels.

From the above Literature survey it is clear that Kalman filter has various applications like Adaptive Synchronization and Channel Estimation. It is used to estimate various type of channel like Rayleigh fading channel, multipath channel, non linear channel etc. The non linear channel can be estimated by using extended kalman filter. The kalman filter is an effective technique used to determined the accuracy of the radio channel estimation system. The kalman Filter is also used to calculate the power of the signal.

V.CONCLUSION

In this paper, a comparative study of different adaptive filter algorithm for channel parameter estimation is described. We presented different parameter estimation approaches of adaptive filtering. In this paper, a complete review of parameter estimation using adaptive filtering is explained.

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