Watermark Criteria for Images

1. Image Quality Assessment

The six images provided by the IHC Committee for quality assessment are shown below. They are color images with more than 10M pixels each. They should be watermarked and then encoded using the YUV422 format. The size of the encoded file should be less than 1/30 that of the original file. The original unwatermarked images should also be encoded using the same parameters?. Both sets of images should then be decoded, and the PSNR (peak signal to noise ratio) should be calculated for each pair. The PSNR of each pair should be higher than 30 dB.

The encoding process that reduces the file size to less than 1/30 the original size consists of two steps, which will be explained in section 2. Although JPEG and JPEG 2000 are the candidate encoding tools, other encoding tools can be used as long as they meet the requirements explained in section 2. If another tool is used, entrants should include relevant information about the tool along with their entry. The IHC Committee will conduct subjective assessments if necessary to evaluate the watermark technologies.

2. Procedure

·   Information should be embedded into the whole image, and the encoding–decoding cycle should be performed twice. The file size should less than 1/15 the original size after the first encoding, and the decoded images should be encoded on the second encoding. After the second

Fig. 1 Image 4 and Cropped Image

encoding, the files size should be less than 1/30 the original size. The compression ratio is not defined by the RGB files but by the YUV files.

·   The files should be decoded after the second encoding. Ten HDTV-size (1920×1080) images should be cropped from each decoded 4608×3456 image. The vertices of these cropped images are listed in Table 1.

·   The watermark embedded in each cropped image should be detectable.

·   During the process of the review the IHC committee may require the reports about the detection rate in different areas.

3. Tolerance Assessment

   The watermarks will be assessed in terms of their tolerance against rotation, enlargement, and shrinking attacks.

4. Amount of Data (Information) to be Detected

   The watermarks should be sufficiently tolerant to be detectable in no less than 200 bits in each cropped image.

5. Embedding and Detecting of Information
   - No reference information including the original image is allowed at the detection.
   - The same watermark information should be embedded in all six images.
   - Ten types of watermarked images should be generated for each original image using ten different bit sequences (as explained below). The average error rate and image quality (PSNR) should be calculated from these ten images
   - No additional information is allowed at the detection.
   - One fixed secret key should be used for all detections

6. Bit Sequences to be Used for Generating Watermarked Images

   The information to be embedded should be generated by using eight ordered maximal length sequences. Each polynomial is generated in the form $x^8 + x^4 + x^3 + x^2 + 1$. The initial values are as follows.

   $$a_7 x^7 + a_6 x^6 + a_5 x^5 + a_4 x^4 + a_3 x^3 + a_2 x^2 + a_1 x + a_0$$

   $$\rightarrow (a_7, a_6, a_5, a_4, a_3, a_2, a_1, a_0)$$

   1. (1,0,1,0,1,0,1,0)
   2. (1,0,1,0,1,0,1,1)
   3. (1,0,1,1,1,0,1,0)
   4. (1,1,1,0,1,0,1,0)
   5. (1,0,1,0,1,0,0,0)
   6. (1,0,1,0,0,0,1,0)
   7. (1,0,0,0,1,0,1,0)
   8. (0,0,1,0,1,0,1,0)
   9. (1,1,1,1,1,0,1,0)
   10. (1,0,1,0,1,1,1,0)

Table 1 Cropped Image Vertices (Refer to Fig. 1)

Cropped Image	x1	y1	x2	y2	x3	y3	x4	y4
1	16	16	1935	16	1935	1095	16	1095
2	1500	16	3419	16	3419	1095	1500	1095
3	2617	16	4536	16	4536	1095	2617	1095
4	16	770	1935	770	1935	1849	16	1849
5	1500	770	3419	770	3419	1849	1500	1849
6	2617	770	4536	770	4536	1849	2617	1849
7	1344	768	3263	768	3263	1847	1344	1847
8	16	1520	1935	1520	1935	2599	16	2599
9	1500	1520	3419	1520	3419	2599	1500	2599
10	2617	1520	4536	1520	4536	2599	2617	2599

Image 1 （Flower garden）

Image 2　（Street view）

Image 3（Library）

Image 4（Port view）

Image 5（Bus）

Image 6（Flower pot）