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Analyzing Distortion Region in Gaussian Broadcast Channel by Bandwidth Compression and Expansion Using Different Coding Schemes

T.Jeslin[1], T.Thanya[2]
Professor, Department of ECE, Universal College of Engineering and Technology[1]
Assistant Professor, Department of ECE, Universal College of Engineering and Technology[2]

***Abstract*— Broadcasting Gaussian sources over a Gaussian broadcast channel is a major problem in information theory. Consider the problem of sending a correlated Gaussian source $\mathbf{S = (S_1, S_2 \ldots \ldots S_m)}$ over a power limited Gaussian broadcast channel. User i $(\mathbf{1, 2, .. m})$ observes the transmitted signal which is affected by Gaussian noise with power $\boldsymbol{\sigma_i^2}$ and desires to estimate$\mathbf{S_i}$. This paper aims to analyze the distortion (squared error) regions that are simultaneously achievable at the receivers by using hybrid digital analog (HDA) joint source channel coding (JSCC) coding scheme. First, consider the problem of broadcasting a bivariate Gaussian source over a two-user power limited Gaussian broadcast channel to two receivers. Two bandwidth mismatch cases are considered: i) broadcasting with bandwidth compression, and ii) broadcasting with bandwidth expansion. The achievable distortion regions of bandwidth mismatch cases are compared with outer bound distortion region. This paper also considers the problem of broadcasting three Gaussian sources over a three user power limited Gaussian channel. First two sources are correlated and the third one is independent to other two sources. The achievable distortion regions are compared with outer bound distortion region.**

***Index Terms* —Bandwidth compression/expansion, Gaussian broadcast channel, Hybrid digital analog coding, separate source channel coding.**

I. INTRODUCTION

The fundamental problem of information theory is transmitting the sources over a Gaussian broadcast channel [1]. This paper considers the problem of broadcasting correlated Gaussian source across a Gaussian broadcast channel and aims to characterize minimum mean squared error pairs that are simultaneously achievable at two receivers using hybrid digital analog (HDA) joint source-channel coding (JSCC). In the separate source channel coding scheme, the Gaussian source is optimally quantized and then the quantization bits are encoded with a capacity achieving channel code, and the corresponding decoding, reconstruct the source without the knowledge of channel [1]. In information theory, joint source-channel coding is the encoding of a redundant information of source which is transmitted over a noisy channel, and the corresponding decoding, using a single source code instead of more steps of source coding followed by channel coding. Previously, many paper discussed the problem of sending a single Gaussian source over a Gaussian broadcast channel [2], [7] having mean zero and variance σ_s^2.

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Shannon proved that the separate source channel coding is optimal in ergodic point to point communication. The

Separate source channel coding is often referred as digital coding scheme. Two main problems associated with digital scheme: the" threshold effect "and "leveling-off effect" [4]. Uncoded (analog) transmission means scaling the encoder input which is given to channel power constraint and transmitting without proper channel coding. The Uncoded transmission is optimal below a certain threshold [5]. Some multi user system shows Uncoded transmission is exactly optimal. The sensor networks able to understand only the analog information, while bits are in appropriate [6]. In the literature survey family of Hybrid schemes are introduced which take both the advantage of analog transmission and digital techniques [7] - [14]. These methods provide great distortion performance compare to purely digital coding or analog transmission schemes. They provide less leveling of effect and do not experience threshold effect [9]. Single Gaussian source with bandwidth expansion that is mismatched bandwidth between the source and channel is discussed in [10]. The inner and outer bound distortion region for Gaussian mixture source is given in [15]. In [16] the problem of broadcasting correlated Gaussian source is discussed. It shows that hybrid scheme can achieve the optimal performance but either an uncoded scheme or a separation based scheme is not alone sufficient. Joint source channel coding is worst for Gaussian setting, when source and noise having same covariance. They are not found of explicit distortion region and not aware of bandwidth mismatched case. In [17] the correlated Gaussians with separate source channel coding is discussed. The separate coding is compared to joint coding in terms of power loss and rate penalty which shows performance of separate coding comes close to that of optimal joint coding, for low distortion pairs. Outer bound region of broadcasting Gaussians with matched bandwidth is analyzed in [3]. Analog sources with different bandwidth ratio (bandwidth compression and expansion) are discussed in [4]. In [18] Slepian-Wolf channel coding with three different HDA coding schemes is discussed.

The system model is illustrated in Fig. 1. This paper aims to determine the achievable distortion regions for correlated Gaussian sources. Distortion region for bandwidth mismatched case is determined for bivariate Gaussian source. Two bandwidth mismatched cases are considered: i) broadcasting with bandwidth compression i.e.,$\eta < 1$ where η channel uses per source sample, and ii) broadcasting with bandwidth expansion i.e.,$\eta > 1$. Typically, $\eta=\frac{1}{2}$ for bandwidth compression and η=2 for bandwidth expansion. This paper also calculates the distortion region for broadcasting three Gaussian sources. Consider, first two sources are correlated and the third source is independent to other two source. The achievable distortion regions are compared with outer bound distortion regions. This paper presents layering with analog, super position and Costa coding for bandwidth compression and layering with analog and Wyner-Ziv coding for bandwidth expansion. Layering with analog, Wyner-Ziv and Costa coding used for broadcasting three Gaussian sources over an average power limited Gaussian broadcast channel.

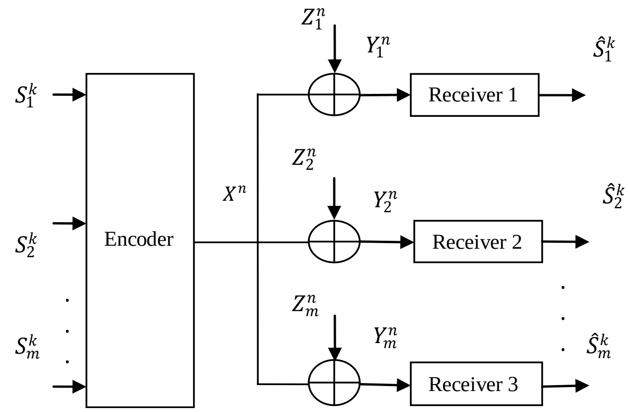

Fig.1. Broadcasting correlated Gaussian sources over a power limited Gaussian broadcast channel. Receiver i aims to reconstruct its source component with distortion D_i.

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The organization of the paper as follows. In the next section, present the system model. In section III, the achievable distortion region of bandwidth compression of bivariate Gaussian source is discussed Gaussian source. In section IV, present the achievable distortion region of bandwidth expansion for bivariate Gaussian source. In section V, an outer bound distortion region for broadcasting bivariate Gaussian source with mismatched bandwidth is discussed. The achievable and outer bound distortion region for broadcasting three Gaussian sources is presented in section VI. Numerical results are discussed in section VII. Section VIII, present the conclusions.

II. SYSTEM MODEL

Consider the problem of broadcasting correlated Gaussian source across a power limited Gaussian broadcast channel. User i $(i = 1,2,3)$ receives the transmitted signals which is corrupted by Gaussian noise with power N_i and reconstruct the sourceS_i. Assume that $N_1 > N_2 > N_3$. Let S_1 and S_2 be correlated Gaussian random variables and S_3 be independent Gaussian random variable to other two random variables. But the three source components are jointly Gaussian. Assume that
$S_1(t)$, $S_2(t)$ And $S_3(t)$ have mean zero and variance $\sigma_{s_1}^2$, $\sigma_{s_2}^2$
And σ_{s3}^2 respectively and the correlation coefficient$\rho \in (-1,1)$.

The three Gaussian sources having k source sample which is represented by $S_1^k = \left(S_1(1), S_1(2), \dots S_1(k)\right)$, $S_2^k = \left(S_2(1), S_2(2), \dots S_2(k)\right)$ and $S_2^k = \left(S_2(1), S_2(2), \dots S_2(k)\right)$ respectively. The three user Gaussian broadcast channel with three receivers estimating source component is shown in Fig.1 (assume m=3). Source data sequences S_1^k , S_2^k and S_3^k are jointly encoded to$X^n = f\left(S_1^k, S_1^k, S_1^k\right)$, the encoder function f is given by,

$$f: \mathbb{R}^k \times \mathbb{R}^k \times \mathbb{R}^k \to \mathbb{R}^n \qquad (1)$$

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Broadcasting bivariate Gaussian source over power limited Gaussian broadcast channel with receiver estimating bivariate source component is shown in Fig.1 (assume m=2). The bandwidth compression/expansion (bandwidth mismatch) ratio is defined by $\eta = \frac{n}{k}$ channel uses per source sample. This paper aims to find achievable distortion region for broadcasting bivariate Gaussian source with bandwidth compression $\eta < 1$ (typically $\eta = \frac{1}{2}$) and expansion $\eta > 1$(typically $\eta = 2$) by using HDA coding scheme. The transmitted sequence $X^n$is average power limited to $P > 0$ is given by,

$$\frac{1}{n} \sum_{t=1}^{n} E[|X(t)|^2] \leq P \qquad (2)$$

Where $E(.)$ stand for expectation operator.
User i receives the transmitted signal $X(t)$ affected by Gaussian noise $Z_i(t)$ with noise variance N_i, the received signal at time t is given by,

$$Y_i(t) = X(t) + Z_i(t), \quad i = 1,2,3 \qquad (3)$$

Where $Z_i(t) \sim N(0, N_i)$ are independently distributed over i and t and independent to transmitted signal $X(t)$.The decoder at receiver i reconstruct S_i^k based on the received signalY_i^k, i.e.

$$\hat{S}_i^k = \emptyset_i(Y_i^n) \quad , \quad i = 1,2,3 \qquad (4)$$

The decoder function $\emptyset_i$ is given by,

$$\emptyset_i: \mathbb{R}^n \to \mathbb{R}^k \quad , i = 1,2,3 \qquad (5)$$

The average mean squared error distortion is given by,

$$\Delta_i = \frac{1}{k} E\left[\sum_{t=1}^{k} \left|S_i(t) - \hat{S}_i(t)\right|^2\right] \qquad (6)$$

The set of all achievable distortion vectors (D_1, D_2, D_3) is called the distortion region.

III. Distortion Region For Bandwidth Compression

Consider the problem of broadcasting a correlated Gaussian source with bandwidth compression 2:1 across a power limited Gaussian broadcast channel. To transmit bivariate Gaussian source $\left(S_1(t), S_2(t)\right)$ with k=2n samples. Split component of both bivariate Gaussian sources in to two equal length parts, i.e., split 2n samples of each source vector S_i^{2n} in to two vectors of length n: $S_{i,1}^n$ and $S_{i,2}^n$.

The layering with analog, superposition and Costa coding is used for bandwidth compression which have three layers shown in Fig.2.The first layer is an analog transmission layer, linear

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combination first n samples of Gaussian source components are so that the power of transmitted signal in this layer X_a^n becomes P_a. Here $X_a(t) = \alpha \sum_{i=1}^{2} a_i S_{i,1}(t)$, where $\alpha = \sqrt{\frac{P_a}{a_1^2\sigma_{s1}^2 + a_2^2\sigma_{s2}^2 + 2a_1a_2\rho\sigma_{s1}\sigma_{s2}}}$. this layer is both for both strong and weak user and satisfy$P = P_a + P_1 + P_2$.

In the third layer, second part of the second source component $S_{2,2}^n$ is broadcasted to strong user. This layer use Costa dirty paper coding for transmission. Wyner-Ziv coded using the estimate of $S_{1,2}^n$ is the receiver side information.

$$D_1 = \frac{1}{2}\left(\sigma_{s1}^2 - \frac{\alpha^2\left(a_1\sigma_{s1}^2 + a_2\rho\sigma_{s1}\sigma_{s2}\right)^2}{\lambda P_1 + P_a + P_2 + N_1} + \frac{1}{2}\frac{\sigma_{s1}^2}{\frac{(1-\lambda)P_1}{\lambda P_1 + P_a + P_2 + N_1}}\right) \qquad (7)$$

The strong user estimate $S_{1,2}^n$ with distortion,

$$D_{12}^* = \frac{1}{1 + \frac{\lambda P_1}{P_a + P_2 + N_1}} \times \frac{1}{2}\frac{\sigma_{s1}^2}{\frac{(1-\lambda)P_1}{\lambda P_1 + P_a + P_2 + N_1}} \qquad (8)$$

This estimate acts as side information for estimate of $S_{2,2}^n$ using the decoding wyner-ziv bits. The resulting distortion at the strong user is given by,

$$D_2 = \frac{1}{2}\left(\sigma_{s2}^2 - \frac{\alpha^2\left(a_2\sigma_{s2}^2 + a_1\rho\sigma_{s1}\sigma_{s2}\right)^2}{P_a + P_1 + P_2}\right) + \frac{1}{2}\sigma_{s2}^2\left(1 - \rho^2\left(1 - \frac{D_{12}^*}{\sigma_{s1}^2}\right)\right)\left(1 + \frac{P_2}{N_2}\right)^{-1} \qquad (9)$$

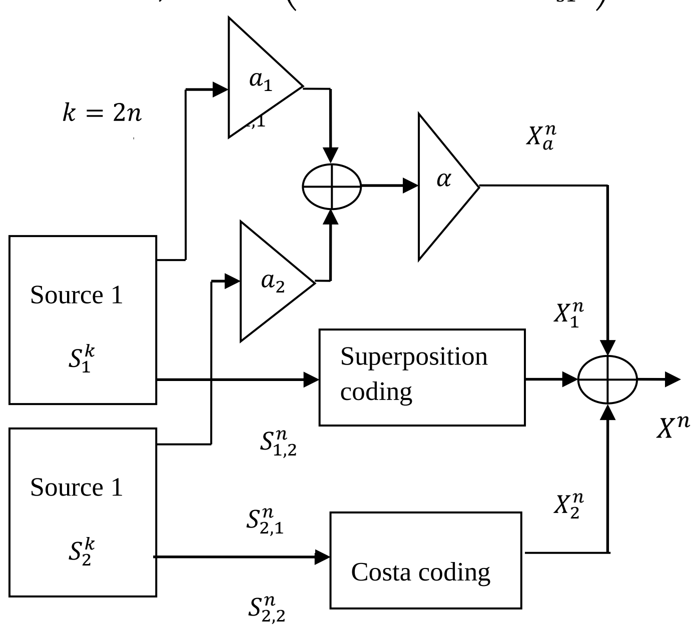

Fig.2. Encoder for bandwidth compression.

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IV. DISTORTION REGION FOR BANDWIDTH EXPANSION

Consider the problem of transmitting $\eta = 2$ bandwidth expansion. Transmit k samples of bivariate Gaussian source $S^k = (S_1^k, S_2^k)$ in $n = \eta k$ uses of power limited broadcast channel. The achievable distortion is analyzed by using layering with analog Wyner-Ziv coding. This scheme consists three layers one analog layer and two layer each consisting of a Wyner-Ziv coder followed by a channel coder.

The block diagram of encoder is shown in Fig.3. The first layer , the analog transmission layer, a linear combination of the k samples of bivariate Gaussian source components are scaled such that power of the power of the transmitted signal, X_a^k, in this layer is P. The transmitted signal $X_a(t) = \alpha \sum_{i=1}^{2} a_i S_i(t)$ where$\alpha = \sqrt{\frac{P}{a_1^2\sigma_{s1}^2 + a_2^2\sigma_{s2}^2 + 2a_1a_2\rho\sigma_{s1}\sigma_{s2}}}$. In the second layer, n-k=k samples of first source S_1^k is Wyner-Ziv coded with powerP_1. In the second layer, second source component S_2^n is Wyner-Ziv coded with powerP_2. The total power $P = P_1 + P_2$.The transmitted sequence can be represented as, $X^n = [X_a^k, X_d^{n-k}]$.

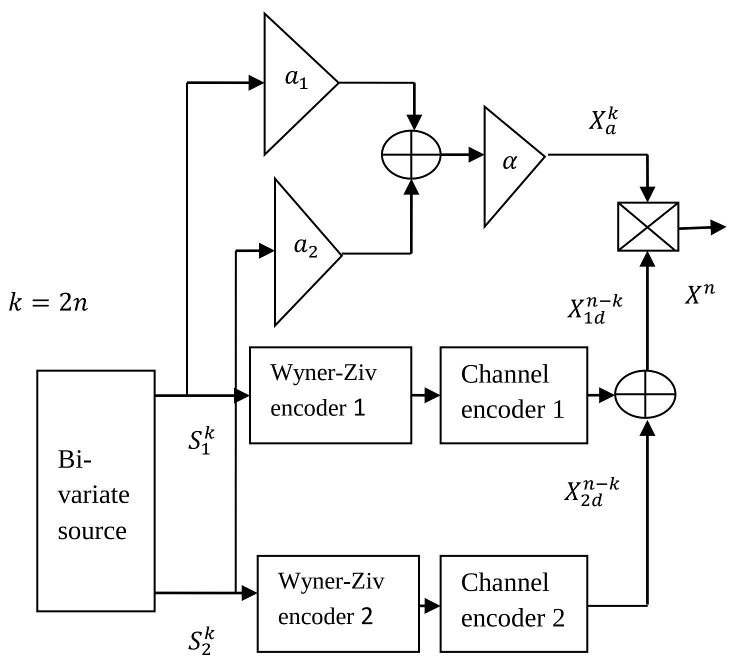

Fig.3. Encoder for bandwidth Expansion.

The overall distortion at the receiver 1can be expressed as

$$D_1 = D_{11}\left(1 + \frac{P_1}{P_2 + N_1}\right)^{1-\eta} \quad (10)$$

From the analog layer, the receiver 2 form the estimate of first source component S_1^k with MMSE distortion,

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$$D_{11}^{*} = \sigma_{s1}^{2} - \frac{\alpha^{2}\left(a_{1}\sigma_{s1}^{2} + a_{2}\rho\sigma_{s1}\sigma_{s2}\right)^{2}}{P+N_{2}} \quad (11)$$

Then, an estimate of the first component of the source can be obtained with distortion

$$D_{1}^{*} = D_{11}^{*}\left(1 + \frac{P_{1}}{P_{2}+N_{1}}\right)^{1-\eta} \quad (12)$$

The overall distortion for the second user (receiver 2) can be obtained from the estimation of S_{2}^{k} is given by,

$$D_{2} = D_{2}^{*}\left(1 + \frac{P_{2}}{N_{2}}\right)^{1-\eta} \quad (13)$$

Where, $$D_{2}^{*} = \sigma_{s2}^{2}\left(1 - \rho^{2}\left(1 - \frac{D_{1}^{*}}{\sigma_{s1}^{2}}\right)\right) \quad (14)$$

V. Outer Bound Distortion Region For Bandwidth Mismatched Case

The outer bound distortion regions for broadcasting bivariate Gaussian source with matched bandwidth were developed in [3]. By making smaller modifications to Theorem 1 in [3], the outer bounds for bandwidth mismatched case is obtained which is given by,

$$D_{1} \geq \sigma_{s1}^{2}\left(1 + \frac{(1-\alpha_{1})P}{\alpha_{1}P + N_{1}}\right)^{-\eta} \quad (15)$$

$$D_{2} \geq \sigma_{s2}^{2}(1-\rho^{2})\left(1 + \frac{\alpha_{1}P}{N_{2}}\right)^{-\eta} \quad (16)$$

Where, $\alpha_{1} \in [0,1]$

These bounds are suitable for lower values of correlation coefficient and might not be tight for higher values of correlation coefficient. Assume that the decoder have access to noisy version of the other source componentS_{1}'. Let S_{1}'=$\lambda S_{1} + \gamma$ with γ being independent of S_{1}, $\sigma_{\gamma}^{2} = \sigma_{s1}^{2}(1-\lambda^{2})$ and$\lambda \in [0,1]$. Obtain the bond which include () and () as a special case where$\lambda = 1$:

$$D_{1} \geq \sigma_{s1}^{2}\left(1 + \frac{(1-\alpha_{1})P}{\alpha_{1}P + N_{1}}\right)^{-\eta} \quad (17)$$

$$D_{2} \geq \max_{\lambda}\left\{\sigma_{s2}^{2}(1-\lambda^{2}\rho^{2})\left(1 + \frac{P(1-\lambda^{2}(1-\alpha_{1}))}{N_{2}}\right)^{-\eta}\right\} \quad (18)$$

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VI. DISTORTION REGION FOR BROADCASTING THREE GAUSSIAN SOURCES

In this section, discussed about broadcasting three Gaussian sources over an average power limited Gaussian broadcast channel to three users. In this case, among the tree source components two are correlated source components, which are independent to remaining one. But the tree sources are jointly Gaussian. The problem set up of broadcasting three source component is shown in Fig.1 (consider m=3).

$$\Lambda = \begin{pmatrix} \sigma^2 & \rho\sigma^2 & 0 \\ \sigma^2 & \sigma^2 & 0 \\ 0 & 0 & \sigma^2 \end{pmatrix} \qquad (19)$$

The Encoder part is shown in Fig.4.The transmitted signal $X^n = X_a^n + X_d^n + X_{S3}^n$ is sent over the channel, where the corresponding power for X_a , X_d and X_{S3} are P_a , P_d and P_{s3} and satisfying P= $P_a + P_d + P_{S3}$. Three encoding layers are there, details are given below:

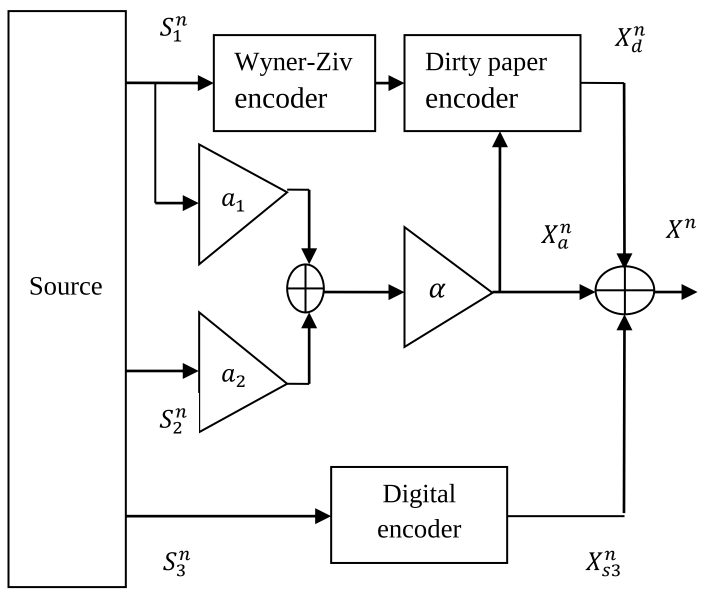

Fig.4. Encoder for transmitting three Gaussian sources over an average power limited Gaussian broadcast channel.

In the analog layer (second layer) the transmitted signal is $X_a^n = \alpha \sum_{i=1}^{2} a_i S_i^n$, where $\alpha = \sqrt{\frac{P_a}{a_1^2\sigma_{s1}^2 + a_2^2\sigma_{s2}^2 + 2a_1a_2\rho\sigma_{s1}\sigma_{s2}}}$ with transmitted signal power is P_a . α is also chosen such that $I(S_1, S_2; \hat{S}_{12}) = I(S_1, S_2; Y'_1)$ where $Y_1'^n = Y_1^n - X_{s3}^n = X_a^n + X_d^n + Z_1^n$. The first source component S_1^n is encoded in the first digital layer. First, the source component of the first source is encoded by using Wyner-Ziv encoder using $Y_1'^n$ as receiver side information with rateR_1. Then use the dirty paper coding approach to encode the $2^{n R_1}$ Wyner-Ziv indices and treating X_a^n as interference.

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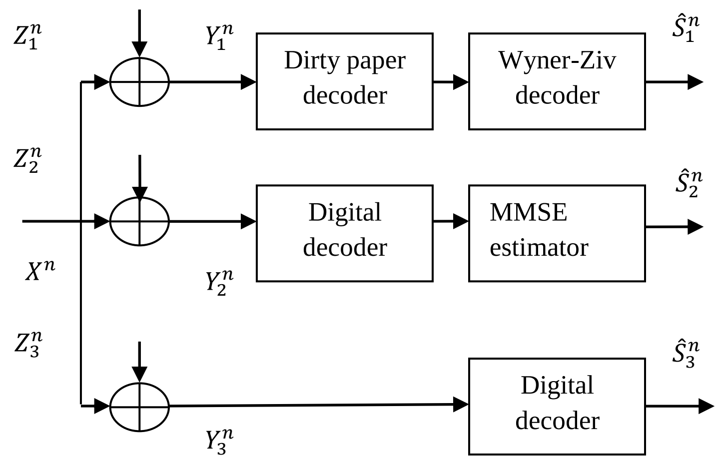

Fig.5. Decoder for broadcasting three Gaussian components over an average power limited Gaussian broadcast channel.

$$D_1 = \frac{N_1(1-\rho^2)\sigma_{S1}^2}{\alpha^2 a_1^2(1-\rho^2)\sigma_{S1}^2 + P_d + N_2} \quad (20)$$

The second source component is estimated at receiver 2 with minimum mean squared error is given by,

$$D_2 = \frac{\sigma_{S2}^2(\alpha^2 a_1^2(1-\rho^2)\sigma_{S1}^2 + P_d + N_2)}{P_d + P_a + N_2} \quad (21)$$

The third source component is estimated at receiver 3 with minimum mean squared error is given by,

$$D_3 = \frac{\sigma_{S3}^2(P_d + P_a + N_3)}{P + N_3} \quad (22)$$

The equations (20), (21) and (22) give an inner of the achievable distortion region for broadcasting three Gaussian sources.

The outer bound distortion regions for broadcasting bivariate Gaussian source with matched bandwidth were developed in [3], by making smaller modifications, the outer bounds for broadcasting three Gaussian source case is obtained :

$$D_1 = \frac{\sigma_{S1}^2 N_1(1-\rho^2)}{\alpha_1 P + N_1} \quad (23)$$

$$D_2 = \frac{\sigma_{S2}^2(\alpha_1 P + N_2)}{(\alpha_1 + \alpha_2)P + N_2} \quad (24)$$

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$$D_3 = \frac{\sigma_{S3}^2((\alpha_1+\alpha_2)P+N_3)}{(\alpha_1+\alpha_2+\alpha_3)P+N_3} \qquad (25)$$

$$D_3 = \frac{\sigma_{S3}^2((\alpha_1+\alpha_2)P+N_3)}{P+N_3} \qquad (26)$$

Where $\alpha_1, \alpha_2, \alpha_3 \in [0,1]$ and also sum of $\alpha_1 + \alpha_2 + \alpha_3 = 1$.

The equations (23), (24) and (25) give the outer bound for broadcasting three Gaussian sources.

VII. NUMERICAL RESULTS

The numerical results shown distortion region for broadcasting bivariate Gaussian source over two user power limited Gaussian broadcast channel under mismatched bandwidth condition and also distortion region for broad casting three sources over an average power limited Gaussian broadcast channel.

Fig.6 shows the distortion region for broadcasting bivariate Gaussian over a power limited Gaussian broadcast channel with bandwidth compression using HDA coding scheme. The transmitted source component having covariance matrix $\begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}$. The Fig.6 shown for two different correlation coefficient $\rho = 0.2$ and $\rho = 0.8$. The system parameters are total power $P = 0$ dB , the noise variances $N_1 = -5\text{dB}$ and $N_2 = 0\text{dB}$. The outer bound region is tight only for small values of correlation coefficient so that not shown for $= 0.8$ .There is a small gap between the inner bound and outer bound distortion region which shows the transmitted signal received with minimum distortion.

Fig.7 (a) shows the distortion region for broadcasting bivariate Gaussian over a power limited Gaussian broadcast channel with bandwidth compression using HDA coding scheme. The transmitted source component having covariance matrix $\begin{bmatrix} 1 & 0.2 \\ 0.2 & 1 \end{bmatrix}$. The Fig.7 (a) shown for the correlation coefficient $\rho = .2$. The system parameters are total power $= 3$ dB , the noise variances $N_1 = -5\text{dB}$ and $N_2 = 0\text{dB}$.

Fig.7 (b) shows the distortion region for broadcasting bivariate Gaussian over a power limited Gaussian broadcast channel with bandwidth compression using HDA coding scheme. The transmitted source component having covariance matrix $\begin{bmatrix} 1 & 0.8 \\ 0.8 & 1 \end{bmatrix}$. The Fig.7 (b) shown for two different correlation coefficient $\rho = .8$. The system parameters are total power $= 3$ dB , the noise variances $N_1 = -5\text{dB}$ and $N_2 = 0\text{dB}$. We observe from the Fig.7 (a)–(b) there is a gap between the achievable distortion region and outer bound distortion region.

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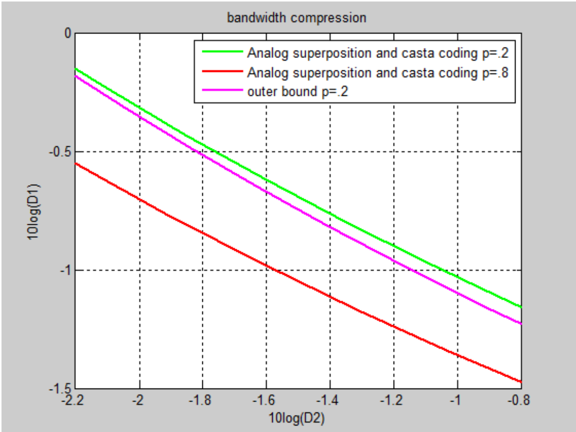
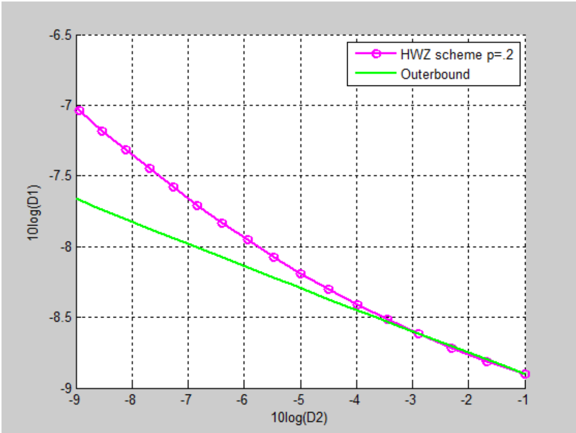
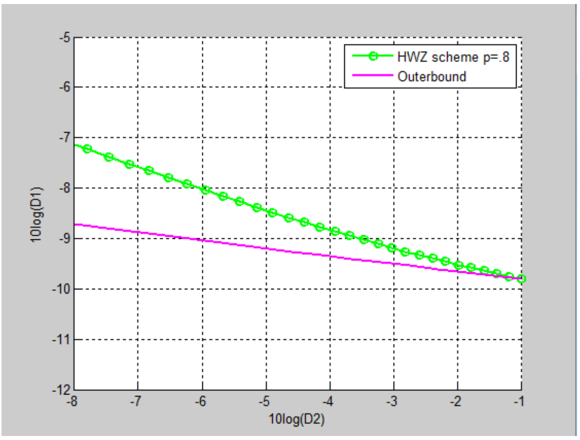


Fig.6. Distortion region for broadcasting bivariate Gaussian source with bandwidth compression.



(a) $\rho = .2$



(a) $\rho = .8$

Fig.7.Distortion region for broadcasting bivariate Gaussian source with bandwidth expansion.

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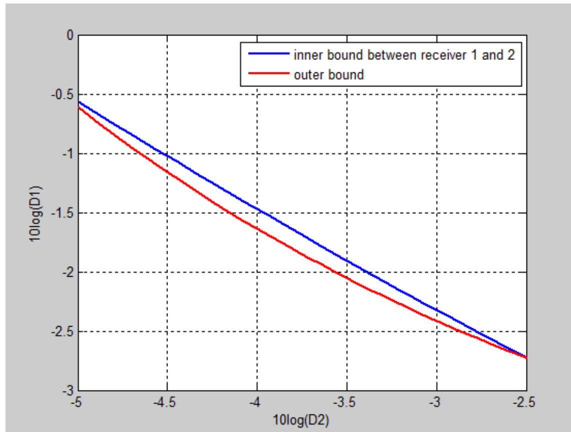
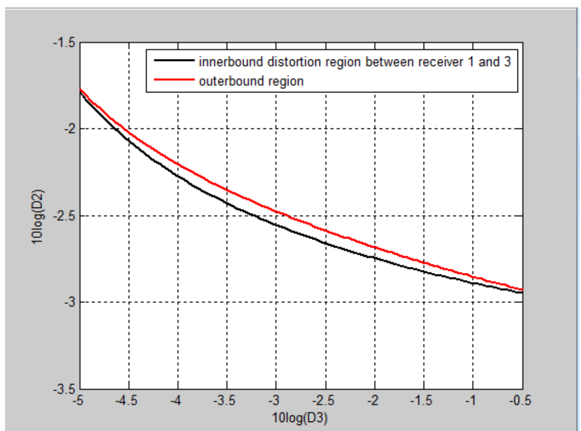
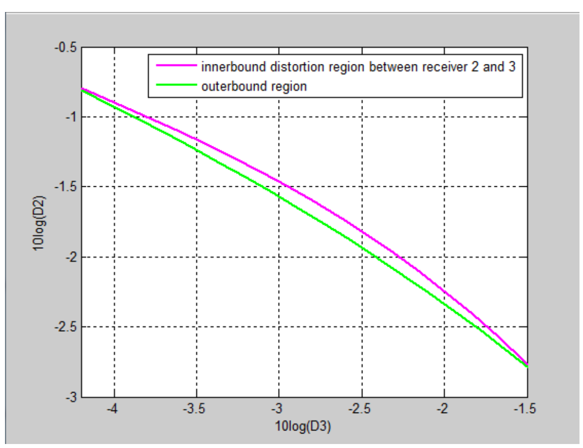


(a) Between receiver 1 and 2



(b) Between receiver 1 and 3



(c) Between receiver 2 and 3

Fig.8. Distortion region for broadcasting three Gaussian sources over a power limited Gaussian broadcast channel.

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Fig.8 (a) , (b) and (c) shows the distortion region for broadcasting three Gaussian source components over a power limited Gaussian broadcast channel using HDA coding scheme. The first two source components having covariance matrix $\begin{bmatrix} 1 & 0.2 \\ 0.2 & 1 \end{bmatrix}$. The third source is independent to other two sources. The system parameters are total power $= 0\text{dB}$, the noise variances$N_1 = -5\text{dB}$, $N_2 = -2.2\text{dB}$ and $N_3 = 0\text{dB}$. The Fig.8 (a) compares the distortion region between the receiver 1and 2(correlated Gaussian sources). The Fig.8 (b) compares the distortion region between the receiver 1and 3 (independent Gaussian sources). The Fig.8 (c) compares the distortion region between the receiver 1and 2(independent Gaussian sources).From the Fig.8 observe that the HDA coding scheme is optimal for both correlated and independent source.

Fig.9 shows the distortion region for broadcasting bivariate Gaussian source over a power limited Gaussian broadcast channel with correlation$\rho = 0.2$. The system parameters are $P = 0\text{dB}$, $N_1 = -5\text{dB}$ and $N_2 = 0\text{dB}$. the figure.9. shown comparison of distortion region using different coding schemes such as layering with analog and Costa coding introduced in [7, section II B], Lattice-based coding scheme in [3] and Uncoded (analog) transmission which scaling the encoder input subject to the channel power constraint and transmitting without explicit channel coding.

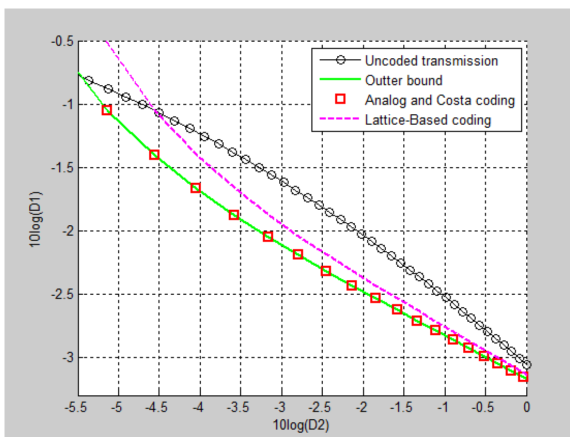

Fig.9. Comparing distortion region of broadcasting bivariate Gaussian source over power limited Gaussian broadcast channel using different coding scheme.

VIII. CONCLUSION

We have studied the problem of transmitting sources over a power limited Gaussian broadcast channel. We have presented a complete characterization of achievable distortion region for broadcasting bivariate Gaussian source by using hybrid digital analog coding scheme under mismatched bandwidth condition. Also compare the outer bound distortion region of bandwidth mismatched case which is derived from outer bound distortion region of matched bandwidth case in [3]. We also presented distortion region for broadcasting three sources over power limited Gaussian broadcast channel by using HDA coding scheme. The proposed HDA scheme is optimal for both independent and correlated Gaussian sources. In future, plan to calculate complete characterization of distortion region of broadcasting m (m>3) correlated Gaussian source components. Besides, the bandwidth mismatch case is also interesting area for (m ≥3). Numerical results show there is a gap between the achievable and outer bound distortion regions. Future work also need to improve coding schemes to close this gap.

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