RESEARCH ARTICLE

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Selection of Optimum Medical Image Compression Method using Cuboid Representation

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Abstract

Medical Images can be compressed using several lossy and lossless compression algorithms. In this research, brain CT images were used to study the effects of compression using EZW, SPIHT, STW, WDR and ASWDR methods and filters Haar, Db, Symlets and Biorthogonal filters. The effectiveness of the algorithms is defined by MSE, PSNR, BPP and CR. For an ideal condition MSE should be minimum, PSNR should be high, the selection of BPP should be such that, BPP should be low but at the same time the compressed image should be clearly visible. Images should be compressed at a higher compression ratio without compromise in the quality of the compressed image.

To decide on the best possible combination which helps in reduction of storage space and cost and also taking into account the quality of the compressed image, it is required to compare the huge tabulated data set. This is a tedious job. Therefore in order to help the physicians or the radiologists to choose the best combination, we have come up with a cube structure.

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Introduction

The cube can be of 2-dimensional, 3-dimensional, or higher-dimensional structure. Dimensions of the cube are the equivalent of entities in a database. The cuboid that holds the lowest level of summarization is called the base cuboid. Each level of the cuboid going up in hierarchy gives summarized data reducing one dimension from the previous level. The top level gives a single value which is a summarization of all the dimensions. The 0-D cuboid, which holds the highest level of summarization, is called the apex cuboid. The apex cuboid is typically denoted by ALL. The top view of 3-D cube structure is shown in Fig 2 and Fig 1 represents Brain CT image.

Representation of the Optimum Condition using Cube Structure

The optimum condition for selection of the best combination is that MSE and BPP should be minimum and CR should be maximum. The criterion for optimum condition (OP) is given in Table 1 and the cube structure is shown in Fig 3. Each vertex of the cube represents one condition.

Selection of Best Possible Combination using Distance Formula

This is carried out by considering the values of different parameters as the points in the cube and by finding their distance from the ideal condition. Table 2 gives different parameter values obtained by compressing CT Brain Image. Minimum distance is the chosen criteria to find the best combination (see Table 3). Taking an example where normalized values obtained from compressing CT Brain image using different algorithms and Bior wavelet are represented as points P0-P5 on the 3-Dimensional axis.

- P0 = (MSE, CR, BPP) = (0, 1, 0) is the ideal condition and the distance between any two points P (x1, y1, z1) and Q (x2, y2, z2) is given by distance formula

$$D = \sqrt{(x2-x1)^2 + (y2-y1)^2 + (z2-z1)^2}$$

Table 4 gives the distance measure between points in a Cube and Fig 3 shows the points in 3-Dimensional axis.

From the minimum distance criteria (value highlighted with blue color in Table), STW method in combination with Bior wavelet can be chosen as one of the best combination for compressing CT Brain Image.

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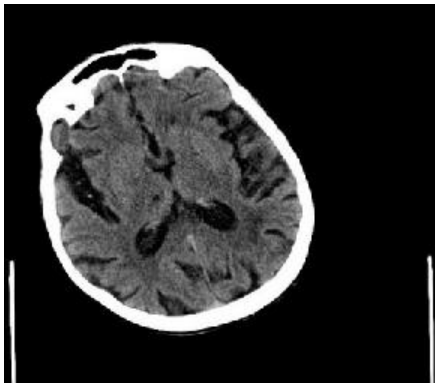

Fig 1: Brain CT image

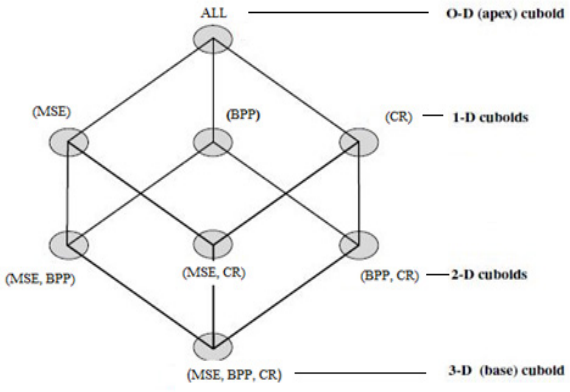

Fig 2: Three- Dimensional Cuboid Structure

Table 1: Criteria for Selection of Optimum Condition

MSE	*CR*	*BPP*	*OP*
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

*OP – Optimum Condition

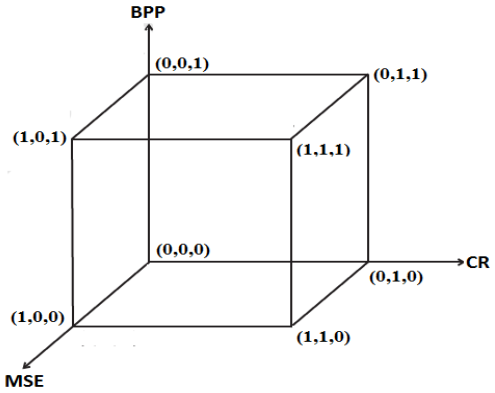

Fig 3: Front View of the 3-Dimensional Cube

Table 2: Parameter Values obtained by Compressing CT Brain Image

Image	*Method*	*Wavelets*	*PSNR*	*MSE*	*CR*	*BPP*
CT Brain Image	EZW	Haar	57.95	0.1	59.25	3.25
		Db	49.3	0.76	68.2	2.5
		Bior	49.2	0.78	70.4	2.37
		Sym	49.3	0.776	69	2.5
	SPIHT	Haar	48.7	0.88	64.83	2.8
		Db	47.8	1.06	64.32	2.85
		Bior	48.59	0.89	65.91	2.73
		Sym	47.7	1.1	64.83	2.81
	STW	Haar	58.8	0.85	60.65	3.14
		Db	58.68	0.088	58.5	3.32
		Bior	58.5	0.09	60.97	3.12
		Sym	58.64	0.89	59.5	3.23
	WDR	Haar	48.32	0.96	52.7	3.8
		Db	45.43	1.86	63.65	2.9
		Bior	45.7	1.72	66.35	2.7
		Sym	45.3	1.9	64.7	2.8
	ASWDR	Haar	48.32	0.96	55.68	3.54
		Db	45.43	1.86	65	2.8
		Bior	45.77	1.72	67.8	2.57
		Sym	45.34	1.9	66.3	2.7

Table 3: Normalized Values for different Parameters

Image	*Method*	*Wavelet*	*MSE/Normalized value*	*CR/Normalized value*	*BPP/Normalized value*
CT Brain Image	EZW	Bior	0.78 / 0.4	70.4 / 0.7	2.37 / 0.3
	SPIHT		0.89 / 0.45	65.91 / 0.66	2.73 / 0.34
	STW		0.09 / 0.05	60.97 / 0.61	3.12 / 0.38
	WDR		1.9 / 0.95	64.7 / 0.65	2.8 / 0.35
	ASWDR		1.72 / 0.85	67.8 / 0.68	2.57 / 0.325

Table 4: Distance Measure between Points in a Cube

Image	*Method/ Points*	*Points*	*Distance b/w two points*	*Distance*
CT Brain Image	EZW)	P1 = (0.4, 0.7, 0.3)	P0-P1	0.58
	SPIHT	P2 = (0.45, 0.66, 0.34)	P0-P2	0.66
	STW	P3 = (0.05, 0.61, 0.38)	P0-P3	0.55
	WDR	P4 = (0.95, 0.65, 0.35)	P0-P4	1.07
	ASWDR	P5 = (0.85, 0.68, 0.325)	P0-P5	0.96

Conclusion

To decide on the best possible combination which helps in reduction of storage space and cost and also taking into account the quality of the compressed image, it is required to compare the huge tabulated data set. This is a tedious job. Therefore in order to help the physicians or the radiologists to choose the best combination, cube structure is very helpful.

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