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실시간 원격 강의에서 영상 인코딩 기법을 적용하기 위한 요소

이부권*, 서영건**, 박순화***, 김호용****, 김형준***

요 약

원격 실시간 강의에서 사용될 수 있는 정지 영상 압축은 관심객체 코딩을 미리 코딩하고 배경을 전송하는 방법을 쓸 수 있다. 관심객체의 기능은 영상의 특정 부분이 다른 영역보다 더 중요한 의미를 갖도록 하는 응용에서 중요하다. 이런 경우에, 그 영역은 배경보다 더 높은 품질로 압축되어야 한다. JPEG2000은 다양한 관심객체 코딩 기법을 제공하며, 많은 연구자들이 이런 우선 처리를 할 수 있도록 다양한 연구를 해 왔다. 그러나 모든 응용에 적용 가능한 관심객체 코딩 기법은 존재하지 않는다. 그래서 본 연구는 원격 실시간 강의를 위한 JPEG2000에서 가장 좋은 관심객체 코딩 기법을 적용하기 위하여 요구사항에 맞는 선택 사항들을 보인다. 또한, 선택된 방법들이 가장 좋은 파라미터를 결정하는 실험적 결과도 보인다.

Parameters to Select the Image Encoding in Real Time Remote Lecture

Bu Kweon Lee*, Yeong Geon Seo**, Sun Hwa Park***, Ho Yong Kim****, Hyung Jun Kim***

Abstract

One of the most significant characteristics of remote real time lecture, the emerging still image standard, is the OOI (Object of Interest) coding. The functionality of OOI is important in applications where certain parts of the image are more important than others. In such cases, these objects need to be encoded at higher quality than the background. JPEG2000 provides a number of OOI coding mechanisms. Many researchers have actively studied the preferred processing from the OOI coding methods to the new methods complementing them. But, there do not exist OOI coding methods suitable for all applications. Therefore, this study shows a criterion to select according to the application requirements for applying the best OOI coding method in JPEG2000 applications, and also shows the experimental results deciding the best parameters in the selected methods.

Keywords : Object-Of-Interest, Maxshift

1. Introduction

Because the visual information of the image that people get is a larger amount of data than that of the simple texts or graphics, the transmission effect of the information using it is excellent. Then, the image data is used in medical diagnosis, web browsing, image databases and computer communications, and different applications[1].

As it needs a large amount of memories and high bandwidths to store and transmit the images, it needs to reduce an amount of data using data redundancy. Currently, a new image compression standard JPEG2000(Joint Photographic Experts Group 2000) has been developed to cope with the problem within the scope that does not decline the quality of the source

※ 제일저자(First Author) : 이부권
접수일:2008년 10월 16일, 완료일:2008년 12월 05일
* 경상대학교 컴퓨터과학과
young@gsnu.ac.kr
** 경상대학교 컴퓨터교육과, 컴. 정보통신연구소원(교신저자)
*** 경상대학교 컴퓨터과학과
**** 영진전문대학 컴퓨터정보기술계열
▣ 본 연구는 2008년도 경상대학교 광대역연구개발망 활성화를 위한 연구과제 지원비를 받아 수행되었음

image[2]. Especially, JPEG2000 offers the OOI coding method not offered in existing compression standards. This method is made use of in the applications that should firstly transfer the specific object of image or user-centered OOI before the overall image is presented. The standard OOI coding methods are Maxshift[3], Implicit[4] and General scaling[3]. The non standard OOI coding methods are Maxshift-like[3], (G)BbBShift[5,6], PSBShift[7] and HBShift[8] which supplement Maxshift and General scaling, and Modified implicit[4], flexible and dynamic[9], fast OOI transcoding[10] and prioritized[11] which supplement Implicit method.

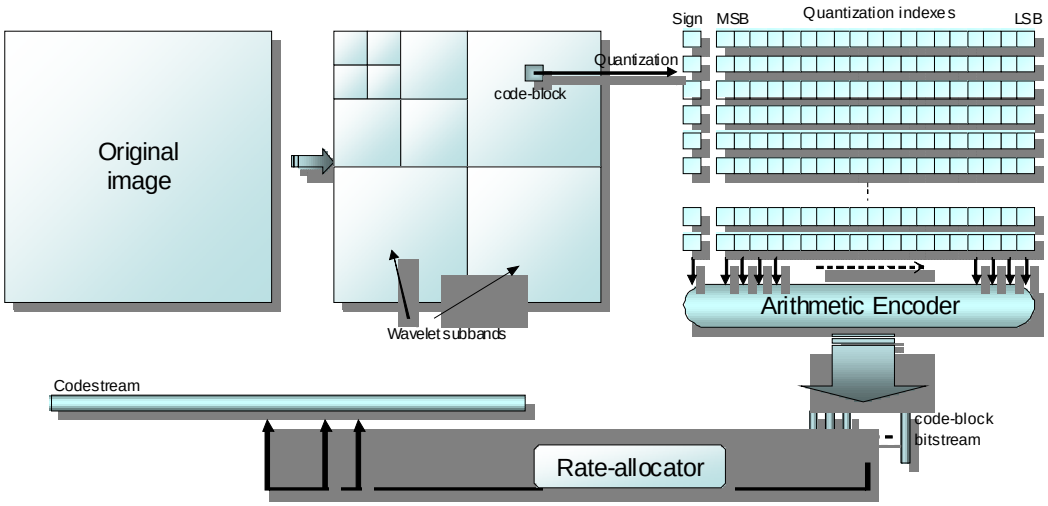
The new studies about OOI coding have been actively progressing like them. But, the studies which can apply the coding to an application are bounded to apply to the standard OOI coding methods using the default parameters. Therefore, our studies propose the methods which can apply the best OOI coding method to a specific application in consideration of a classification table of OOI coding methods by the requirements, effects of parameters by the experiments and several key points.

2. Related studies

2.1 JPEG2000 image coding standards

(Fig. 1) shows the coding overview of JPEG2000. A new image coding standard, JPEG2000 that uses state-of-the-art compression techniques based on wavelet technology. This is intended to provide low bit rates operation with rate-distortion and subjective image quality performance superior to existing standards, without sacrificing performance at other points in the rate-distortion spectrum. Early results show a 20-30% compression efficiency improvement over JPEG. JPEG2000 addresses areas where JPEG fails to produce the best quality of performance, such as:

. Low bit rates compression performance (rates below 0.25 bpp for highly-detailed gray-level images)



(Fig. 1) Coding overview

. Lossless and lossy compression in a single codestream

. Seamless quality and resolution scalability, without having to download the entire file. The major benefit is the conservation of bandwidth

. Large images: JPEG is restricted to 64k X 64k images (without tiling). JPEG2000 will handle image size up to (232 - 1)

. Single decompression architecture

. Error resilience for transmission in noisy environments, such as wireless and Internet

. OOI coding

. Improved compression techniques to accomodate richer content and higher resolutions

2.2 OOI coding methods

2.2.1 Necessities of OOI

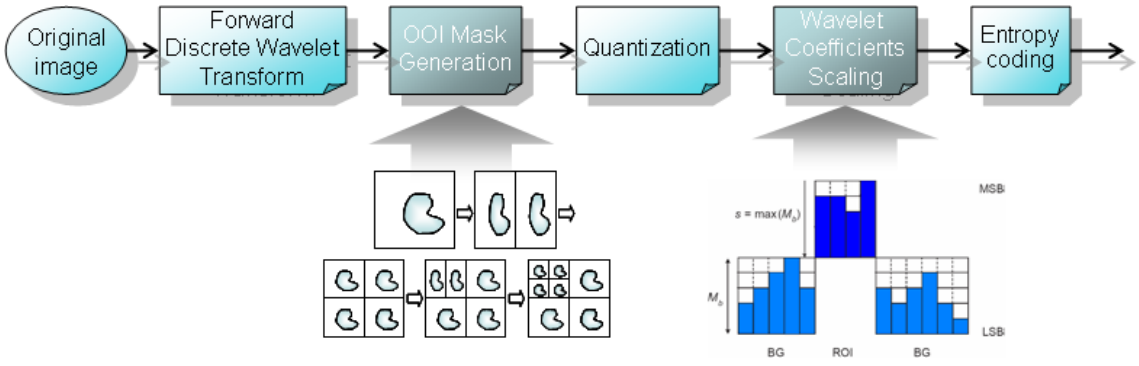
OOI coding can be used in the applications that a specific object of image has higher importance than the other objects of the image. To support OOI coding, OOI must be encoded with higher quality than BG(background) and sent to a receiver with higher priority. This can be achieved by progressive image coding basis using multi-resolution analysis. The merits of OOI image are not only to reduce the compression ratio and the transmission time but also to satisfy the different requirements of users and the efficient memory managements.)Fig. 2) shows Lena image reconstructed by progressive image and OOI image in 0.125bpp. OOI coding method is divided into tile-based, coefficient scaling-based and EBCOT(Embedded Block Coding with Optimized Truncation Algorithm)-based. (Fig. 3) shows a scaling- based OOI coding method.

(a) (b)

(Fig. 2)(a) Progressive image (b) OOI image

2.2.2 OOI coding methods.

Tiling is to separate a large image into non overlapped rectangular blocks and these blocks are encoded to reduce memory consumption. These separated blocks are called tiles. Because the compression is independently processed on each tile, OOI can be coded on unit of each tile instead of an overall image. This means that OOI tiles can be coded and decoded with higher quality than BG tiles. This is a simple OOI coding method which can be used in applications with the constraints of memory and hardware.



(Fig. 3) Coefficient scaling-based OOI coding

Coefficient scaling-based method classifies OOI WC(Wavelet Coefficients) and BG WC of quantized WC and makes BP(Bit-Plane) of OOI WC shift by the importance of OOI. This belongs to static OOI coding method defining OOI in encoding time. The process of general coefficient scaling-based OOI coding is in (fig. 3) and the decoding process is the reverse order of the step. Maxshift[3], scaling-based[3], Maxshift-like[3], (G)BbBShift[5,6] and PSBShift[7] belong to this method.

The method defining OOI in decoder is called by dynamic OOI coding. And the specific one, EBCOT-based coding belongs to dynamic coding method. In EBCOT, each quality layer includes an arbitrary contribution degree from the embedded bitstream of CB(Code Blocks), packets or precincts. So, emphasis of OOI is achieved by including the relatively high contribution degree about the quality layer of CB, packets or precincts that should be reconstructed. Here are Implicit[4], Modified implicit[4], flexible and dynamic[9], fast OOI transcoding[10] and Prioritized[11].

2.3 Necessities of the best OOI coding method

Because the OOI coding supplies a good tradeoff between the image quality and compression ratio, it can make satisfy the user requirements in different applications. But there does not exist the best OOI coding method applicable in all applications. The reason is that the requirements of each application are different, OOI coding methods have their merits and demerits in their own ways and there exists a number of OOI parameters influencing OOI coding performance. In order to offer the best service, it needs to select and apply OOI coding methods and OOI parameters suitable for a specific application.

(Table 1) Comparisons of the OOI coding methods

	OOI coding methods	Compatibility	Dynamic/ Static mode	OOI-shape	OOI coding unit	Degrees of OOI importance	Lossy to lossless reconstruction	Control of OOI/BG importance
Based on Coefficient Scaling	①Maxshift	Part1	Static	Arbitrary	WC	Same	Yes	No
	②Scaling based	Part2	Static	Rectangle and Ellipse	WC	Different	Yes	Yes
	③Maxshift-like	Part1	Static	Arbitrary	WC	Same	No	Yes
	④BbB/GBbB Shift	No	Static	Arbitrary	WC	Same	Yes	Yes
	⑤PSBShift	No	Static	Arbitrary	WC	Different	Yes	Yes
	⑥HBShift	No	Static	Arbitrary	WC	Different	Yes	Yes
Based on EBCOT	⑦Implicit OOI	Part1	Dynamic	Regular Polygon	CB	Different	Yes	Yes
	⑧Improved implicit OOI	Part1	Dynamic	Arbitrary	CB/WC	Different	No	Yes
	⑨Flexible layer insertion	Part1	Dynamic	Regular Polygon	Precinct	Same	Yes	No
	⑩Fast OOI Transcoding	Part1	Dynamic	Regular Polygon	Packet	Different	No	Yes
	⑪Prioritized OOI coding	Part1	Dynamic	Regular Polygon	Packet	Different	Yes	No*

3. The comparisons of OOI coding methods

In this chapter, we classify OOI coding methods suitable for several requirements through the comparison of them and introduce some parameters influencing OOI performance.

3.1 Comparisons of coding methods

<Table 1> shows OOI coding methods. In standard field of the table, ①, ② and ⑦ are the standard method of JPEG2000, ④, ⑤ and ⑥ are not compatible with the standard, and the others are compatible with it. Part1 of compatibility item means to be compatible with part1 standard of JPEG2000. Part2 is part2 of JPEG2000. No of that means to be not compatible with the standard. Lossy/lossless reconstruction means that on decoding with OOI whether decoder offers lossless decoding or not. Control of OOI/BG importance is if it is possible to adjust the importance between OOI and BG or not

The shape of OOI is closely related to the processing unit of it. Coefficient scaling-based coding methods support the arbitrary shape because of processing the OOI by the unit of WC. However, ② supports only rectangular and elliptical shapes because of the overhead of OOI shape coding. EBCOT-based methods support polygonal shapes because of processing it by the unit of CB(or precinct or packet). However, ⑧ supports arbitrary shape. OOI importance is an important degree of OOI comparing to BG.

3.2 Factors to select OOI coding method

This problem is the same as how well a selected OOI coding method satisfies the requirements of the application. In this paper, we made a classification table of OOI coding methods by the requirements. The classifications are static OOI or dynamic OOI, the OOI importance, the real time application and the multiple OOIs, and these are the typical requirements of the OOI application.

<Table 2> Effects of coding parameters

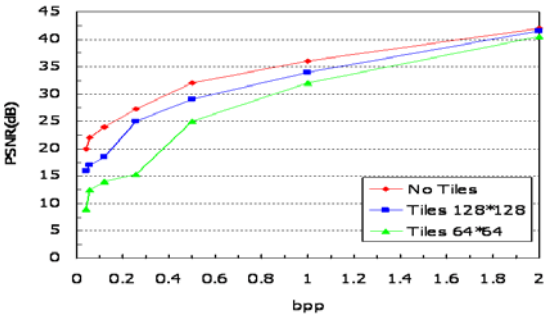
Parameters	Block Boundary Artefacts	OOI Performance	OOI Periphery Performance	Background Performance
Tile Size	○	○		
DWT Filter Type		○	○	
Code-Block Size	○	○	○	
Number of DWT Decomposition level		○	○	
Number of Quality layers		○	○	○
OOI Size		○		
OOI Shape and Location		○		
Number of OOIs		○		
OOI Importance Score		○	○	○
Low Resolution Sub-band Importance Score		○		○

Most applications need only static OOI coding, but in case of being not aware of OOI in encoding it needs a dynamic OOI coding that is useful in an interactive application. In real time of static OOI, ③ which deletes BPs is the most excellent and ② is the most inferior because of OOI shape coding. In that of the dynamic OOI, ⑨ and ⑩ is the most excellent because of processing it by the unit of packet or precinct based on reconstruction, the next is ⑦ and ⑧ which processes by the unit of CB, and lastly ⑪ is the most inferior owing to processing the control of the OOI importance. In multiple OOIs of static OOI, ② ⑤ and ⑥ offer with the diverse importance degrees and ① ③ and ④ do with a same degree. In those of the dynamic OOI, only ⑨ offers with a same degree and the others do with the diverse degrees.

3.3 OOI parameters

The OOI parameters influencing the OOI coding performance are tile size, wavelet filter type, count of quality layers, CB size, count of OOI, OOI size, shape and position of OOI and importance of OOI. Of these parameters, we use tile size, numer of layers and OOI size since they are the most important parameters in JPEG2000.

The smaller the tile size the fewer the count of DWT decomposition levels and CB size and the less the coding performance of OOI, since the blocking artifacts occur. For OOI coding, multiple quality layers have to be used. If an image is encoded with one layer, the merits of OOI coding do not exist. The overhead occurred by using multiple layers(to 50 layers) in lossless coding might be ignored. But the overhead is increased in low bit rates[1]. If CB size is small, the count of CB increases and then there is a demerit which is to code more CB. But, there is a merit which the spacial locality is excellent. This phenomenon will appear more clearly on EBCOT-based method which manages the OOI by the unit of CB.



(Fig. 4) Performance with tile size

4. Experiments and evaluations

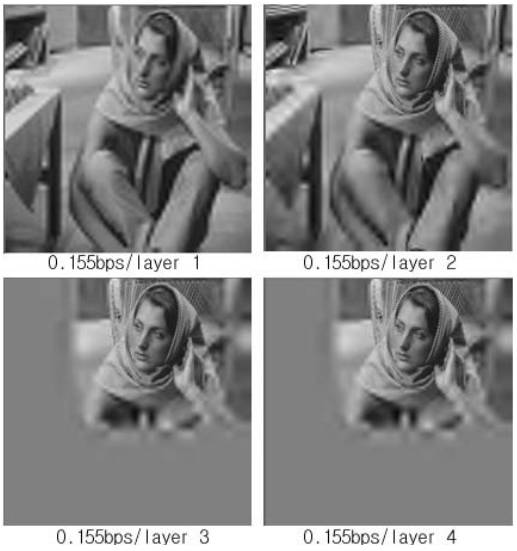
In this chapter, we experiment empirically to define the effects for OOI parameters using the standard OOI coding methods. The experimental result is an average of values got from 6 images. All images are represented with gray image(8 bpp), and if the image is a layered progressive, the bit rates are set from 0.03125 bpp to 2bpp. This compression rate means from 256:1 to 4:1. Other parameters are that the decomposition is 5-level DWT, the lowest level is included in OOI, the layer is 20, code block size is 64X64 with no ROI and wavelet filter is 9/7 filter.

(Fig. 4) shows the performance evaluation according to the change of tile size. The smaller the tile size, the lower the compression efficiency. Especially in low bit rates, compared to the image compressed on one tile, it decreased by about 5dB on 128 X 128 tile and about 10dB on 64 X 64 tile.

<Table 3> Comparison of average lossless bit rates for different numbers of layers

Layer number	With OOI	Without OOI
Layer 1	3.197	3.056
Layer 10	3.214	3.072
Layer 20	3.226	3.080
Layer 30	3.234	3.085
Layer 40	3.237	3.087
Layer 50	3.241	3.090

<Table 3> compares the effect of multiple layers on the lossless coding efficiency with OOI and no OOI. As mentioned in chapter 2, in order to facilitate bit stream truncation, it is desirable to construct as many layers as possible. However, the number of packets increases linearly with the number of layers, which also increase the overhead associated with the packet headers. Whereas, increasing the number of layers from 1 to 50 does not linearly increase the lossless bit rates. It can be shown that the overall coding overhead using multiple layers (even up to 50 layers) is negligible compared to a single layered code stream. (Fig. 5) shows that there is no gain in OOI coding if a single layer is used to encode the image at full quality.



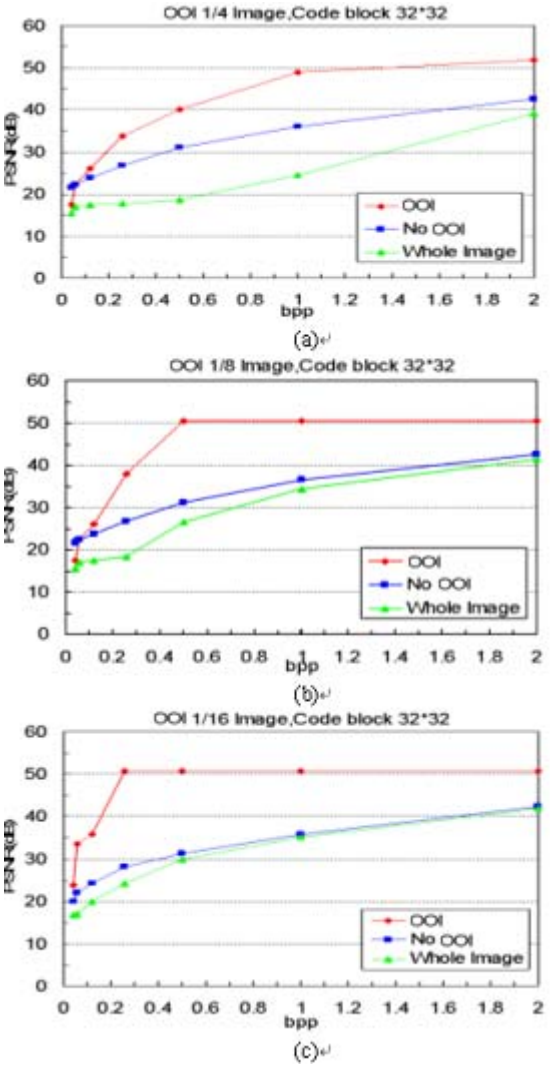
(Fig. 5) Coding image with the increasing number of layer

In (fig. 6) we use Maxshift method and the OOI centered on the image, and the OOI sizes are 1/4, 1/8 and 1/16 rectangular shapes of the whole image with CB size 32 X 32. The smaller OOI size, the lower the bit rates receiving the whole OOI. PSNR of OOI in low bit rates(<0.125bpp) is lower than that of BG when the OOI size is big(>1/8), because of the overhead for OOI coding. If the count of subband of the decomposition levels regarded as OOI increases, the quality of BG to be reconstructed is higher. But the performance of OOI is influenced by high data rates. Extremely, if all resolution levels are included in OOI, that is the same as not encoding OOI.

Finally, the bigger the tile size is, the more effective. The bigger the number of quality layers, the more effective. When the compression rate is high and the OOI size is small, it's relatively uneffective. In coding methods, when OOI is already known in encoding time and the OOI shape is arbitrary, if the user simply uses an OOI method, the user may use Maxshift method.

5. Conclusion

Since there does not exist the best OOI coding method suitable for all applications, it is needed to select parameters and coding methods satisfying the requirements of a specific application. In order to do this, we proposed the methods selecting the parameters to apply an OOI coding method in JPEG2000 by the experiments about OOI parameters and the classification table of OOI coding methods according to the requirements. In our future study, we will experiment one or more complicated parameters, and study an automatic OOI detection and simpler OOI coding algorithm.



(Fig. 6) Rate-distortion performance of OOI 1/4, 1/8 and 1/16 of image size

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이 부 권

1972년 : 경상대학교 농경제학 학사
1978년 : 미시건주립대학 대학원 시스템 공학전공 석사
2001년 : 경남대학교 대학원 컴퓨터공학과 박사

1980년~현 재 : 경상대학교 컴퓨터과학과 교수
관심분야: : 시뮬레이션, 멀티미디어, 원격교육

서 영 건

1987년 : 경상대학교 전산과 학사
1997년 : 숭실대학교 전산과 박사
1989년~1992년 : 삼보컴퓨터

1997년~현 재 : 경상대학교 컴퓨터교육과 부교수
2001년~현 재 : 경상대학교 컴퓨터정보통신연구소원
관심분야 : 멀티미디어통신, 영상인식, 원격교육

박 순 화

1996년 : 진주산업대학교 전산 학사
2000년 : 경상대학교 컴퓨터과학 석사
2005년 : 경상대학교 컴퓨터과학과 박사 수료

관심분야 : 데이터베이스, 데이터 압축, 원격교육

김 호 용

1985년 : 울산대학교 전산과
1987년 : 숭실대학교 전산과 석사
1990년~1991년 : 한국과학기술원
1991년~1995년 : 현대자동차(주)

1996년~현 재 : 영진전문대학 컴퓨터정보기술계열 조교수
관심분야 : 데이터베이스, 데이터 압축, 원격교육

김 형 준

1987년 : 부산대학교 계산통계학과
1989년 : 숭실대학교 전산과 석사
1989년~현 재 : 국방과학연구소

관심분야 : JPEG2000, CIM, MPEG21, 원격교육