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Prediction and Estimation of Channel in Multi-User Environment in OFDMA

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Abstract:—In this paper we project an approach of channel prediction and estimation when multiple users are transmitting simultaneously, and that to by overlapping pilots. Pilots are nothing but reference symbols used transmitter and receiver, estimation of channel performance is done by using NMSE which is calculated in MMSE and KALMAN estimator, a plot is drawn between SNR and SER for multi user transmission using overlapping pilots for the two estimators, and the performance of these two estimators is observed, Similarly a plot is drawn between NMSE and Wavelength to analyze the characteristics when the user is mobile

I. INTRODUCTION

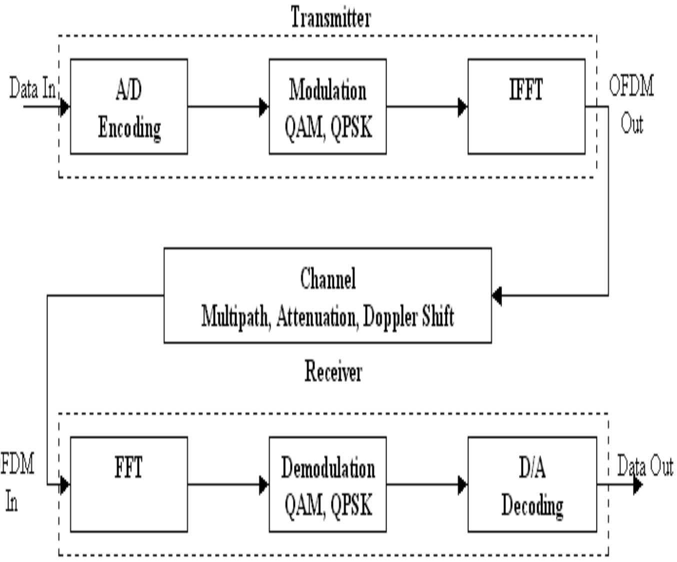
Adaptive systems for wireless transmission allocate time/frequency resources based on channel quality and user requirements. They enable efficient resource utilization and multiuser diversity gains. In the system based on OFDMA/TDMA time-frequency bins,consisting of a number of sub channels are allocated.

For mobile users, the SNR will vary between bins both in frequency and in time. The feasibility of adaptive transmission in the downlink, based on channel prediction .This paper will consider the problem of estimating and predicting channels in the corresponding uplinks.The less challenging is the downlink scenario when overlapping pilots are not used,.

II. OFDM

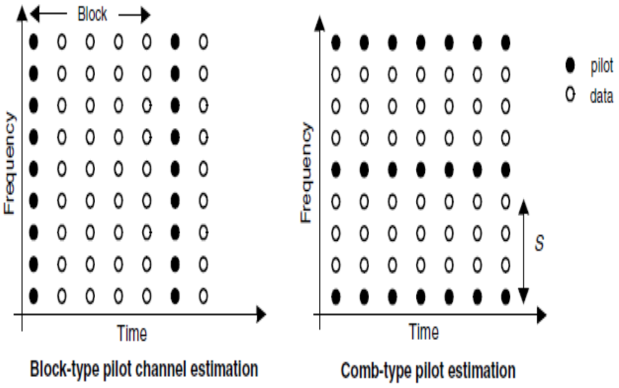
OFDM is becoming widely applied in wireless communications systems due to its high rate transmission capability with high bandwidth efficiency and its robustness with regard to multi-path fading and delay [. It has been used in digital audio broadcasting (DAB) systems, digital video broadcasting (DVB) systems, digital subscriber line (DSL) standards, and wireless LAN standards such as the American **IEEE**® Std. 802.11™ (WiFi) and its European equivalent HIPRLAN/2. It has also been proposed for wireless broadband access standards such as **IEEE** Std. 802.16™ (WiMAX) and as the core technique for the fourth-generation (4G) wireless mobile communications.

The use of differential phase-shift keying (DPSK) in OFDM systems avoids need to track a time varying channel; however, it limits the number of bits per symbol and results in a 3 dB loss in signal-to-noise ratio (SNR). Coherent modulation allows arbitrary signal constellations, but efficient channel estimation strategies are required for coherent detection and decoding.



A. Problem in channel estimators

There are two main problems in designing channel estimators for wireless OFDM systems. The first problem is the arrangement of pilot information, where pilot means the reference signal used by both transmitters and receivers. The two basic 1D channel estimations are block-type pilot channel estimation and comb-type pilot channel estimation, in which the pilots are inserted in the frequency direction and in the time direction, respectively. The estimations for the block-type pilot arrangement can be based on least square (LS), minimum mean-square error (MMSE), and modified MMSE.



Block-type pilot channel estimation

Comb-type pilot estimation

III. ESTIMATION TECHNIQUES

A. Ls Estimator

This estimator minimizes the parameter (Y-XH)(Y-XH)H where $(.)^H$ represents conjugate transpose operation.LS estimator of H is given by $\hat{H}_{LS}=X^{-1}Y$.

B. Mmse Estimator

It employs second order statistics to minimize the mean square error .In this we make use of second order auto correlation andcross correlation functions.The equations used are

$$Y=DFT_N(IDFT_N(X)\otimes g+n)=\underline{X}\,\underline{F}\,g+N$$

$$\underline{R}_{HH}=E\{H\,H^H\}=E\{(\underline{F}\,g)(\underline{F}\,g)^H\}=\underline{F}\,R_{gg}\,\underline{F}^H$$

$$\underline{R}_{gY}=E\{g\,Y^H\}=E\{g(\underline{X}\,\underline{F}\,g+N)^H\}=\underline{R}_{gg}\,\underline{F}^H\,\underline{X}^H$$

$\underline{R}_{gg}$ = *Auto correlation of estimate of channel conditions(g)*

$$\underline{R}_{YY}=E\{Y\,Y^H\}=\underline{X}\,\underline{F}\,\underline{R}_{gg}\,\underline{F}^H\,\underline{X}^H+\sigma^2_N I_N$$

$$\hat{g}_{MMSE}=\underline{R}_{gY}\,\underline{R}_{YY}^{-1}\,Y^{HH}$$

where $H=\underline{F}\,g$ ($\underline{F}$ = DFT Matrix)

C. Kalman Estimator

It is used in the analysis of a dynamic system, it makes use of predictor and corrector equations,it calculates the next state and the output based on the guesses.

The Equations used are :

PREDICTOR EQUATIONS

xapriori(j)=a*xaposteriori(j-1)
residual(j)=z(j)-h*xapriori(j)
papriori(j)=a*a*paposteriori(j-1)+Q

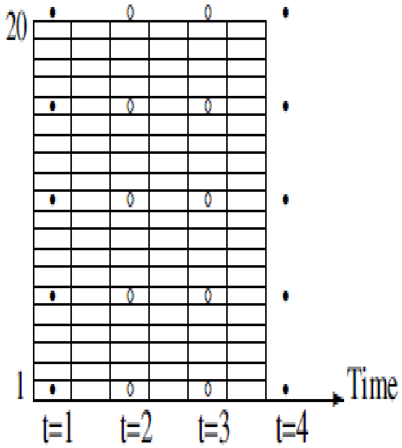
CORRECTOR EQUATIONS

k(j)=h*papriori(j)/(h*h*papriori(j)+R)
paposteriori(j)=papriori(j)*(1-h*k(j))
xaposteriori(j)=xapriori(j)+k(j)*residual(j)

In the above equations a and h are the system specific parameters,Q and R are measurement and performance noise.

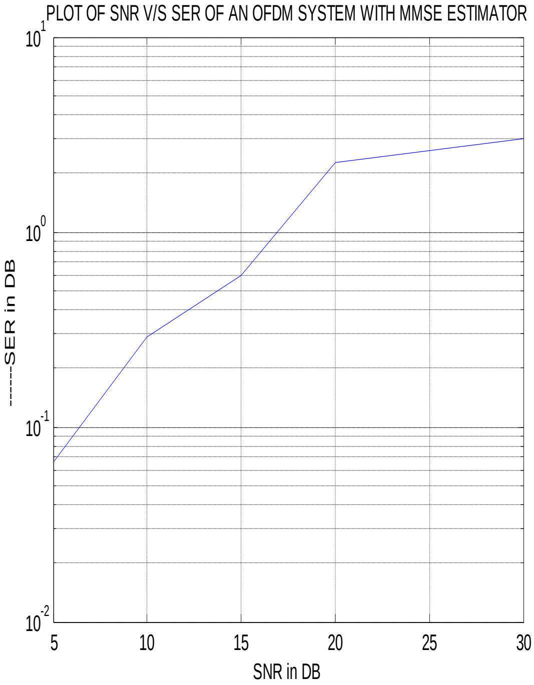
IV. OVERLAPPING PILOTS EXAMPLE

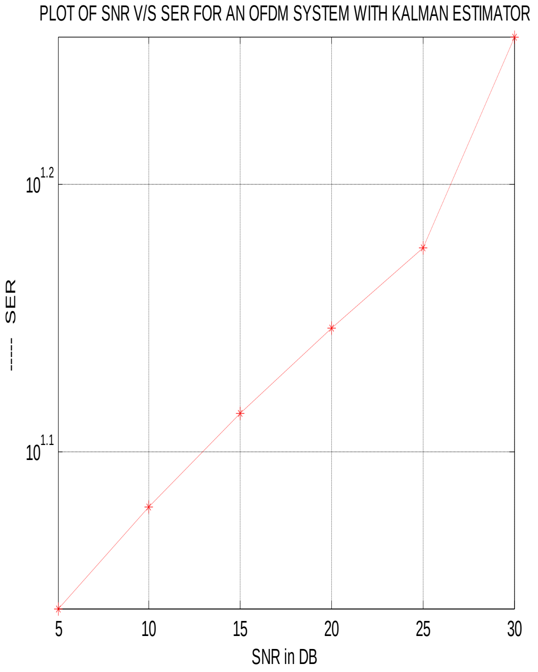
One of the time-frequency bins of the investigated system,containing 20 subcarriers with 6 symbols each. Known 4-QAM pilot symbols (black) and 4-QAM control data symbols (rings) are placed on four pilot subcarriers. The modulation format for the other (payload) symbols is adjusted adaptively. The bin is assumed to be exclusively allocated to one out of *K* users. All payload symbols within a bin use the same modulation format.



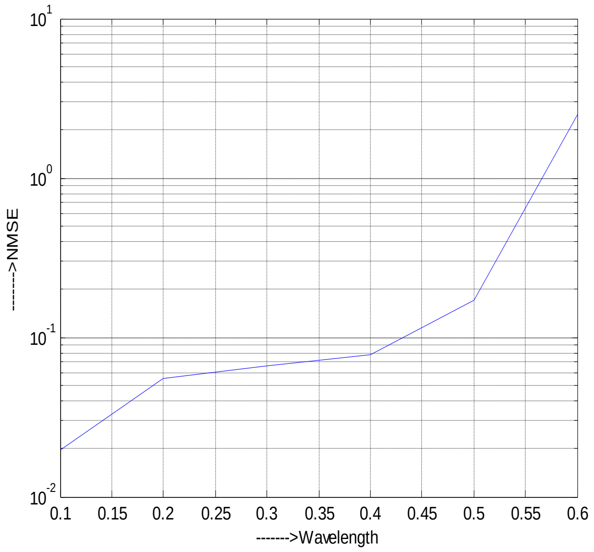
The available uplink bandwidth within a sector (cell) is assumed to be partitioned into *time-frequency bins* of bandwidth Δfb and duration T. These bins are assumed to be exclusively allocated to one of K users. We here assume T = 0.667 ms and Δfb = 200 kHz, which is appropriate for stationary and vehicular users in urban or suburban environments . We also assume a subcarrier spacing of 10 kHz, a cyclical prefix of length 11 μs and an OFDM symbol period (including cyclic prefix) of Ts = 111μs. Thus, each bin of 0.667 ms × 200 kHz carries 120 symbols, with 6 symbols of length 111μs on each of the 20 10 kHz subcarriers.Of these 120 symbols, four locations are reserved for overlapping pilot symbols, assumed to be 4-QAM symbols.Furthermore, 8 symbols are allocated for control information,that utilizes a fixed modulation (here assumed to be 4-QAM), leaving 108 payload symbols.

V. RESULTS





Plot for NMSE vs Wavelength



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