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System analysis of DSTTD-CDMA system with polarization diversity for frequency-selective channel☆

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ABSTRACT

In this treatise, we consider the image transmission by means of turbo coded Double Space-Time Transmit-Diversity (DSTTD) Code Division Multiple Access (CDMA) structured module using Polarization diversity (PD) through wireless networks. We consider Advanced Encryption Standard (AES) algorithm for data hiding and discrete wavelet transform (DWT) technique for image compression. We consider dual-Polarized antenna both at transmitter and mobile station (MS) to establish PD. At each MS, we implement non-linear detector which comprises of Block-nulling technique, which can separate two STBC block units and offers higher throughput. In specific, we examine the effects of nine tap delay pertaining to LTE-Extended vehicular channel models for DWT and encrypted image transmission of coded DSTTD-CDMA system. From our simulation, we observe that our system with PD provides secured image transmission with better picture quality for less SNR which offers high throughput with compact size of MS in the perspective of downlink DL communication.

1. Introduction

In recent past, the development in wireless communication technologies have drawn major attention towards digital image transmission through wireless networks. However, transmission of such images through wireless communication becomes challenging issue as an illegal data access turn out to be an uncomplicated task. Hence, in order to protect valuable data or image from unauthorized readers, data or image encryption is essential. The image information contains larger measure of data, higher redundancy and stronger correlation between pixels which is actually different from text information therefore, traditional encryption algorithms such as Data Encryption Standard (DES) are not prescribed for digital image encryption. Henceforth, secured Advance Encryption Standard (AES) algorithm has been proposed by research community for digital image encryption. In AES encryption algorithm, the secret key is shared between sender and receiver. It has been elucidated that the AES algorithm finds many application such as smart cards, cell phones, Automated Teller Machines and World Wide Web servers etc., The authors Meghdad, AshtiyaniParmida, and MoradiBirgani [1] have illustrated that Chaos based medical image encryption using symmetric cryptography method provides better echelon of security for medical image transmission. They combined chaotic map for scrambling the addresses of pixels and chaotic simplified AES encryption algorithm, they have also verified through experimental tests that higher efficiency can be obtained by exploiting the benefits of both scrambling and encryption. The authors DalelBouslimi, and his team [2] have elucidated the performance of joint

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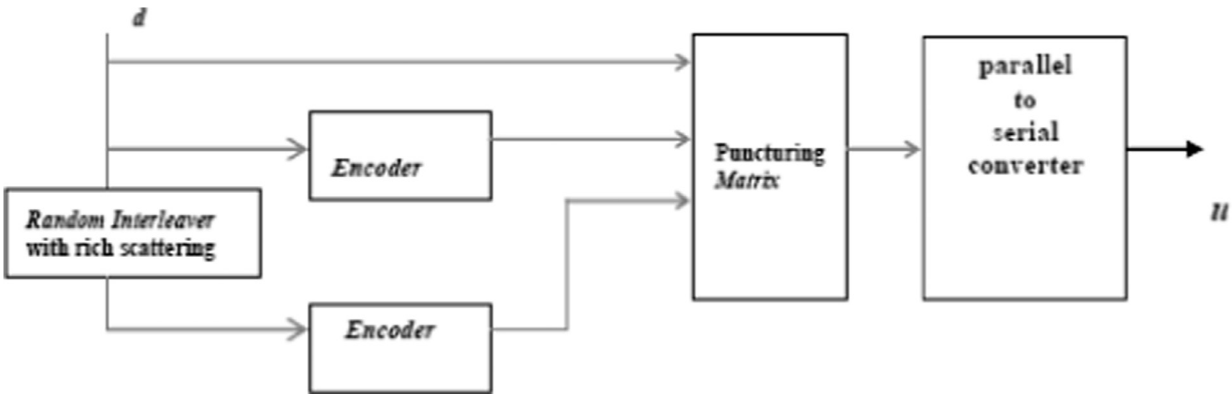

Fig. 1. Structure of systematic channel encoder.

encryption/watermarking system for validating the medical image transmissions reliability. The authors has also considered that joint encryption/watermarking system in order to protect the medical images for security purpose so that unauthorized person cannot access. They have validated that higher quality can attain with low signal to noise ratio (SNR) of image reliability while maintaining high level of security. In [3] the authors Zhu Yu and his team have taken Chaos-Based Encryption Algorithm. They have demonstrated that one can achieve higher coding while maintaining satisfied security by applying encryption algorithm centred by Discrete Wavelet Transform (DWT) and chaotic map. They have applied wavelet decomposition technique while focusing on high frequency sub-band image of the image information and finally encryption algorithm is applied for those images.

Researcher suggested that multiple-input (I\P) multiple-output (O\P) (MIMO) obtain higher spectral efficiency without need of additional bandwidth [4]. Such MIMO system uses Vertical Bell Laboratories Layered Space-Time (VBLAST) encoder to achieve high data rate [5] by transmitting independent bit streams simultaneously from multiple antennas. But it has been demonstrated that we can obtain better performance with higher SNR. Subsequently, the Alamouti Space-time Block codes (STBC) [6,7] delivers spatial diversity using two transmitting antenna with orthogonal designs. It has been demonstrated in the literature that double space-time diversity (DSTTD) architecture [8] provides both better error-rate performance and spectral efficiency. The research community suggested that hybrid STBC-SM systems for 5G as they need higher spectral efficiency and higher throughput for data communication. In [9] it has been explicated that detection algorithm based on low-complexity layered block nulling technique offers better bit error rate (BER) performance with less number of computation when compared with zero-forcing (ZF) and Minimum Mean-Square Error (MMSE) detection algorithm. But uni-Polarized MIMO system involves atleast 1/10 of the wavelengths antenna spacing at BS [10] and 1/2 of wavelength antenna spacing at mobile station (MS), to exploit the benefits of MIMO gain. Therefore, dual-Polarized (*dP*) & triply-Polarized antennas will exploited to obtain such MIMO gain with compact size of MS for downlink (DL) communication. In [8], *dP* antenna was replaced by a single *dP* antenna instead of 2 spatially separated antennas and by invoking such orthogonal polarizations, we can achieve higher throughput while retaining the size of MS. While designing *dP* antenna, channel cross polarization discrimination factor (XPD) and channel correlation coefficient [11] has to be considered. XPD represents the channel ability to separate vertical Polarization (*VP*) and Horizontal Polarizations (*HP*).

The author in [12] investigated the performance analysis of Multi-Carrier (MC) code division multiple access (CDMA) system for fading wireless channels. The authors in [13] elucidated the analysis of a single carrier-MIMO aided CDMA in time-varying channels. In [14] the authors have addressed the performance of MC–CDMA system using Multi- user detection (MUD). In [15] the authors have explicated BER results of CDMA system using successive interference cancellation technique. In [16] authors have exemplified the BER system analysis of relay-aided cooperative MC–CDMA. In this literature [4], the authors have investigated the performance analysis of coded triply-Polarized antenna aided MIMO–CDMA structure for various standard channel models.

In this contribution, we consider Discrete Wavelet Transform (DWT) technique to achieve higher spectral efficiency and AES algorithm for secured medical image transmission through wireless networks. Further, we realize the DSTTD architecture as MIMO profile to enhance data rate with spatial diversity. We realize the channel encoder using turbo code and is shown in the Fig. 1. We construct channel encoder using parallel concatenated convolutional encoder in which random interleaver is followed by second encoder. We form puncturing matrix using encrypted binary information and parity bits generated by two encoders. Finally, we puncture certain parity bits to achieve desired code rate. We examine the performance analysis of coded DSTTD-CDMA module using Polarization diversity (PD) for the transmission of secured image in frequency-selective channels centred on Stanford University Interim (SUI-1) channel model. In receiver, we realize block nulling detection algorithm to alleviate the effects of Multi Access Interference (MAI) and Multi-Stream Interference (MSI) and also iterative decoding algorithm to obtain picture quality with high coding gain.

The remaining section of the manuscript is arranged as: Section 2- system model description and signal estimation technique. Section-3 demonstrates the system performance and last Section- IV is the Conclusion.

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