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CHANNEL MODELING BASED ON 3-D WAVE SCATTERING COHERENT DD EW-RLS AND DD NLMS ESTIMATION OF OFDM-MIMO IN WIRELESS COMMUNICATION

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

In this work, a geometrically-based of three-dimensional (3-D) wave scattering MIMO channel model is developed to accomplish practical mobile communication systems with MIMO and OFDM technologies, which is concerned with MIMO channel modeling and effect of realistic channels on the theoretical capacity. For this aim, the correlation of joint spatial-temporal and temporal functions are derived and analytically evaluated. Numerical results show that the elevation angle has considerable effect on the spatial correlation, thereby on the MIMO system capacity, in case of vertical orientation of the antenna array of the mobile station (MS). Thus, 3-D scattering MIMO channel modeling is necessary for accurately predicting the MIMO systems performance. Particularly the focus has been made on the estimation performance of the exponentially weighted recursive least square (EW-RLS) and low complexity least mean square (NLMS) estimators. These estimators are then extended to work in the decision-directed (DD) mode to track the time variations of the channel in Low mobility (indoor) as well as moderate mobility (outdoor) environments. For performance comparison, channel estimation based on least-squared (LS) method has been used as the baseline study. All the purpose estimators use either preamble sequences or pilot symbols to carry out the estimation process. Simulation results have demonstrated that time-domain adaptive channel estimation and tracking in MIMO OFDM systems based on the DD EW-RLS and DD-NLMS is very effective in slowly to moderate time-varying fading channels. The proposed estimator has good estimation and tracking capabilities especially for slow fading channel ($f_d T_s = 0.00544$) It has also shown that time-domain channel estimation in MIMO OFDM system is in more accurate and fewer complexes compared to its counterpart in frequency-domain. Furthermore, it was observed that the performance of the DD EW-RLS estimator always outperform the DD-NLMS estimator in slowly time-varying channels (indoor environments). However, it was found that the tracking performance of the DD-NLMS estimator is better than that of the DD EW-RLS at higher mobility (outdoor environments) and higher SNR environment. As the training rate reduces, the performance of the DD EW-RLS estimator outperforms that of the DD-NLMS at low SNR; however, similar performance of both estimators is obtained at high SNR. The results are shown for Doppler frequencies of $f_d = 40Hz$ (i.e. Doppler rate of variations, $f_d T_s = 0.00544$) and $f_d = 75Hz$ (representing Doppler rate $f_d T_s = 0.0102$), which are corresponding to mobile speeds of roughly 18 Km/h (indoor scenario) and 34 Km/h (outdoor scenario), respectively, assuming radio frequency of 2.4 GHz.

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CHAPTER ONE
INTRODUCTION

1.1 Background of Study

The most important thing in radio communication systems design is to have accurate channel models. The principal contributor of the problems and limitations that severely degrade on the performance of the systems is called the propagation channel. Channel model is the hardest part in evaluating the capacity of Multiple Input Multiple Output (MIMO) system because the characteristic of the channel can give the best performance at the detector or receiver [4, 5, 6, 7]. The prediction of system performance will be more accurate if a physical understanding in mathematical modeling of the channel to provide the mechanism to investigate methods algorithms for mitigating impairments caused by the radio wave.

1.2 OFDM Channel Estimation

Channel estimation is the challenging problem in the case of communication system designing especially when the channel is time-varying. The knowledge in channel state information (CSI) is very important to perform the symbol detection, space time coding, diversity combining and the efficient equalizers at the receiving end. The modulated data symbols are amplitude and phase distorted during propagation due to the frequency selectivity and time-varying nature of wireless channels in Orthogonal Frequency Division Multiplexing (OFDM) system. At the detector part, coherent detection or non-coherent detection are applied to recover the original symbols [6] in order for the receiver to acquire the original symbols, it needs to take into account these unknown changes. It means that coherent detection requires the knowledge of the CSI that can be obtained through using reference information symbols that are transmitted along with data symbols and the receiver can estimate the channel only at these reference symbols locations and one of the several interpolation techniques can be used to estimate the entire channel 6],[7]. In non-coherent detection OFDM systems, on the other hand, the CSI knowledge is not required, but differential phase-shift keying (DPSK) modulation is used,