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PERFORMANCE IMPROVEMENT OF SPIHT COMPRESSED IMAGE TRANSMISSION USING DIVERSITY SELECTION COMBINING TECHNIQUE IN WAVELET DOMAIN

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ABSTRACT
This paper describes a simulation of SPIHT compressed image transmission on wireless channels by using diversity selection combining technique in wavelet domain. It proposes Reed Solomon Channel Coding and Diversity Selection Combining Method to combat errors during image transmission on wireless channels. When the data arrive at the receiver, the coding is used to recover from the errors in the bit stream. Diversity is used to obtain multiple data streams corresponding to the transmitted image at receiver. These individual image data streams are combined to form a composite image with the higher quality. The results shown both methods demonstrate improving in quality of received image significantly.

Keywords: *Selection Combining Diversity,* Wavelet, SPIHT, Reed Solomon.

INTRODUCTION

Technology in telecommunication is growing rapidly specially on wireless communication (11). It is supported by the growing of portable communication technology that make it possible to exchange the multimedia information (data, voice image and video) where it becomes more popular and more desire. Among the multimedia information, the use of image become one of the important features and has been widely use in various applications such as internet, medical image, distance security camera, MMS (Multimedia Messaging Service) and other applications (2). It indicates that the use of image transmission system wirelessly is more desire and keeps growing.

On transmission over wireless channel, there are cases that can cause the degrade quality of information: noise and fading (5). The disturbance can cause the error in receiving information on receiver. The occurrence of disturbances is random and unpredictable. It needs a technique to improve the quality of signal on receiver.

Beside that, the transmission over wireless channel has limitation bandwidth, while image tends to have big capacity. It can cause the ineffective use of bandwidth (8). To overcome the problem, it needs a technique to reduce number of data in image without loosing the important data that appropriate with human visual characteristic.

Said and Pearlman (1996) purpose an compressed image technique wavelet called SPIHT that has fast algorithm and it is simple to use in compression process. Hourani (2004) proposes a research about techniques in overcoming the phenomena of fading and noise on wireless channel. He purposes diversity techniques as one of the ways to overcome fading and noise in wireless communicatrion systems.

Several methods for image transmission over wireless channels have been done such as Ramac and Varshney propose *A Wavelet Domain Diversity Method for Transmission of Images over Wireless Channels* (6) that used diversity techniques on domain wavelet to get the good reconstruction image. In this image transmission, two-state Gilbert-Elliott channel (3),(4) was used. Sherwood and Zeger used data protection technique during transmission (7), while Thomos, Boulgouris, and Strinzis used *Turbo Codes* to protect image during transmission (10).

The research proposed here refers to compression technique (1). For selection combining techniques referred to A Wavelet Domain Diversity Method (6), but channel model used in this research is fading distribution reyleigh and noise which has normal distribution gaussian (9).

In this paper, image information with size 8 bpp was compressed with rate 0.8 bpp. SPIHT algorithm were used to get the image transmission system to maximize the use of bandwidth and diversity selection combining technique were used to improve image quality on receiver and Reed Solomon channel coding (31.15) were used to protect data during transmission process. So the title of this research is "Performance Improvement of SPIHT Compressed Image Transmission Using Diversity Selection Combining Technique in Wavelet Domain"

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DESIGN SYSTEM

Diversity Combining Method for Compressed Images

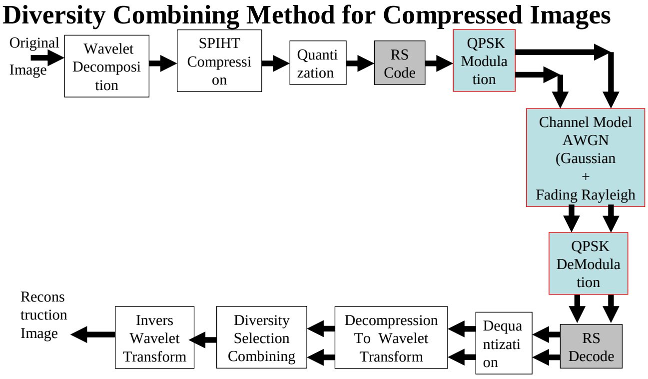

Figure 1. Diagram block of compressed image transmission SPIHT with *Diversity Selection Combining technique* in Wavelet Domain

The process of diversity combining uses two diversity channels by implementing error correction with interleave bit stream binary 100 bit in row and grouped bit stream to blocks. Figure 2 showed coding method with interleaving and RS channel coding for a given data block. Blocks are transmitted by rows and then interleaving the blocks by coloum. Diversity combining method uses the basic of combination block on wavelet domain. The received bit stream from diversity channal that uncorrelate are devided to L blocks and compare to block by block. The diversity rule used on compressed image transmission system SPIHT is based on the deviding block. (6)

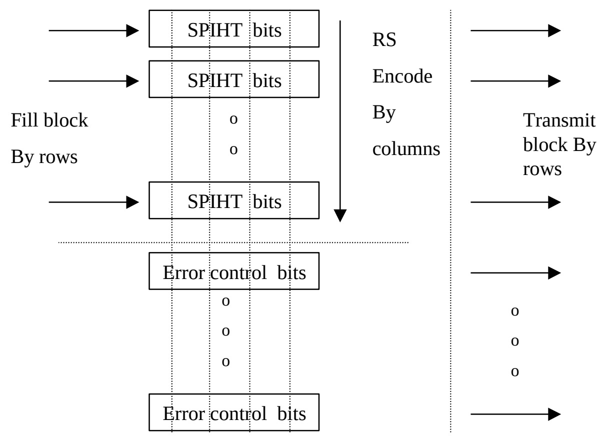

Figure 2. Interleaving scheme with coding for a given data block. (6)

Diversity Selection Combining Algorithm

Algorithm of this diversity is based on block choosing of bit *b(l)*, from one bit stream, it is based on the characteristic of wavelet transformation, and this rule can be defined as follow:

a. Diversity selection combining rule for approximation coefficient block.

If the value of approximation coefficient block from channel diversity 1 less than the value of approximation coefficient block from diversity channel 2, the value of approximation coefficient block is one. Then, if the value of approximation coefficient block from diversity channel 1 is more than the value of approximation coefficient block from channel 2, the value of approximation coefficient block will be minus one and if the value of approximation coefficient block from channel diversity 1 is the same with the value of approximation coefficient block from channel diversity 2, the value of approximation coefficient block is zero. The value of approximation coefficient block is given in the equation 1 below: (6)

$$h_L^l(i,j)=\begin{cases}1 & d_1(i,j)<d_2(i,j)\\ -1 & d_1(i,j)>d_2(i,j)\\ 0 & c_{L1}(i,j)=c_{L2}(i,j)\end{cases} \qquad (1)$$

b. Diversity combining rule for detail coefficient block.

If the value of block coefficient detail from channel diversity 1 is less than the value of block coefficient detail from channel diversity 2, the value of block coefficient detail from channel diversity will be one. Then if the value of block coefficient detail from channel diversity 1 is more than the value of block coefficient detail from channel diversity 2, the value of block coefficient detail from channel diversity will be minus one and if the value of block coefficient detail from channel diversity 1 is the same with the value of block coefficient detail from channel diversity 2, the value of block coefficient detail will be zero. The value of block coefficient detail is given in the equation 2 below: (6)

$$h_H^l(i,j)=\begin{cases}1 & t_1(i,j)<t_2(i,j)\\ -1 & t_1(i,j)>t_2(i,j)\\ 0 & c_{H1}(i,j)=c_{H2}(i,j)\end{cases} \qquad (2)$$

c. Rule of choosing block from diversity selection combining will be done by:

if the measure of block $\omega(l)$ is more likely zero, the chosen block is $b_1(l)$, but if the measure of block $\omega(l)$ is less than zero, $b_2(l)$ is choosen. The choosen block is given in the equation 3 below: (6)

$$b(l)=\begin{cases}b_1(l) & Jika\ \omega(l)\geq 0\\ b_2(l) & Jika\ \omega(l)<0\end{cases} \quad \text{for } l=1,2,\ldots,L \qquad (3)$$

Where

$$\omega(l)=\sum_{\substack{(i,j)\in lowrcs\\ subband}} h_L^l(i,j)+\sum_{\substack{(i,j)\det ail\\ subband}} h_H^l(i,j)$$

and

this is the value of approximation coefficient

$d_k(i,j)=\left|c_{Lk}(i,j)-c_{Lk}(i,j+1)\right|$ and

this is the value of detail coefficient (6)

$$t_k(i,j)=\left|c_{Hk}(i,j)-\left(\sum_{m=0}^{1}\sum_{n=0}^{1}c_{Hk}(2i+m,2j+n)/4\right)\right|$$

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For $k=1,2$, k is diversity branch, where l refers to the l th block of bits received and $\omega(l)$ is updated for each new block of data.

RESULT

Table 1. Compressed Image Transmission over fading channel + Noise with rate 0.946 bpp

SNR (dB)	BER	PSNR Diversity (dB)	PSNR without Diversity (dB)
10	0.0204	14.7464	14.6946
12	0.0175	19.5597	19.3743
14	0.0153	24.5918	21.2786
16	0.014	26.2011	24.6029
18	0.0134	30.2538	27.166
20	0.0126	33.7379	32.09

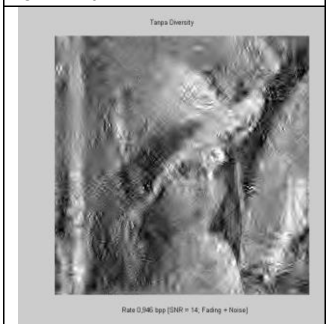
Without Diversity SNR 14 dB	Diversity selection combining SNR 14 dB
	
BER =0.0153 PSNR = 21.2786 dB	BER =0.0153BER =0.0092 PSNR = 24.5PSNR = 34.7698 dB

Figure 3. Comparison result of image reconstruction between using diversity and without diversity for SNR 14 dB

Table 1 and figure 3 and 4 represent the comparison of performance between using diversity and without diversity over compressed image transmission SPIHT with rate 0.8 bpp for fading channel distribution rayleigh and noise distribution normal Gaussian. For SNR 10 dB the value of BER 0.0204. For the system that uses diversity, the value of PSNR is 14.7464 dB while the value of PSNR without using diversity is 14.6946 dB. The improvement of performance diversity system is about 0.0518 dB if it is compared to the system without diversity. The improvement continues up to SNR 20 dB, for BER value 0.0126. The subjective result for SNR 14 dB on rate 0.8 bpp for the condition of fading and noise is given in figure 1.

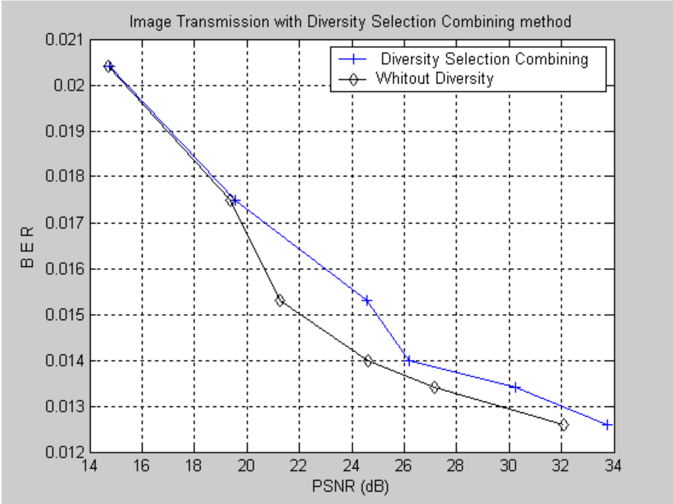


Figure 4. Comparison graph of performance between using diversity and without diversity system. On compressed image transmission with rate 0.8 bpp for channel fading + noise

CONCLUSIONS

The used of diversity combing for compressed image improved the performance of system when it compared to compressed image without using diversity. The tests of this pattern were done with compressed ratio 0.8 bpp. Compressed ratios were tested on the condition of channel fading and noise. The simulation result showed that the used of diversity combining on compressed image transmission system were improved 1.6479 dB when it compared to compressed image without diversity.

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