¹.   ¹,².   ¹,²,⁴.   ³,⁵,⁶

¹   BK21   ,²   ,
  ³   ⁴   ,
  ⁵   ⁶

A Study on the Vector Quantization of Medical Imaging System

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= Abstract =

Since PACS (Picture Archiving and Communications System) was installed in the hospital , storing and transmitting digital images have been possible. However, in the present condition, the size of digital medical images is so large that huge storage and fast network were necessary. To increase efficiency of storing and transmitting medical images, the present study suggests the image compression method using full search VQ (Vector Quantization) and TSVQ (Tree Search VQ).

1.

PACS(Picture Archiving and Communicatios System)

DICOM(Digital Imaging and Communications in Medicine)
,   ,   . PACS

.

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.   200

kbyte- 7 Mbyte
.   PACS
,   [1].

.

RLE(Run- Length Encoding)
JPEG, JPEG2000   .

.

MR(Magnetic Resonance)/CT(Com- puted Tomography)
VQ(Vector Quantization)
.

$Q:R^k$ C

2.

$C = [y_1, y_2,..., y_N]$ (codebook)

(pixel)   (code)   ,   i   [1, 2,..., N]

, N y_i R^k

[1].   .

N R_k N

(cell) R_i . i

.   DCT

(Discrete Cosine Transform)   DWT(Discrete Wavelet

Transform)   (space domain) $R_i = [x \quad R^k : Q(x) = y_i]$

(coefficient)

.

,

(block) $_i R_i = R^k$, i j R_i $R_{j = \emptyset}$

VQ   .   , R^k (partition)   [3].

lossy   (quantization)

X

[1].   . Shannon

.   (scalar)   .

.

(algorithm)

. $d(X, Y_i)$ $d(X, Y_j)$, all j

2.1.

[3].   2.2. Full Search Vector Quantization

,

,   .   Full Search VQ(Vector Quantization)

.   .

,   . Full Search VQ

(templet)   . (clustering)   Lloyd (Forgy, Isodata, k-

.   mean)   [4, 5, 6].

N   k   (minimum distortion)

Q k (Euclidean space) R^k

N   C   (map-   (nearst neighbor)

ping)   . ,   .

2.3. Tree Search Vector Quantization

Shannon   VQ   .

                                                    [2].   (balanced binary tree)

        .   .

                                                            TSVQ   P. C. Cosman, K. L

        lattice- bsed codes, classified VQ, multistep VQ, prod-   [2].
uct code(gain/sharp and mean removed), predictive VQ,
finite- state VQ, tree structed VQ   [4].   2.4.
TSVQ(Tree Search Vector Quantization)

        [2].   CT   (modality)   brain   transverse
    TSVQ   full   . DICOM   RAW
search VQ   (root node)   PiView(Infinitt, Seoul, Korea)
                                                                        .   512× 512   8bit
        .   .   full search VQ
                        (unbalanced binary tree)   TSVQ   4,16,64,256
                                                                ,   (average distortion),
            .   (fixed rate code)   (entropy), PSNR(Peak Signal to Noise Ratio)
                                                            .

                                                                                                            (train-
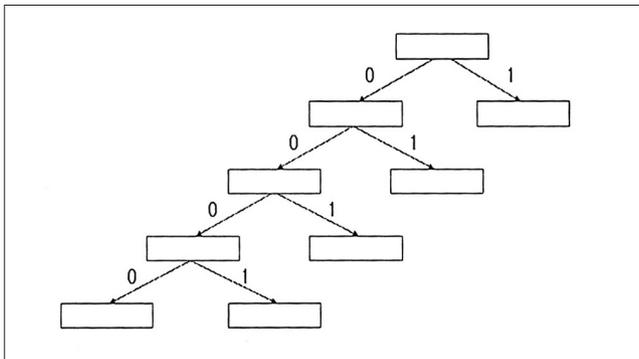

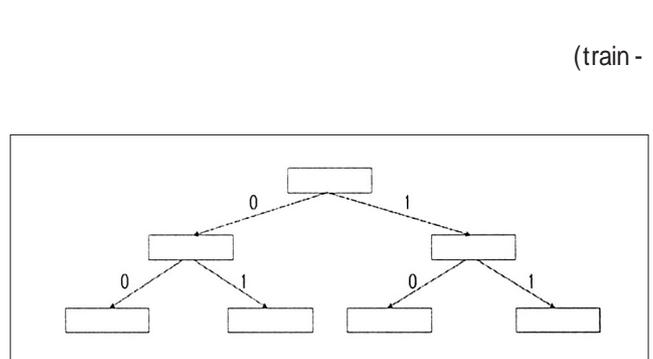Fig. 1. This figure shows how to grow Unbalanced tree.

Fig. 2. This figure shows how to grow balanced tree.

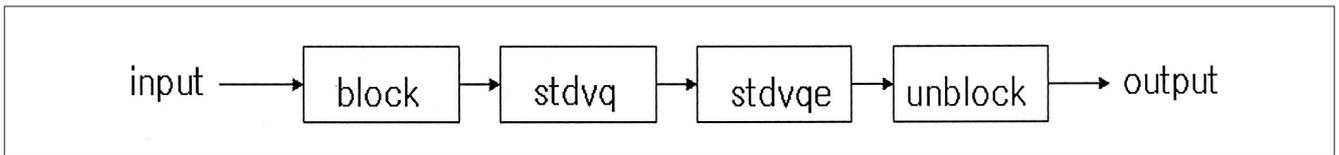Fig. 3. This figure shows the diagram of full search VQ

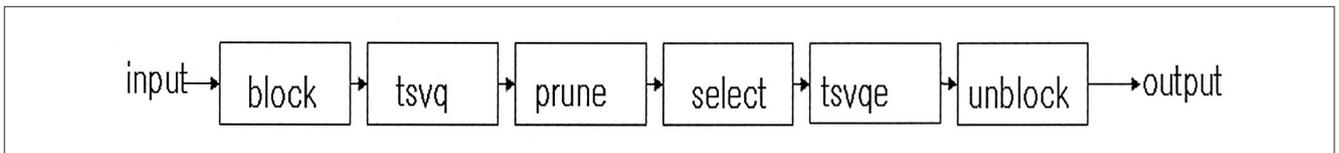Fig. 4. This figure shows the diagram of TSVQ

ing)   . Figure 3, 4   full   PSNR
search VQ   TSVQ   .   . ,   (sequence)

full search VQ

3.   4

.

Table 1   *full search* VQ   .   Table 2   TSVQ   . TSVQ   full
Figure 1   brain   .   search VQ
            16   PNSR   [3].

.

64   PSNR
(background)   .

Table 1. The result using full search vector quantization

dimension	num. of encoded vector	average rate	entropy	average distortion	PSNR
4	65536	1.386294	0.772711	45.971858	37.514513
16	16384	1.386294	0.794885	704.781493	31.687617
64	4095	1.386294	0.813372	7015.466799	27.730471
256	1024	1.386294	0.922285	42802.68913	25.897412

Table 2. The result using tree search vector quantization

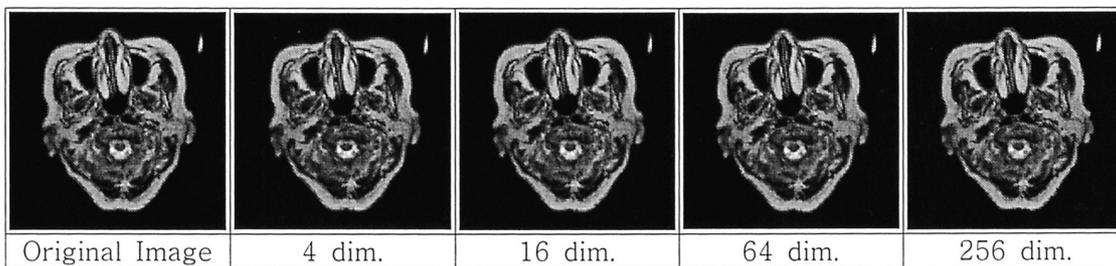| dimension	num. of node	average rate	entropy	average distortion	PSNR
4	55509	9.862686	1.301292	0.045381	67.536313
16	52479	9.778137	1.225222	0.099946	70.133474
64	3571	6.910156	0.997414	94.055189	46.426487
256	867	5.358398	0.846192	5673.920211	34.664378

Fig. 5. This figure shows that full search vector quantized images over 16 dimension have distortion.
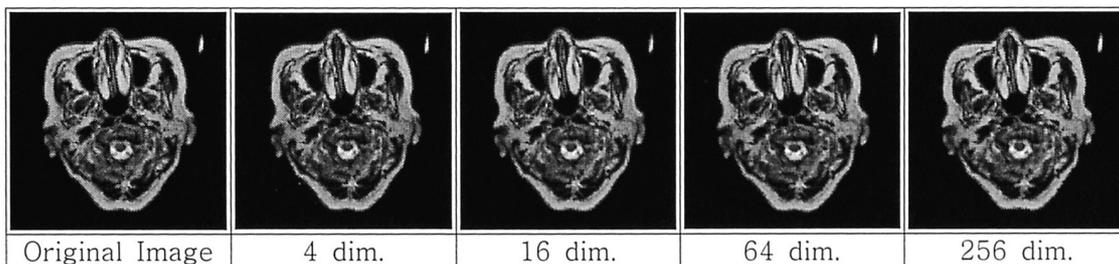

Fig. 6. This figure shows that tree search vector quantized images over 64 dimension have distortion.

Table 3. Compressed ratio about full search VQ when we use 256 KB 512× 512 CT brain image

dim.	codebook size	training image num.	compress ratio
4	9 K	22	28.4
16	33 K	22	7.75
64	129 K	22	1.98
256	513 K	22	N/A

Table 4. Codebook size about TSVQ when we use 256KB 512× 512 CT brain image

dim.	codebook size	training image num.	compress ratio
4	506 K	22	N/A
16	1158 K	22	N/A
64	1815 K	22	N/A
256	1832 K	22	N/A

256   . Figure 6
TSVQ   .
Table 3   full search VQ

. Full search VQ   PSNR
             4   30:1   .   JPEG
                          10:1   [1].
Table 4   TSVQ

TSVQ
                        .
                                        .

             4.

             CT brain   full search VQ,
TSVQ   ,
                                        .
                                   JPEG
   .   JPEG
                 .   12- bit
               .   0.25bpp
             .
          (block artifact)   .
             DICOM WG   JPEG2000
. JPEG2000   JPEG   16- bit
          0.25bpp

                              .
       CT   MR

        .   .

                      .

                        .

                          ,

             .

                          .

Acknowledgments

1.   ,   ,   ,   , JPEG, JPEG2000
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       PACS   2003;9:1-7
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   29, April 1984

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   PACS   .
200kbyte- 7Mbyte   .
                                        JPEG/JPEG2000   VQ(Vector Quantization)
            full search VQ   TSVQ(Tree Search Vector Quantization)   .