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PERFORMANCE ANALYSIS OF SISO AND MIMO SYSTEM ON IMAGE TRANSMISSION USING CANNY EDGE DETECTION

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ABSTRACT

This paper deals with the comparative performance analysis of transmission technique (SISO AND MIMO) and shows the effect on transmission of image. We used four techniques for this category; SISO with Canny edge detection, MIMO with Canny edge detection, SISO without Canny edge detection and MIMO without canny edge detection. The results for each technique are compared with one another so as to choose the best result. These techniques applied on one image for calculating the parameters such as PSNR, MAE, and RMSE. In this paper an attempt is made to study the performance of most commonly used transmission techniques for image transmission and also the comparison on basis of these techniques is carried out by using MATLAB software.

KEYWORDS: SISO, MIMO, PSNR, RMSE AND MAE.

INTRODUCTION

MIMO stands for multiple-input multiple-output and means multiple antennas at both link ends of a communication system, i.e., at the transmit and at the receive side. The multiple-antennas at the transmitter and/or at the receiver in a wireless communication link open a new dimension in reliable communication, which can improve the system performance substantially. The idea behind MIMO is that the transmit antennas at one end and the receive antennas at the other end are “connected and combined”. The difference between a SISO system and a MIMO system with n_t transmit antennas and n_r receive antennas is the way of mapping the single stream of data symbols to n_t streams of symbols and the corresponding inverse operation at the receiver side. Systems with multiple antennas on the receive side only are called single input/multiple output (SIMO) systems and systems with multiple antennas at the transmitter side and a single antenna at the receiver side are called multiple input/single output (MISO) systems. The MIMO system is the most general and includes SISO, MISO, and SIMO systems as special cases.

The core idea in MIMO transmission is space-time signal processing in which signal processing in time is complemented by signal processing in the spatial dimension by using multiple, spatially distributed antennas at both link ends. Several transmission schemes have been proposed that utilize the MIMO channel in different ways, e.g., spatial multiplexing, space-time coding or beamforming. Space-time coding (STC) is promising methods where the numbers of the transmitted code symbols per time slot are equal to the number of transmit antennas. These code symbols are generated by the space-time encoder in such a way that diversity gain, coding gain, as well as high spectral efficiency are achieved. Space-time coding finds its application in cellular communications as well as in wireless area. There are various coding methods as space-time trellis codes (STTC) and space-time block codes (STBC). In this paper we used Alamouti scheme. Alamouti scheme is the first Space-time block codes in which two transmitter antennas and no. Of receiver antennas are used.

MIMO provided high transmission rate and reliability but due to interferences noise is generated at the receiver side. These noise are not eliminated by the receiver (Zero-forcing receiver) so these noise are can be overcome by Image segmentation method. Image segmentation can be done by various methods such as Histogram method, Thresolding method, Edge based method and Region based method.

In this paper we used edge based method. Edge based method is very useful for image segmentation method. Canny edge detection is one of type of the edge based method. To remove noise occurs at the receiver of the MIMO system is overcome by apply of Canny edge detection.

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METHODOLOGY

In this paper we are using an image which is transmitted over AWGN channel, using SISO and MIMO systems with and without using Canny edge detection method.

First Original Image to be feed at input, after feeding this image will be converted from colour image to gray image form then again gray scale image is converted into binary form. This binary form of image is received by Parallel to Serial converter and parallel data are converted into sequential binary data, which is feed to Binary Phase Shift Key (BPSK) modulator to modulate & generate modulated signal.

After receiving signal, set the signal to noise ratio (SNR) values for the AWGN channel. This signal passes through noisy channel which is disturbed by additive noise. The presence of noise affects image quality.

Resulting signal of the AWGN Channel is received and load to demodulator for demodulation. After demodulation, the signal is converted from binary form into image pixel form that should be identical to input image.

The output of the image is applied to the Canny edge detector and find the parameters; Root Mean Square Value (RMSE) and Peak Signal to Noise Ratio (PSNR) and Means Absolute error (MAE) are calculated in accordance with the different SNR value. At last comparison is done for these parameters PSNR, RSME, and MAE for following systems:-

1. SISO system without Canny edge detection.
2. MIMO system without Canny edge detection.
3. SISO system with Canny edge detection.
4. MIMO system with Canny edge detection.

EXPERIMENTAL RESULT

We use digital modulation technique (BPSK) for the image transfer from transmitter to receiver side using SISO and MIMO system and we also apply canny edge detection on the result of SISO and MIMO system. There are many measures for examining image quality, such as the mean structural similarity, mean absolute error, mean square error (MSE), and peak signal-to-noise ratio (PSNR) etc. but in this paper we calculated parameters MAE, PSNR and RMSE.

3.1 MAE vs. SNR for SISO and MIMO system using Canny edge detection:

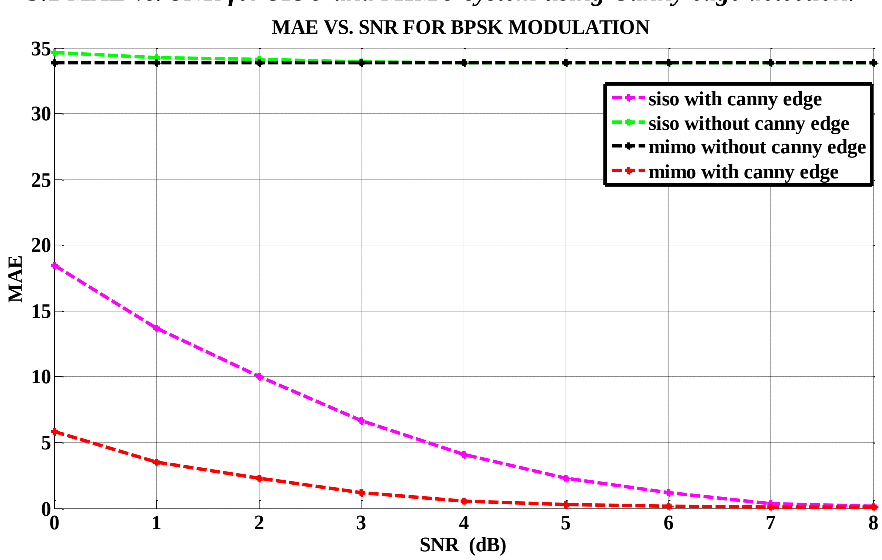

Figure 3.1. MAE vs. SNR

Table 1. Comparison table for MAE vs. SNR for SISO and MIMO system using Canny edge detection.

SNR (dB)	MEAN ABSOLUTE ERROR			
	SISO WITHOUT CANNY EDGE	MIMO WITHOUT CANNY EDGE	SISO WITH CANNY EDGE	MIMO WITH CANNY EDGE
0	34.6106	33.8983	18.5827	5.7102
1	34.243	33.8774	13.5397	3.1911
2	33.9556	33.8674	9.3779	2.5551
3	33.879	33.8808	5.7905	1.7409
4	33.8754	33.8787	3.4226	0.2537
5	33.8794	33.8787	1.5889	0.1411
6	33.8785	33.8787	0.7426	0.106
7	33.8784	33.8787	0.3086	0.1032
8	33.8784	33.8787	0.1645	0.0999

Figure 3.1reveals that the performances (in terms of Mean Absolute Error) of the MIMO and SISO system with and without Canny edge detection over AWGN channel. From the figure it is clear that when the SNR is increase, MAE value decrease. MIMO system with Canny edge detection has the best performance in comparison to SISO system with Canny edge detection, followed by MIMO system without Canny edge detection and then SISO system without Canny edge detection. Comparison table 1.shows that SISO system without Canny edge detection start from value 34.6106 and reaches to value 33.8784, MIMO system without Canny edge detection start from value 33.8983 and reaches to value 33.8787, SISO system with Canny edge detection start from value 18.5827 and reaches to value 0.1645 and MIMO system with Canny edge detection start from value 5.7102 and reaches to value 0.0999.

3.2 RMSE vs. SNR for SISO and MIMO system using Canny edge detection:

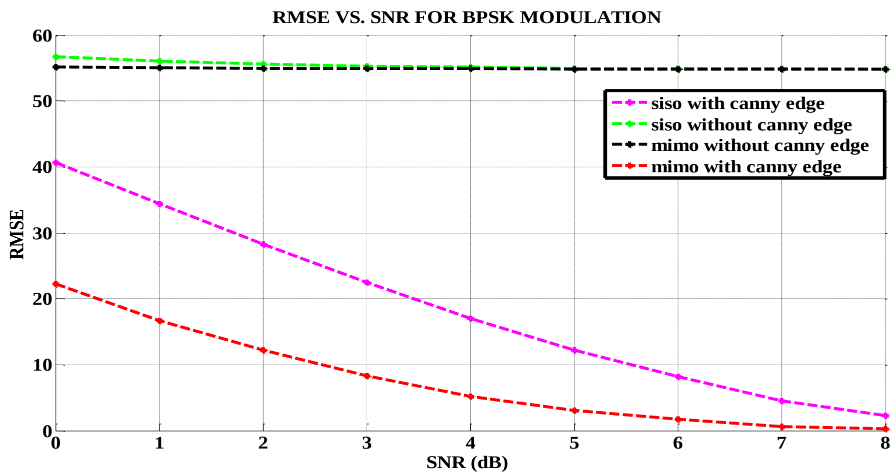

Figure-3.2: RMSE vs. SNR

Table 2. Comparison table for RMSE vs. SNR for SISO and MIMO system using Canny edge detection.

SNR(dB)	ROOT MEAN SQUARED ERROR			
	SISOWITHOUT CANNY EDGE	MIMO WITHOUT CANNY EDGE	SISO WITH CANNY EDGE	MIMO WITH CANNY EDGE
0	56.5946	54.9371	40.6706	22.0085
1	55.9718	54.8648	34.381	16.9902

2	55.4135	54.8476	28.5691	11.0585
3	55.0859	54.8643	22.2364	9.2559
4	54.9662	54.8595	16.9669	6.6534
5	54.9074	54.8595	11.2098	3.1169
6	54.8583	54.8595	7.5822	1.9984
7	54.8681	54.8595	4.2406	0.96607
8	54.8627	54.8595	2.5975	0.31603

Figure 3.2. reveals that the performances (in terms of Root Mean Square Value) of the MIMO and SISO system with and without Canny edge detection over AWGN channel. From the figure it is clear that when the SNR is increase, MAE value decrease. MIMO system with Canny edge detection has the best performance in comparison to SISO system with Canny edge detection, followed by MIMO system without Canny edge detection and then SISO system without Canny edge detection. Comparison table 2. shows SISO system without Canny edge detection start from value 56.5946 and reaches to value 54.8627, MIMO system without Canny edge detection start from value 54.9371and reaches to value 54.8595, SISO system with Canny edge detection start from value 40.6706 and reaches to value 2.5975and MIMO system with Canny edge detection start from value 22.0085 and reaches to value 0.31603.

3.3 PSNR vs. SNR for SISO and MIMO system using Canny edge detection:

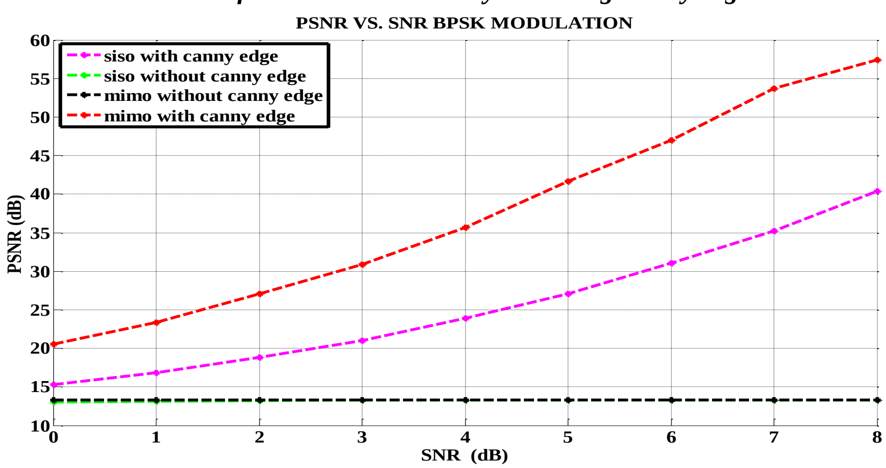

Figure-3.3: PSNR vs. SNR

Table 3. Comparison table for PSNR vs. SNR for SISO and MIMO system using Canny edge detection.

SNR(dB)	PEAK SIGNAL TO NOISE RATIO (dB)			
	SISO WITHOUT CANNY EDGE	MIMO WITHOUT CANNY EDGE	SISO WITH CANNY EDGE	MIMO WITH CANNY EDGE
0	13.0753	13.3335	15.2726	20.6064
1	13.1714	13.3449	16.7319	23.2732
2	13.2585	13.3476	18.3403	26.5844
3	13.31	13.345	21.5169	31.7783
4	13.3289	13.3458	24.8662	35.2042

5	**13.3382**	**13.3458**	**26.9663**	**41.8061**
6	**13.346**	**13.3458**	**31.8623**	**47.9184**
7	**13.3444**	**13.3458**	**35.0097**	**54.6052**
8	**13.3453**	**13.3458**	**40.1672**	**57.4637**

Figure 3.3. reveals that the performance (in terms of Peak Signal to Noise Ratio) of the MIMO and SISO system with and without Canny edge detection over AWGN channel. From the figure it is clear that when the SNR is increase, PSNR value increase MIMO system with Canny edge detection has the best performance in comparison to SISO system with Canny edge detection, followed by MIMO system without Canny edge detection and then SISO system without Canny edge detection. Comparison table 3. shows SISO system without Canny edge detection start from value 13.0753 and reaches to value 13.3453, MIMO system without Canny edge detection start from value 13.3335 and reaches to value 13.3458, SISO system with Canny edge detection start from value 15.2726 and reaches to value 40.1672and MIMO system with Canny edge detection start from value 20.6064 and reaches to value 57.4637.

Figure 3.4. Original Image.

Figure 3.5. Result of SISO system without canny edge detection.

Figure 3.6. Result of MIMO system without Canny edge detection.

Figure 3.7. Result of SISO system with Canny edge detection.

Figure 3.8. Result of MIMO system with Canny edge detection.

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CONCLUSION

SISO system is a conventional system, but in this system many transmission problems occur during the high efficient application and cause wastage of bandwidth and power. MIMO system is gaining much attention as it overcome the problems occurs in the SISO system.

The performance of an SISO and MIMO system using Canny edge detection over AWGN channel is discussed above. It has been observed that with increase in SNR values MAE values decreases, RMSE values also decreases and PSNR values increases for all the comparisons.

From the results it can be concluded that MIMO with Canny edge detection performs better than rest other systems. MIMO with Canny edge detection is better than SISO with Canny edge detection followed by MIMO without Canny edge detection and worst of all is the performance of SISO without Canny edge detection. Also performance of systems, using Canny edge detection for transmission of image is better than systems not using Canny edge detection. Finally conclusion is occurring from this paper is that MIMO system with canny edge detection is the best system among all the systems used.

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