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Performance Analysis of Progressive Coefficients Significance Compression Methods for ROI-based DICOM Image

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ABSTRACT: Medical images have some spatial regions which are diagnostically more important than the others. These important spatial regions are known to be region of interest (ROI). The lossless compression technique which is capable of delivering higher reconstruction quality for ROI are more desirable and demanding in the present scenario. Therefore region based coding(RBC) with progressive transmission is most appropriate compression technique in this situation. Lossless compression scheme with secure transmission play a key factor in accurate diagnosis and research. The proposed work begins with the preprocessing of medical image. The region base segmentation is applied to the medical image, to separate ROI and non-ROI part of image. The ROI is compressed using lossless scalable RBC and non-ROI is compressed with distortion limiting(lossy) compression using Discrete Wavelet Transform (DWT). The work is analyzed using EZW and SPIHT compression algorithms separately. The resultsshows that the performance metrics of SPIHT compression algorithm is better than the EZW algorithm.

KEYWORDS : Medical Image, ROI-based lossless compression,non-ROI lossy compression, EZW,SPIHT

I. INTRODUCTION

Nowadays when huge amount of data is produced in field of medical imaging in form of medical image like Computer Tomography(CT-scans),Ultrasound Images, Medical Resonance Imaging (MRI),X-Ray, which are to be either stored in hospital information systems or transmitted via channel to other hospitals. The compression of these imaging data is highly demanding due to limitation of storage memory space and transmission bandwidth.Compression is an application of data compression that encodes the original image with fewer bits. It also deals with techniques for reducing the redundancy of image and to store or transmit data in an efficient form. Redundancy is the existence of data that is additional to actual data and transmits correction of errors in stored or transmitted data. To reduce the increasing demand of storage space and transmission time, compression techniques are the need of the day.It is of two types i.e. lossy and lossless. Lossy techniques are used whereloss can be accepted and Lossless techniques are used for the application that cannot afford any loss of informationfor example in medical field.For the image compression, many efficient compression techniques havingdifferent efficient features, have been developed by using discrete wavelet transform (DWT) based EZW & SPIHT.

In this paper, we are interested to evaluate the two mentioned techniques such as EZW and SPIHT algorithms using CT-scan DICOM medical image. The quality of the picture is measured by Peak Signal to Noise Ratio (PSNR) and simulation results are obtained by using MATLAB tool. The obtained results are compared which gives the performance comparison of these two techniques for various distortion levels.

A. Image Compression

The fundamental components of compression are redundancy and irrelevancy reduction.Redundancy means repetition or duplication and Irrelevancy means the parts of signal that will not be noticedby the signal receiver, which is the HumanVisual System (HVS).

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There are three types of redundancy can be identified:

- Spatial Redundancy**:** It is the correlation or similarity between neighboring pixel values.
- Spectral Redundancy**:** It is the correlation or similarity between different spectral bands or color planes.
- Temporal Redundancy: It is the correlation or similarity between adjacent frames in a sequence of images.

Image compression is a technique which focuses to reduce the number of bits required to represent an image byremoving the spectral and spatial redundancies. The spatial and spectral redundancyis often removed by the predictive coding or transforms coding. Quantization is the mostimportant means of irrelevancy reduction [1].

B. Need of Compression.

One of the important aspects of medical image storage and transmission is its efficient compression. Compression is an essential component of the solutions available for creating filesizes of manageable and transmittable dimensions. Increasing the bandwidth is another method, but the cost sometimes makes this a less attractive solution and as bandwidth is increasing so the users are also increasing day by day, so bandwidth available per user is still a limitation.In telemedicine, patient's medical records are being transferred from one multispecialty hospital to the local or district hospital. Hospital stores this information for the future use purpose. But the size of medical image is very large. Multispecialty hospital produces large no. of images per patient. The amount of images produces by the hospital takes the 5 to 15 GB of storage space per day [3].It is too difficult to manage the storage system in the hospitals because many hospitals keep the medical record of their each patients. Moreover to send these images over the network needs high bandwidth [4] .It may increase the transmission cost. In rural area, there are many problems such as network issues which may cause the trouble in transmission of data. So compression was introduced to deal with the above problems. Compression reduces the size of images. It is of two types i.e. lossy and lossless. Lossy techniques can be used where loss of some information can be accepted.

II. REGION OF INTEREST

The medical image includes three parts in image. These are ROI (region of interest), non ROI and background.These part have their own advantages.ROI is the most critical part of the image that located over very small regionsof the image. Non ROI is also included so that user can easily find out the most critical part from the whole image.Part other than image contents is known as background and most ignored part of the image. In medical field, thesecritical parts needed to be compressed with high quality compression without any loss than other parts of image. Thecritical parts from the image obliged to be transmitted first or at higher need amid the transmission for telemedicinepurposes. Figure 1 is given below that shows the three different parts of the medical image.

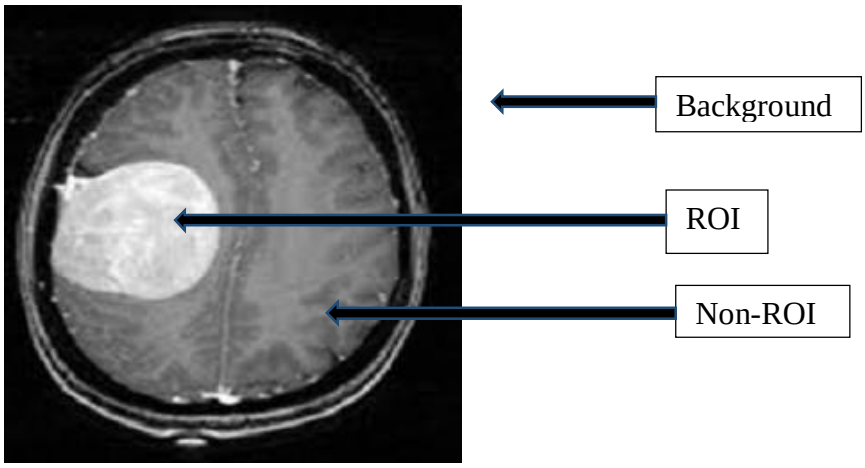

Fig. 1 Different parts of Medical Image

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III. COMPRESSION PERFORMANCE

Compression is mainly analyzed by different compression performance parameters such as, compression ratio (CR), Peak Signal to Noise Ratio (PSNR), Mean Square Error (MSE). The compression ratio CR refers that the compressed image is stored using only compressed ratio percentage of the initial storage size.

A. Compression Ratio

As the compression ratio increases, reconstructed image is more compressed.

$$CR = \frac{\text{(Original image File size)}}{\text{(compressed Image File size)}} \quad (1)$$

B. PSNR

The Peak Signal to Noise Ratio (PSNR) represents a measure of the peak error and is expressed in terms of decibels. It is represented as:

$$PSNR = 10\log_{10}\left(\frac{255^2}{MSE}\right)(db) \quad (2)$$

As the PSNR value increases, the quality of compressed or reconstructed image is better.

C. MSE

The Mean Square Error (MSE) represents the mean squared error between the compressed and the original image and is given by:

$$MSE = \frac{\sum_{x=0}^{N-1}\sum_{y=0}^{N-1}[I(x,y)-\hat{I}(x,y)]^2}{NXN} \quad (3)$$

Where, I(x, y)is the original image and Î(x, y) is the compressed image, N x N represent the size of grayscale image.The lower value of MSE will result in lower the errors.

IV. LITERATURE REVIEW

In this paper, a novel method for the adaptation of SPIHT algorithm (Set Partitioning in Hierarchical Trees) & EZW (Embedded Zerotree Wavelet) to the medical images is proposed by using symlet wavelets. The SPIHT process was mainly based on the wavelet transform. Set Partitioning in Hierarchical Trees (SPIHT) algorithm is based on embedded zero tree wavelet (EZW) coding method which employs spatial orientation trees and uses set partitioning sorting algorithm. The Coefficients corresponding to the same spatial location in different sub bands in the pyramid structure display self-similarity characteristics. SPIHT states and defines parent children relationships between these self- similar sub bands to make the spatial orientation trees. Amongst the techniques of compression using the wavelet transform proposed in the literature, the coding method called EZW which was introduced by the scientist J.Shapiro. This technique gives the dual benefit of being very effective and enormously quick. EZW is a universal lossless data compression method which is achieved via adaptive arithmetic coding. An EZW encoder is an encoder especially designed to use with wavelet transforms, that explains why it has the word wavelet in its name. The EZW encoder was mainly based on progressive encoding to compress an image into a bit stream with increasing accuracy. Thus, Shapiro predicts why in a hierarchical system in sub-bands, each coefficient at a given scale, was connected to a set of coefficients being on a subsequent finer scale and defines a tree structure precise by its "parent-child" relationship.

An enhancement of the EZW algorithm, recognized as SPIHT algorithm was proposed by Said and Pearlman. This improved version, using a different tree structure, processes all the non-significant descendants of a wavelet coefficient like a set and uses only one symbol to represent it. Considering the efficiency and the performances brought by the SPIHT algorithm on images at the point of gray.

V.PROPOSED WORK

A medical image is preprocessed and segmenting on region of interest basis. A mask is generated using MATLAB freehand tool after segmentation, which is logically AND with the original image to extract the ROI from it. The ROI is separated is separated from non-ROI part of the image. The classification of segmented image is done. Then wavelet transform of ROI

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and non-ROI is performed.Progressive coefficients significance compressionmethods combine wavelet decomposition and quantization. This is the basicprinciple of progressive methods.This method's progressivity on one hand, makes it possible during decoding to obtain an image whose resolution increases gradually and on other hand additionally, it is possible to obtain a set of compression ratios based on the length of the preserved code. This typecompression technique enables both lossy and lossless compression.Such methods are based on three ideas,the two ideas are already told before, that is the utilization of wavelet decomposition to ensuresparsity (a large number of zero coefficients) and classical encoding methods. The third idea is the decision for the use ofwavelets in image compression, is to exploit fundamentally the tree structure of the wavelet decomposition. The CT-scan DICOM image of 256x256 size is taken for the compression. Then the ROI is compressed losslessly while non-ROI part of image is compressed for different distortion level. The block diagram of proposed work is shown in figure.2.

A. Coding algorithm

By combining the DWT with the progressive coefficients significance compression methods, both the lossy and lossless compressionmodes are now supported. The major advantage of using this coding technique isthat, it supports embedded coding along with progressive transmission, which is suitable fortelemedicine applications.EZW and SPIHT are progressive coefficient significance compression methods which combines the step of thresholding and progressive quantization, focusing on the more efficient way to encode theimage coefficients, in order to improve the compression ratio. SPIHT is refined versions of the EZW algorithm.

Proposed coding stepsare as follows:

(i) Read the medical image and get dimensions
(ii) Convert the image into grayscale image
(iii) Select the ROI and separate it from non-ROI
(iv) Accept the compression level from user.
(v) Perform the DWT of ROI and non-ROI.
(vi) Do operation of compression as per level selected by user for Non-ROI, and Lossless compression for ROI.
(vii) Perform inverse- wavelet recursively combine ROI.
(viii) Compare the quality of original image with newly reconstructed image.

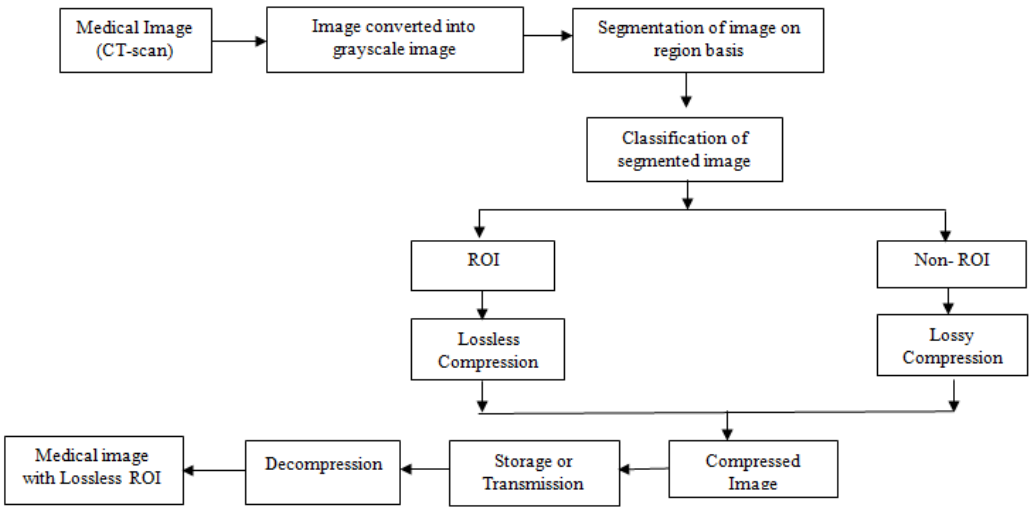

Fig.2 Block Diagram of the Proposed Work

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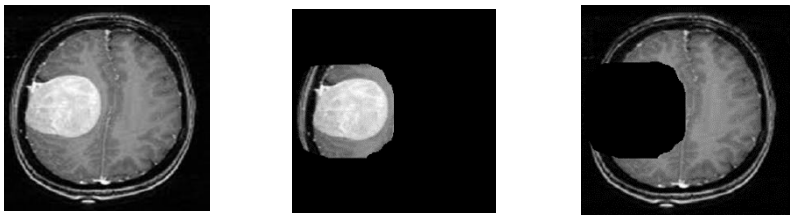
VI.EXPRIMENTAL RESULTS

EZW and SPIHT progressive coefficients significance algorithms are implemented on CT-SCAN medical image separately. SPIHT is proved to be the better than EZW.But for ROI-based compression computational complexity is also one of the important issuesto be considered, while addressing real time applications. A new and simple algorithm as explained above is used to encode the image.Figure 3and figure.4 shows the different stages of development. Original image formatted in DICOMformatof size 256 X 256 with 8 bit resolution is input to MATLAB software. At the decoder side,the compressed image is generatedafter reconstruction process. The output of encoder is abit stream of numbers arranged in a manner so as to support the progressive transmission, withinitial part as a ROI compressed losslessly.



Original Image Region of Interest Region of non-ROI

Fig. 3 Different stages of processing before compression

After classification of segmented images the lossy and lossless compression is performed using EZW and SPIHT algorithm separately.Lossy compression is done with different distortion levels from zero distortion level to tenth distortion level. This shows that using progressive coefficients compression methods, enables the precise rate control that is achieved withthese algorithms is a distinct advantage. The user canchoose a bit rate or a distortion level and encode the image to exactly thedesired bit rate.Fig.4 showing different levels of distortion or required bit rate to encode same compressed image.In the result of all ten levels, it is difficult to distinguish between ROI and Non-ROI up to level 6, but after level 7 this difference is significant.

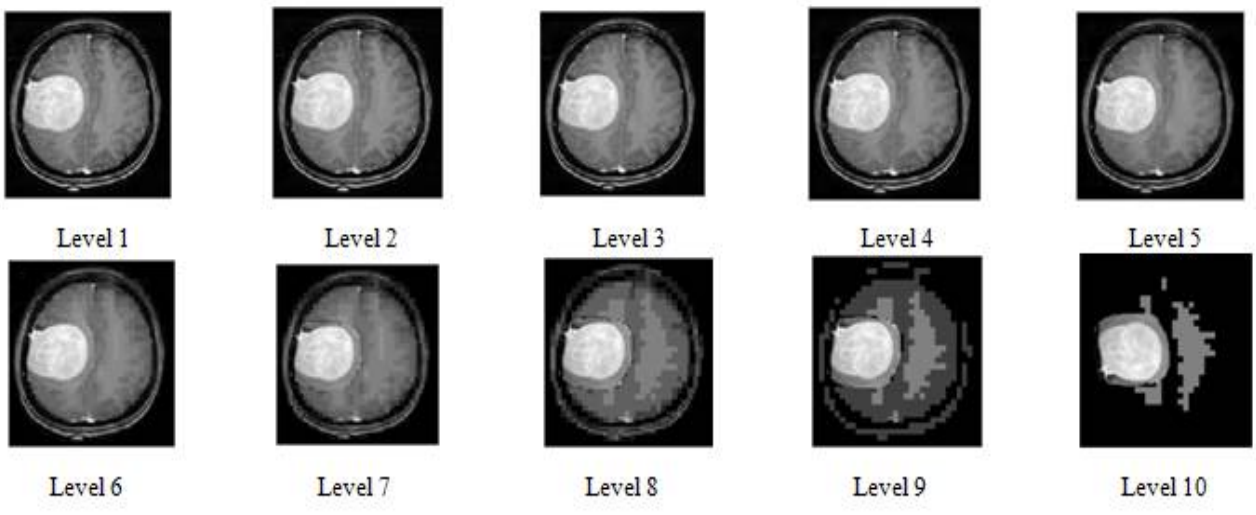


Fig.4 Reconstructed Image of ROI based encoding with respect to different distortion levels for non-ROI region.

Table.1. shows the comparison of two compression algorithm on different performance parameters like Mean Square Error (MSE),Peak Signal to Noise Ratio(PSNR),compression ratio percentage(CR),and bits per pixel calculated using

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equation (1,2,3) with respect to number of decomposition level(ITU-T recommendation H.263,1998). Symlet 1 wavelet is used in DWT decomposition. ROI selected is kept constant for every compression level to get unique results.Fig.4 and fig.5 shows the comparison of EZW and SPIHT compression results in terms of compression ratio and PSNR for different levels.

Table No. 1. Performance ofprogressive coefficients significance algorithms for different distortion levels

	EZW algorithm				SPIHT algorithm			
Distortion Level	CR	BPP	MSE	PSNR (db)	CR	BPP	MSE	PSNR (db)
0	51.1752	4.094	1.6216	46.0313	59.7814	4.7825	0.0705	59.6468
1	49.7725	3.9818	8.3876	38.8944	55.9845	4.4788	0.1378	56.7376
2	45.342	3.6273	16.4028	35.9816	49.3787	3.9503	0.3567	52.608
3	41.2834	3.3027	34.4286	32.7616	45.1411	3.6112	1.3089	46.9618
4	32.2411	2.5793	64.8515	30.0116	36.1531	2.8922	3.5423	42.6379
5	22.7759	1.8221	16.2975	29.0096	26.4606	2.1168	10.0977	38.0886
6	15.3468	1.2277	81.6808	27.6865	21.7579	1.7406	25.1066	34.1329
7	10.5543	0.8443	408.084	22.0233	18.8424	1.5074	56.2596	30.6288
8	7.9924	0.6394	852.825	18.8222	17.4221	1.3938	129.9418	26.9933
9	6.6413	0.5313	2854.6	13.5752	16.6885	1.3351	384.7628	22.2789
10	6.1267	0.4901	7776.43	9.223	15.882	1.2706	1275.5	17.074

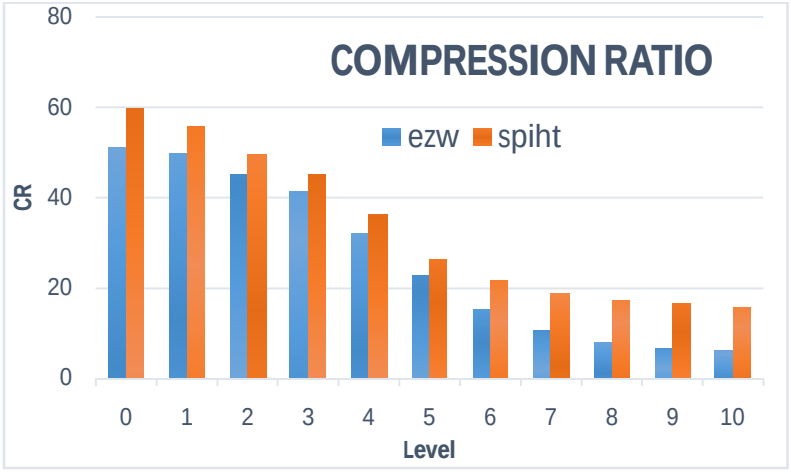

Figure 4. Comparison of EZW and SPIHT algorithm (parameter CR)

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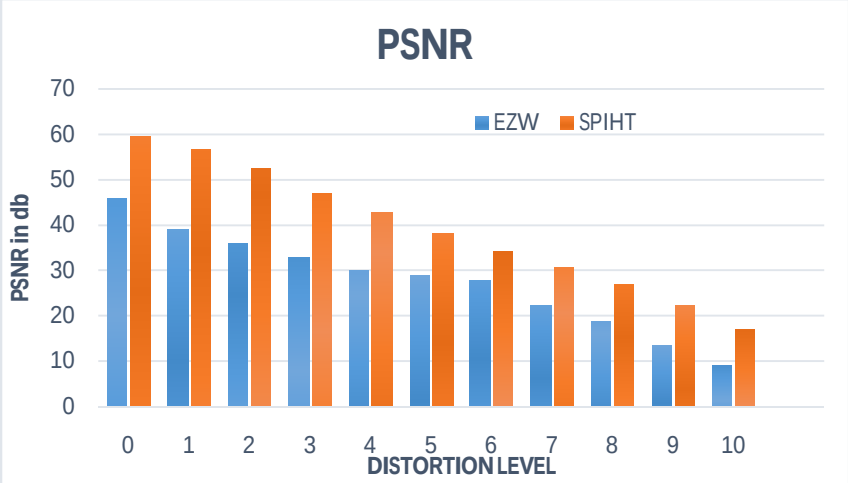

Figure 5.Comparison of EZW and SPIHT algorithm (parameter PSNR)

VII.CONCLUSION

Medical image compression is extensively used in real time applications where data is transmitted over network for telemedicine applications. In this paper scalable region based lossless compression of ROI and lossy compression with respect to different distortion level for non-ROI area using SPIHT and EZW algorithms with symlet1 wavelet, is implemented. From the outcomes, the proposed strategies with SPIHT algorithm have demonstrated a low Mean Squared Error rate, high PSNR and High Compression Ratio when contrasted with the EZW algorithm. So SPIHT progressive coefficient significance compression method is better compression methods as proven by above results.

REFERENCES

[1] Jerome M.Shapiro," Embedded Image Coding Using Zerotrees of Wavelet Coefficients,"IEEE Transactions on Signal processing, vol 41,no.12,pp, 3445-3462, December 1993.

[2] Amir Said and William A Pearlman," A new fast, and efficient image codec based on Set Partioning in Hierarchical Trees," IEEE Transactions on circuits and systems for video technology,vol 6,no.3,pp.243-250,June 1996.

[3] B. Venkateswara Reddy, Dr. P.Bhaskara Reddy, Dr. P. Sateesh Kumar and A SateeshReddy," Lossless compression of medical images for better diagnosis," IEEE 6th International Conference on Advanced Computing, pp.404-408, 2016.

[4] Vinayak K Bairagi and Ashok M Sapkal, "ROI-Based DICOM Imaages Compression for Telemedicine," Springer, Indian Academy of Science, part 1,pp. 123-131, February 2013.

[5] Brindha B. and Raghuraman G., "Region based lossless compression for digital images in telemedicine application," International ConferenceinCommunications and Signal Processing (ICCSP), 2013; pp. 537-540.

[6] Koff, D., and Shulman, H.,"An overviewof digital compression of medical images:can we use lossy image compression inradiology?,"Canadian Assoc. ofRadiologists Jr. Vol.57,No.4,pp.211–217,2006.

[7] M. MesbahuddinSarker, "EZW Algorithm and Computation of Its Coefficients for Image Compression by Using "Bottom-Up" Approach" in International Journal of Scientific Engineering and Technology Volume No.2, Issue No.6, pp : 532-538 June 2013.

[8] Chang Shoarang and Lawrence Carin, "A modified SPIHT algorithm for image coding with a joint MSE and classification distortion measure" IEEE Transaction on Image Processing, Vol 15 Pg. No. 713-725, March 2006.

[9] R. A. DeVore, B. Jawerth, and B. J. Lucier, "ImageCompression Through Wavelet Transform Coding,"IEEE Trans. On Information Theory, Vol. 38, No. 2,pp. 719 - 746, (1992).

[10] Ali T J and Akhtar P , "Significance of region of interest applied onMRI and CT images in teleradiologytelemedicine".Heidelberg: Springer-Verlag Berlin, 151–159,2008