Performance of Image over AWGN Channel Using BPSK Modulation

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Abstract— This paper demonstrates the effect of an image transmission through AWGN channel using Binary Phase Shift Key (BPSK) System. Bit Error Rate (BER) & Root Mean Square Error (RMSE) values decreases and Peak Signal to Noise ratio (PSNR) values increases for different Signal to Noise ratio (SNR) value on transmission of simple image. In this paper we see the effect of image on AWGN channel to find the best result for BER, RMSE, PSNR, MAE.

Index Terms— AWGN Channel, BER, BPSK Image size, MAE, PSNR, RMSE, SNR.

I. INTRODUCTION

Binary Phase Shift Key (BPSK) is one of the best Communication System in which image can be transfer from one place to another through a communication channel. Hence the channel plays a very important role in Communication System. Sometimes ideal image cannot be received by receiver because of an Additive White Gaussian noise (AWGN) channel. In short image can be affected by communication Channel. Phase-shift keying is a digital modulation system that conveys data by modulating the phase of a mention signal. In figure show the flow chart. The details of flow are described as First Original Image (A) to be load at input, after loading this image will convert into color image into gray image form (B) then image convert into binary form(C).after the binary convert ,image Then serial binary data (c) feed to Binary Phase Shift Key (BPSK) modulation to modulate & generate (D). After receiving (E), set the signal to noise ratio (SNR) values for the AWGN channel. This signal passes through noisy channel which is disturb by additive noise (AWGN). Resulting signal (E) is received and demodulated (F) then convert the binary form into image pixel form (H) that should be identical to input image (A).For every value of SNR, Bit error Rate (BER), Root Mean Square Value (RMSE) and Peak Signal to Noise Ratio (PSNR) changes after PSK demodulation. find the output of the image (I),and calculate the value of Root Mean Square Value (RMSE) and Peak Signal to Noise Ratio (PSNR), Bit error Rate (BER)and Means Absolute error(MAE).

II. PHASE SHIFT KEY (PSK) MODULATION AND DEMODULATION

Phase-shift keying (PSK) is a digital modulation scheme that conveys data by changing, or modulating, the phase of a reference signal. PSK modulation in Mat lab can be simulated using the pskmod() function and demodulation can be performed using pskdemod().

In BPSK system, change in phase of the sinusoidal carrier to indicate the information or data. In this system, if we pass the input binary (0) then the phase of sinusoidal will shift by 180 degree. Phase shift represent the change in state of information.
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\[
\text{PSK}(t) = \begin{cases} 
\sin(2\pi ft) \text{ for } bit 1 \\
\sin(2\pi ft + \pi) \text{ for } bit 0
\end{cases}
\]

III. IMAGE

In computer vision, Image is a two-dimensional signal that can be observed by human visual system. The image consists of number of elements called pixels and we process these pixels.

IV. MEAN SQUARE ERROR (MSE)

MSE is a difference between original image and noisy image.

\[
MSE = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} [I(i, j) - \hat{I}(i, j)]^2
\]

where, \(I(i, j)\) is an original image and \(\hat{I}(i, j)\) is an estimate of \(I(i, j)\) after Reconstruction.

V. PEAK SIGNAL TO NOISE RATIO (PSNR)

PSNR is the ratio between maximum possible pixel of an image and the pixel of corrupting noise. PSNR is usually expressed in terms of the logarithmic decibel scale.

\[
PSNR = 10 \log \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} |I(i, j)|^2
\]

VI. SIGNAL TO NOISE RATIO

Signal-to-noise ratio is defined as the power ratio between a signal (meaningful information) and the background noise (unwanted signal):

\[
SNR = 10 \log \frac{1}{MN} \sum_{x=0}^{n_x-1} \sum_{y=0}^{n_y-1} [r(x, y)]^2
\]

\[
= \frac{1}{MN} \sum_{x=0}^{n_x-1} \sum_{y=0}^{n_y-1} [r(x, y) - t(x, y)]^2
\]

VII. BIT ERROR RATE (BER)

The bit error rate or bit error ratio (BER) is the number of bit errors divided by the total number of transferred bits during a studied time interval. The bit error rate of BPSK in AWGN can be calculated as

\[
\text{BER} = \frac{\text{Error}}{\text{total number of bit}}
\]

VIII. ADDITIVE WHITE GAUSSIAN NOISE (AWGN) CHANNEL

An AWGN channel is a adds white Gaussian noise to the signal that passes through it. An AWGN channel is typically described by quantities such as Signal-to-Noise ratio (SNR) per sample and this is the actual input parameter to the AWGN function. The standard model of amplifier noise is additive, Gaussian, independent at each pixel and independent of the signal intensity, caused primarily by Johnson–Nyquist noise (thermal noise). In color cameras where more amplification is used in the blue color channel than in the green or red channel.

IX. RESULT

Performance of Image over the AWGN Channel. Figure 2 shows original image and Figure 3 shows output of the of the image over AWGN Channel.

Figure 2

Figure 3

Figure 4

Figure 4 shows Bit Error Rate (BER) performance of BPSK over AWGN Channel.
Figure 5 shows Root Mean Square Value (RMSE) performance of BPSK over AWGN Channel. It has been observed that with increase in SNR values RMSE values decrease.

Figure 6 shows Peak Signal to Noise ratio (PSNR) performance of BPSK over AWGN Channel. It has been observed that with increase in SNR values PSNR values also increases.

Figure 7 shows Mean Absolute Error (MAE) performance of BPSK over AWGN Channel. It has been observed that with increase in SNR values MAE values decreases.

**OBSERVATION TABLE**

Table 1 shows performance of the image over AWGN Channel.

<table>
<thead>
<tr>
<th>SNR</th>
<th>PSNR</th>
<th>RMSE</th>
<th>MAE</th>
<th>BER</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15.8255</td>
<td>41.235</td>
<td>18.6298</td>
<td>0.080436</td>
</tr>
<tr>
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<td>36.3763</td>
<td>14.4774</td>
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<td>22.1747</td>
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<tr>
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<td>3.6605</td>
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<tr>
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<td>5.5840e-018</td>
<td>0.000231</td>
</tr>
<tr>
<td>9</td>
<td>377.197</td>
<td>3.5212e-017</td>
<td>5.5840e-018</td>
<td>4.62E-05</td>
</tr>
</tbody>
</table>

X. **CONCLUSION**

A communication channel is used to convey an information signal, for example a digital bit stream, from one or several senders (or transmitters) to one or several receivers. AWGN channel is the better channel for the communication. In this paper, Table 1 shows the performance of image over the AWGN Channel. It has been observed that with increase in SNR values PSNR values increase and RMSE, MAE and BER values also decrease.
REFERENCES


