PERFORMANCE ANALYSIS OF RMSE WITH DIFFERENT IMAGE FORMATS TRANSMISSION USING UNILEVEL HAAR WAVELET BASED ON MAX-MIN POWERCONTROL

M. Padmaja[1], P. Satyanarayana[2], K. Prasuna[3]
[1]Asst. Prof., ECE Dept., VR Siddhartha Engg. College, Vijayawada (A.P.), India
[2]Prof. and Head of EEE, Sri Venkateswara University College of Engg. Tirupati (A.P.), India
[3]Asst. Prof., ECE Department, Vijaya Institute of Tech. for Women, Vijayawada (A.P.), India
padmaja19m@gmail.com,p22880@gmail.com

ABSTRACT

This paper addresses performance of RMSE with power allocation methods for multimedia signals over wireless channels. The objective is to minimize total power allocated for image compression and transmission, while the power for each bit is kept at a predetermined value. Different image formats exist in multimedia.RMSE is analysed for five types of image formats. In this work, an approach for minimizing the total power allocated of a multimedia like image due to source compression and transmission subject to a fixed bit source distortion for different image format is considered. Simulations are performed using unilevel haar wavelet over AWGN channel with maxima and mimima power control.

KEYWORDS: *RMSE, JPG, PNG, TIF, BMP*

I. INTRODUCTION

By the advent of multimedia communications and the information superhighway has given rise to an enormous demand on high-performance communication systems. Multimedia transmission of signals over wireless links is considered as one of the prime applications of future mobile radio communication systems. However, such applications require the use of relatively high data rates (in the Mbps range) compared to voice applications. With such requirement, it is very challenging to provide acceptable quality of services as measured by the Root Mean Square Error (RMSE) due to the limitations imposed by the wireless communication channels such as fading and multipath propagation. Furthermore, the user mobility makes such a task more difficult because of the time varying nature of the channel. The main resources available to communications systems designers are power and bandwidth as well as system complexity. Thus, it is imperative to use techniques that are both power and bandwidth efficient for proper utilization of the communication resources [1]. Power control has been an effective approach to mitigating the effect of fading channels in the quality of signal transmission over wireless channels. The system typically involves a mechanism of measuring the quality of the channel seen by the receiver and providing such information to the transmitter to adjust the amount of transmitted power. For instance, if the channel is good then less power is used while if the channel is bad then more power is used. Few modifications to this strategy have been proposed such as to send higher data rates rather than reducing the power if the channel is good or not to send at all if the channel is bad. These systems are considered as opportunistic systems since they take advantage of the information about the channel to optimize the communications process [2]. The main issues for these systems are the need for a feedback link fast enough to track the time variation

of the channel and not utilizing the message structure of the image or video signal to be transmitted in power allocation.
The remainder of the paper is organized as follows. In section 2, a review of the necessary background required to effectively implement our algorithm is presented. The proposed algorithm is described in Section 3. After that, application of the proposed algorithm is discussed in section 4, and conclusion is drawn in the last section.

II. PROBLEM FORMULATION

Efficient use of the multimedia power is one of the major challenges in information devices. The controlling of power becomes even more critical with devices integrating complex video signal processing techniques with communications, [4].Some of the key technologies that affect the power in this respect are source signal compression, channel error control coding, and radio transmission. Power consumption of base band processing should also be taken into account. On the other hand, the work on improving the power has focused on separate components such as algorithms and hardware design for specific video and channel coders and low power transmitter design [3]. Joint optimization of source compression, channel coding, and transmission to balance the quality of service and power requirements of the multimedia has only recently attracted interest [5]. The work by Appadwedula et al. [6], considers minimization of the total energy of a wireless image transmission system. By choosing the coded source bit rate for the image coder, redundancy for the Reed–Solomon (RS) coder, transmission power for the power amplifier and the number of fingers in the RAKE receiver, the total energy due to channel codec, transmission, and the RAKE receiver is optimized subject to end-to-end performance of the system. The proposed system is simulated for an indoor office environment subject to path loss and multipath. Significant energy saving is reported. In [7] and [8], by changing the accuracy of motion estimation different power and distortion levels for H.263 encoder are provided [9].The coded bits are packetized and unequally protected using RS codes and are transmitted over a code-division multiple-access system operating over a flat fading channel.
Depending on the Allocation, power control algorithms can be categorized as either centralized or distributed. An optimum centralized power control algorithm which can achieve the minimum outage probability was studied in [3]. It is assumed that all the active link gains are available and remain constant during execution of the algorithm. This assumption, of course, is not realistic because of the high computational complexity required for the algorithm [10][11].
In the previous algorithms of power allocation methods only local information is used to adjust transmitting power. However, a normalization procedure is required in each iteration to determine transmitting power and, thus, these algorithms are not fully distributed. In this paper, a controlled power adaptation algorithm which does not need the normalization procedure is proposed [14],[15],[16]. The excellent performance and the Maximum distributed property make our proposed algorithm a good choice for multimedia systems [12][13].

III. RMSE OPTIMIZATION USING POWER ALLOCATION METHODS

When there are N number of images and M number of bits in a multimedia system, then the powers transmitted by the bits be $p=[p_1, p_2, ...p_M]$ and the respective RMSEs at the bits be $RMSE=[RMSE_1, RMSE_2, ...RMSE_M]$. Let $RMSE^T$ be the target RMSE.

1. Minimum Controlled Power Adaptation

MCPA is one of the best- Controlled Power Adaptation algorithms, which achieves very good performance in Multimedia. As the name itself is self-explanatory, it is minimum because the algorithm uses only minimum power and does not depend on the large information for controlling the power.
The power-updating step of Minimum Controlled Power Adaptation is given by

$$P_i^{n+1} = R_i^n \times P_i^n \quad (1)$$

Where

$$R_i^n = \frac{\min(RMSE_i^n, RMSE^T)}{RMSE_i^n} \quad (2)$$

Where

$RMSE_i^n$ =Root mean square error of ith bit in nth iteration

$RMSE^T$ =Target Root Mean Square error

Here the new power level is calculated by the product of the previous power level and the ratio of RMSEs

Minimum Controlled Power Adaptation Algorithm:

1. Initialize power values for all the bits.
2. For 1 to No. of iterations and No. of bits, calculate the RMSE and update the power of all the bits using Equation (1)
3. Calculate the minimum power of each bit.

2. Maximum Controlled Power Adaptation Algorithm

MACPA is is an improved version of the previous MCPA algorithm proposed in [9]. The previous algorithm considers the minimum value of the CIRs. The present algorithm differs from it in its consideration of the maximum value of the same.

All the properties of MCPA are also satisfied by MACPA. The power-updating step of Minimum Controlled Power Adaptation is given by equation (1)

Where

$$R_i^n = \frac{Max(RMSE_i^n, RMSE^T)}{RMSE_i^n} \quad (3)$$

Where

$RMSE_i^n$ =Root mean square error of ith bit in nth iteration

$RMSE^T$ =Target Root Mean Square error

Here the new power level is calculated by the product of the previous power level and the ratio of RMSEs

Maximum Controlled Power Adaptation Algorithm:

1. Initialize power values for all the bits.
2. For 1 to No. of iterations and No. of bits, calculate the RMSE and update the power of all the bits using equation (1)
3. Calculate the minimum power of each bit.

IV. WAVELETS AND IMAGE FORMATS

Wavelets are mathematical functions that cut up data into different frequency components, and then study each component with a resolution matched to its scale[17]. The wavelet transform has the ability to decorrelate an image both in space and frequency there by distributing energy compactly into a few low frequency and a high frequency coefficients.The efficiency of a wavelet based image compression scheme depends both on the wavelet filters chosen as well as on the coefficient quantization scheme. In the discrete wavelet transform, an image signal can be analyzed by passing it through an analysis filter bank followed by decimation operation[19],[20]. The analysis filter bank consists of a low pass and high pass filter at each decomposition stage.when the signal passes through these filters it splits into two bands. The low pass filter corresponds to an averaging operation, extracts the coarse information of the signal [18],[21], The high pass filter corresponds to a differencing operation that extracts the detail information of the signal. The output of the filtering operation is then decimated by two.A two dimensional transform is accomplished by performing two separate one dimensional transforms. First the image is filtered along the row and decimated by two.

It is then followed by filtering the sub image along the column and decimated by two. This operation splits the image into four bands, namely LL, LH, HL and HH respectively. The LL band is transmitted along the channel by allocating power allocation and one level of decomposition was taken into consideration. The four bands are transmitted over wireless channel and the coefficients are reconstructed using inverse transform. The approximation coefficients are reconstructed using inverse discrete transform process and various parameters are studied in the proposed and conventional methods for one level of sub band decomposition.

There are different image formats available for different applications.Inthis paper only five types of formats.JPEG, PNG, BMP, TIF and GIF are considered.Each format undergoes one different application in real-time. Bitmap is a home Windows raster format, which is used practically for all possible raster data storage. All BMP versions were designed for computers with Intel processors. The main advantage of the format is considered to be its usability and wide software support. Tiff format is one of the most multipurpose and integrated raster formats.It is easily ported among platforms and used for different purposes. Png file format is a comparatively new progressive format originally designed to replace dated Gif. Png format has got a set of new features that Gif lacks.Png also performs a lossless compression with the help of Deflate algorithm. Gif file format is used to hold and transfer images in index colormode.The format also supports a lossless LZW compression algorithm and interlaced mode. Jpeg format was designed to transfer graphic data and images via digital telecommunication networking and was generally used to hold and transfer full color photorealistic images.

V. NUMERICAL RESULTS AND CONCLUSIONS

Root Mean Square Error (RMSE) values are obtained for Equal Controlled Power Adaptation Algorithm, Minimum Controlled Power Adaptation Algorithm and Maximum Controlled Power Adaptation Algorithms. Image transmission over AWGN is considered with an average value of Eb / No = 3 dB and M = 8 bpp for both methods. The improvement in performance obtained by the Minimum Controlled Power Adaptation Algorithm is affected by the Maximum Controlled Power Adaptation Algorithm and the value of Eb/ No at which the system is operating as shown in TableI.A better Performance is observed in Maximum Controlled Power Adaptation Algorithm compared with Equal Controlled Power Adaptation Algorithm as shown in Table.II and Table III

Fig.1, Fig.2 and Fig.3 shows the plots of Eb/No versus RMSE for Maximum, minimum and Conventional Equal control power method.Both minimum Adaptation Algorithm and Maximum Controlled Power Adaptation Algorithms show better RMSE performance in image transmission using unilevel of haar wavelet compared with equal Controlled Power Adaptation.

In all the three methods, JPG format shows better performance with less error.gif image format shows drastic increase in error compared with remaining formats.PNG format has showed better performance compared with other formats. Jpg format also shows better performance than TIFF and BMP formats.

Table.1 RMSE values using MCPAA with haar wavelet at level 1 for different image formats

	RanchHouse.jpg	barbara.png	lena.bmp	cameraman.tif	lena1.gif
Eb/No	MACPAA-RMSE				
1	0.5955	0.5938	0.5941	0.5948	0.595
2	0.5568	0.5565	0.5561	0.5559	0.5571
3	0.5142	0.5155	0.5162	0.5164	0.5157
4	0.4711	0.4693	0.4705	0.4708	0.4688
5	0.4212	0.4194	0.4206	0.4196	0.4173
6	0.3653	0.3642	0.364	0.3633	0.3632
7	0.2996	0.3006	0.2991	0.302	0.3021
8	0.2262	0.2274	0.2271	0.2252	0.2259
9	0.1274	0.1252	0.1283	0.1264	0.1271
10	0.0313	0.0299	0.0294	0.0295	0.0295

Table.1I RMSE values using MACPAA with haar wavelet at level 1 for different image formats

	RanchHouse.jpg	barbara.png	lena.bmp	cameraman.tif	lena1.gif
Eb/No	MCPAA -RMSE				
1	0.2705	0.2714	0.2693	0.2675	0.2704
2	0.2138	0.2104	0.213	0.212	0.2119
3	0.1528	0.1514	0.1532	0.1509	0.1523
4	0.0952	0.0958	0.0933	0.0956	0.0933
5	0.0493	0.0486	0.0459	0.0503	0.0501
6	0.0187	0.0189	0.0166	0.0156	0.0181
7	0.0028	0.0039	0.0028	0	0.0055
8	0	0	0.0028	0	0
9	0	0	0	0	0
10	0	0	0	0	0

Table.III RMSE values using ECPAA with haar wavelet at level 1 for different image formats

	RanchHouse.jpg	barbara.png	lena.bmp	cameraman.tif	lena1.gif
Eb/No	ECPAA-RMSE				
1	0.7065	0.705	0.7078	0.7079	0.708
2	0.7071	0.7067	0.7072	0.7062	0.7061
3	0.7074	0.7058	0.707	0.7056	0.704
4	0.7066	0.7077	0.7081	0.7082	0.7088
5	0.7068	0.7052	0.7081	0.7068	0.7077
6	0.7059	0.7076	0.7084	0.7061	0.7077
7	0.7074	0.7075	0.7068	0.7067	0.7069
8	0.7065	0.7056	0.7077	0.7071	0.707
9	0.7076	0.7074	0.7069	0.7058	0.7068
10	0.7085	0.706	0.708	0.708	0.7079

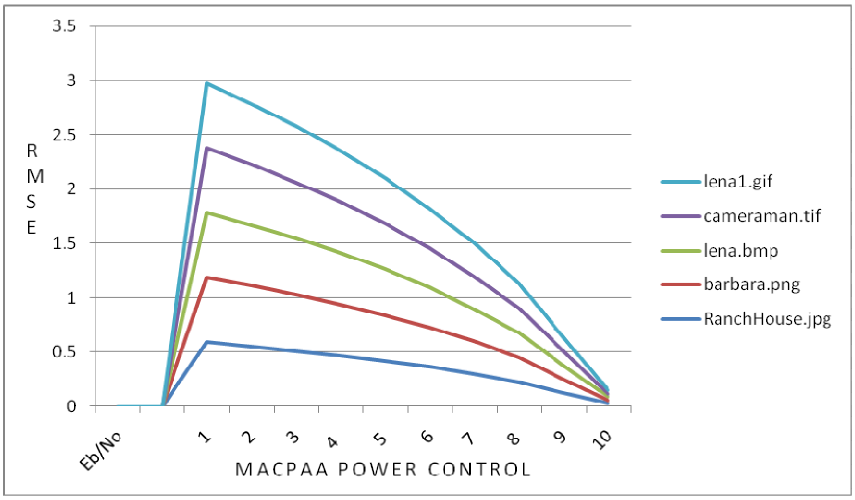

Fig.1 Plot showing E_b/No versus RMSE Maximum Controlled PowerAdaptationAlgorithm for different image formats

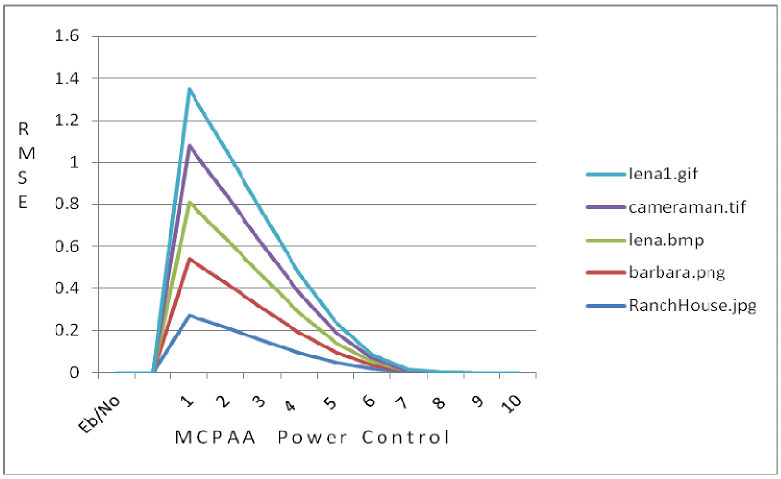

Fig.2 Plot showing E_b/No versus RMSE Minimum Controlled Power AdaptationAlgorithm for different image formats

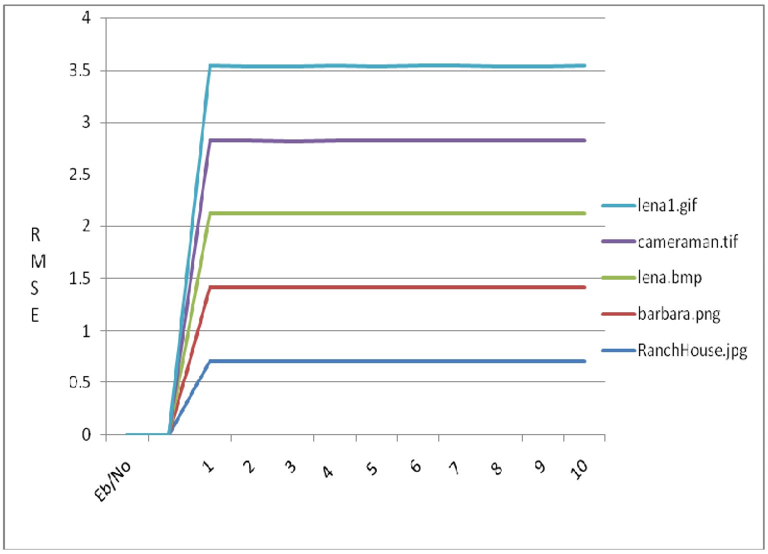

Fig.3 Plot showing E_b/No versus RMSE Equally Controlled Power AdaptationAlgorithm for different image formats

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M Padmaja is currently working as Associate Professor in the Department of ECE, VR Siddhartha Engineering College, Vijayawada. She is working towards her Ph.D at Sri Venkateswara University College of Engineering, Tirupati, under the guidance of Dr P Sathyanarayana. She has 16years of experience in teaching various courses at B.Tech and M.Tech. Her research areas are Signal Processing and Communications. She has more than 12 research papers to her credit. She is Fellow of IETE, Life member of IE (I), ISTE, SEMCEI, and BMESI.

P Sathyanarayana received the B. E., M. E., and Ph. D. degrees from Sri Venkateswara University, Tirupati, A. P., India, in 1976, 1978 and 1987 respectively all in Electronics and Communication Engineering. He Joined the Department of Electrical and Electronics Engineering, Sri Venkateswara University College of Engineering, Tirupati, in July 1979 as an assistant Professor and became Professor in July 1999. His research interests are in the field of one and two dimensional Signal Processing particularly in Image/ Video processing and Communication.He was with the Dept. of Electrical and Computer Engg., Concordia University Montreal, Canada from 1988 to 1990 as Post Doctoral Fellow, and he was with School of Aerospace Engg., University Sains Malaysia, Penang, Malaysia as a visiting faculty from 2004 to 2007.

K Prasuna obtained M. Tech in Communications and Signal Processing from Acharya Nagarjuna University in 2009.She has more than 5 years of teaching experience. Presently she is working as Assistant Professor in ECE department in Vijaya Institute of Technology for Women, Vijayawada. Her areas of interest are Digital Signal Processing, Wireless Communications, Image Processing and Wireless Networks.