Adaptive monitoring technique for MIMO-OFDM systems

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ABSTRACT

The major requirements in the wireless communication system are to increase the speed, range and reliability of the system by using a Multi User and Multi Carrier Modulation scheme like MIMO-OFDM. The MIMO-OFDM is designed for high speed data rate, higher spectral efficiency and lower latency by using beam forming and multiplexing techniques therefore it is used in Long Term Evolution-Advanced(LTE-A) systems. Multiple Input Multiple Output(MIMO) uses the multiple antennas at the transmitter and receiver. MIMO antennas adapts itself to pick a user signal, in any direction without the user intervention. OFDM is a popular method for high data wireless transmission. OFDM may be combined with antenna arrays at the transmitter and receiver to increase the diversity gain and /or to enhance the system capacity in a time-variant and frequency selective channels resulting in a MIMO configuration. This paper describes an adaptive algorithm i.e., Recursive Least Square Algorithm (RLS) in the downlink for continiously monitoring the user equipment.

***Keywords:** Beam forming, MIMO-OFDM,LTE-A, Adaptive algorithm*

INTRODUCTION

Multiple Input Multiple Output (MIMO) is a radio communication technology is used in many new technologies in these days. Wi-Fi, LTE (Long Term Evolution) and many other radio and wireless technologies are using the concept of MIMO to provide an increased link capacity, spectral efficiency and datarate. Even now there are many MIMO wireless routers in the market, and as this radio communications technology is becoming more widespread and popular. The MIMO routers and other concepts of wireless MIMO are elaborated in [1]. MIMO is effectively a radio antenna technology as shown in fig(1). It uses multiple antennas at the transmitter and receiver to enable a variety of signal paths to carry the data, choosing separate paths for each antenna to enable multiple signal paths between the transmitter and the receiver. The variety of paths available occurs as a result of the number of objects that appear to the side or even in the direct path between the transmitter and receiver. Previously these multiple paths only served to introduce interference.

By using MIMO, these additional paths can be used to increase the capacity of a link. To take advantage of this in a MIMO wireless system, the transmitted data must be encoded using what is termed as the space-time code to allow the receiver to extract the fundamental transmitted data from the received signals. The space-time code optimises the Signal to Noise (SNR) ratio, and the codes used define the performance gain that can be achieved and obviously the more gain that is achieved, the more processing power is required [2].

MIMO-OFDM: As a result, MIMO wireless systems combine the use of MIMO with OFDM (Orthogonal Frequency Division

Multiple). The reason is that the problems created by multi-path channel are handled efficiently using OFDM[3]. The IEEE 802.16e standard incorporates MIMO-OFDM and the IEEE 802.11n standard also uses MIMO-OFDM. In addition to this the new 3G LTE (Long Term Evolution) format for cellular telecommunications also uses MIMO-OFDM[4].

Beam forming is an array signal processing which increases signal to interference-noise ratio (SINR) by mitigating co channel interferences present in wireless mobile cellular system. This Project presents importance of beam forming technique for next generation broadband wireless mobile systems. Beam forming is a powerful means of increasing capacity, data rates and coverage of the cellular system. In recent decades, Beam forming antennas for mobile wireless communications have received enormous interest. Beam forming is a promising technology which reduces interferences and noise and thereby ensures high signal to interference-noise ratio (SINR). This makes mobile wireless operators to provide high speed data services as per the demand in affordable price to subscribers by supporting large number of users over limited available spectrum. Beam forming is a signal processing technique used in sensor arrays for directional signal transmission or reception. This spatial selectivity is achieved by using adaptive or fixed receive/transmit beampatterns. The beam pattern is formed by adjusting complex weights of the antenna elements so that beam is directed in the direction of interest. When receiving, information from different sensors is combined in such a way that the expected pattern of radiation is preferentially observed. Thus Receive Beamforming increases the sensitivity in the direction of desired user than that of interferences. When transmitting, a beamformer controls the phase and relative amplitude of the signal at each transmitter, thus produces a high directional beam in the direction of desired user and null in the direction of interferences, thereby increasing SINR of the desired user and reducing the wastage of transmitted power in the undesired direction as shown in fig(2). The receive beam forming is achieved independently at each receiver while in transmit beam forming, transmitter has to consider the all receivers to optimize the beam former output. Thus beam forming antenna produces high directional beam in the direction of intended user, thereby increasing SINR and coverage area. Beam forming mitigate multipath propagation present in mobile radio environments by constructively adding multipath signal to increase the strength of desired signal.

The **Recursive least squares (RLS)** is an adaptive filter which recursively finds the coefficients that minimize a weighted linear least squares cost function relating to the input signals. This is in contrast to other algorithms such as the least mean squares (LMS) that aim to reduce the mean square error. In the derivation of the RLS, the input signals are considered deterministic, while for the LMS and similar algorithm they are considered stochastic. Compared to most of its competitors Sample Matrix Inversion (SMI), LMS, the RLS exhibits extremely fast convergence. However, this benefit comes at the cost of high computational complexity.

LITERATURE SURVEY:

In 3GPP LTE uses the MIMO technology to enhance the data rate, capacity and system performance[5]. Here, the radio channel is frequency selective and time varying for wideband mobile communication systems.3GPP estimation based on LS and MMSE in the mobile communication environment.LS is simpler but which does not need channel information. MMSE is the correlation between subcarrier and channel information. In this paper, 3GPP uses 2D-IWF(Iterative Wiener Filter) for both time and frequency domain.LS and MMSE supports only for one dimensional.IWF based on LMMSE algorithm in both time and frequency domain which can reduces the noise effects and BER performance. By introducing the new horizon in the area of digital communication systems, the combination of MIMO and OFDM is emerged into the telecommunications world. LTE combines both OFDM and MIMO because to increase the data rate up to 100 Mbps. Scattered pilots are employed in the LTE downlink for proper channel estimation. MMSE type channel estimation is used in this paper and it is suitable for fast fading environments [6].

The adaptive Frequency Domain Channel Estimation (FD-CE) is used in 4x4 MIMO-OFDM symbols and it achieves 10% packet error rate. This decreases the complexity because of alamouti like matrix. To increase the throughput, the numbers of pilots are smaller than that of the data carriers in MIMO-OFDM systems. This algorithm measures channel variations and prevents performance loss in time varying frequency selective fading[7].

The adaptive RLS channel estimation in MIMO-OFDM systems are three different forgetting factors in that two steps are adaptive and one step applied to RLS channel estimation. This increases the estimation accuracy and robustness over the frequency selective fading channels. ARLS is used for adjusting forgetting factor adaptively to track and estimate the channel parameters in MIMO-OFDM systems. It overcomes the disadvantages caused by propagation effects in environment by means of adjusting forgetting factor value adaptively. Therefore, this algorithm is more efficiently applied in MIMO-OFDM systems[8].

The decision directed RLS adaptive channel tracking algorithm used in 2X2 spatial multiplexing. MIMO-OFDM systems are used under high mobility. After MIMO signal detection and then activates the RLS adaptive algorithm only when less interference and less error will be generated. Here, 2D-RLS algorithm is used to suppress the error propagation and coefficient mis adjustment. The quality detection is depends on the tracking accuracy of time varying channels. This improves the SNR and system performance [9].

METHODOLOGY:

In the project 4G and LTE-A network based mobile user detection is performed using subspace computation of the array correlation matrix. When the radiation pattern is formed it forms the main beam towards the desired mobile users and nulls or reduced radiation towards the interference users. The Tracking is done in such a way that the Mean Square error is very less in case of 4G LTE network. Also in order to improve the convergence and capacity of 4G networks Recursive Least Square (RLS) algorithm is used for the downlink and MIMO CSI based Channel estimation is used on the Uplink. The Sample Matrix Inversion (SMI) is used if the desired and interference signals are known before or have been estimated. This provides the direct and fastest solution to compute the optimal weights. However, if the signals are not known exactly, then signal environment undergoes frequent changes. Thus, the signal processing unit must continuously update the weight vector to meet the new requirements imposed by the varying conditions. Here, Comparing Sample Inversion Matrix(SMI) and Recursive Least Square algorithm(RLS) adaptive beam forming techniques. SMI supports only less number of antenna elements and less number of jammers.RLS supports as well as more antenna elements and more jammers. The flowchart for SMI algorithm is shown in fig(3). The results of SMI beam forming algorithm is shown in fig (4) and fig(5).

CONCLUSIONS:

In this paper, gives the information about MIMO systems and Beam forming algorithms. MIMO is used to increase the capacity, data rate and spectral efficiency of the system. Beam forming is used to form the beam towards the desired user and null towards the interference users in time varying environment. Here, comparison between the SMI and the RLS adaptive beam forming algorithms is also discussed in this paper.RLS supports more jammers and more antenna elements compared to SMI. RLS supports more jammers and more antenna elements compared to SMI.RLS supports both static and non static environments and also used as well as real time applications.

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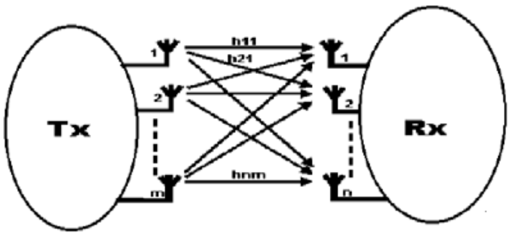

Fig.1: Basic MIMO system

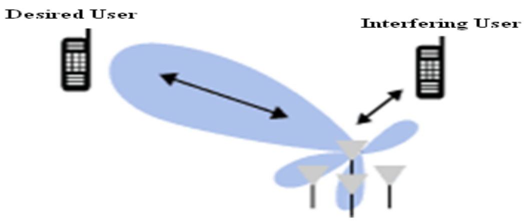

Fig.2: Smart antenna systems

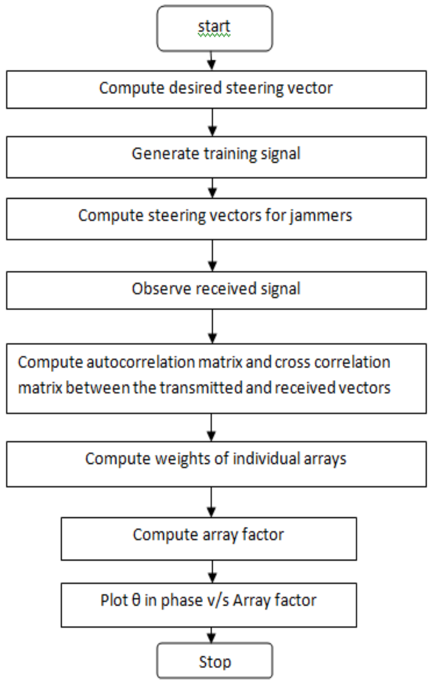

Fig.3: Flowchart of SMI algorithm

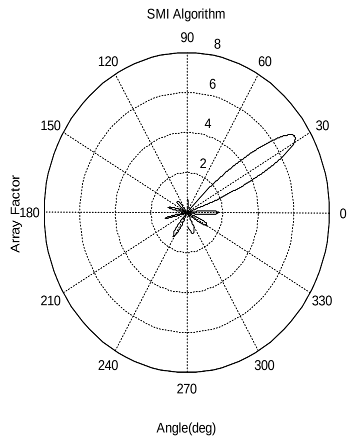

Fig.3: Polar Plot Representing Main Beam Along Desired User at30°

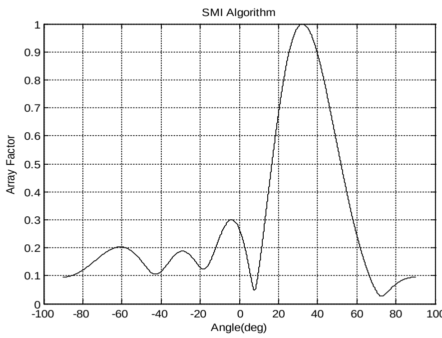

Fig.4: Normalized Array Factor Plot for SMI Algorithm