DECREASING CAPACITY OF JPEG2000 STANDARD IMAGE ON FPGA BOARD

GIẢM DUNG LƯỢNG ẢNH CHUẨN JPEG2000 TRÊN BẢNG MẠCH FPGA

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TÓM TẮT

Trong bài báo này, một phương pháp được đề xuất để tăng tốc độ xử lý đồng thời giảm dung lượng hình ảnh trong chuẩn nén ảnh JPEG2000. Trong một hình ảnh, có những vùng quan trọng, cần thiết và được chủ động lựa chọn gọi là vùng trọng tâm (ROI). Phương pháp này giữ lại những phần quan trọng của hình ảnh và giảm bớt dung lượng hình ảnh ở những khu vực khác. Ưu điểm của phương pháp được đề xuất là: Hỗ trợ thực hiện biến đổi wavelet thuận (FDWT) 5 tầng. Độ rộng bit của phương pháp này không phải tăng lên như một số phương pháp thông thường mà là giữ nguyên số bit. Chất lượng trong vùng mặt nạ được giữ lại và phần ngoài vùng ROI sẽ được giảm bớt tùy theo yêu cầu. Giải thuật S + P được dùng để phân chia mặt nạ của ROI thành các tầng khác nhau. Phương pháp lựa chọn ROI hỗ trợ được nhiều hình ảnh, kích thước mặt nạ khác nhau. Thực nghiệm hóa hệ thống trên bảng mạch FPGA là một bước cần thiết để minh chứng cho hiệu quả của phương pháp đề xuất.

Từ khóa: *JPEG2000, ROI, phương pháp S+P, FDWT, phương pháp Maxshift.*

ABSTRACT

In this paper, a method proposed to increase processing speed and reduce image capacity in JPEG2000 image standard. The selected region of interest (ROI) utilized to retain the important parts of the image and ignore the other regions. The advantages of this proposed method is: It can be performed 5 levels corresponding to the levels in FDWT. The bit width of image does not increase if it compared with the size of image entrancing ROI block. The quality of the background could reduce as requirement. The S + P method is chosen to divide the mask of ROI into many layers. The method selecting ROI in JPEG2000 standard is implemented on the hardware which supports many regions of interesting and different shapes. The experiment carried out on the FPGA to demonstrate the effectiveness of this proposed method.

Keywords: *JPEG2000, ROI, S+P method, FDWT, Maxshift method.*

I. INTRODUCTION STYLE AND FORMAT

JPEG2000 image compression standard which provides an additional algorithm, allows compression adjustment process priority of an arbitrary sample without depending on each code-block limit. This algorithm enables that the ROI could be the small areas and arbitrary shapes.

The photographer or user often selects ROI in the space of images. After selecting the ROI, it encoded with higher quality than the

rest of the image (background). The encoding process implemented with the information related to ROI, which always encrypted before information concerning the background.

Choosing the S+P method to divide ROI mask and Shift up background method to push background down an area around shift distance named max shift config_in. This signal input the shift up background module. The structure of JPEG2000 encoder system is showing in Figure 1.

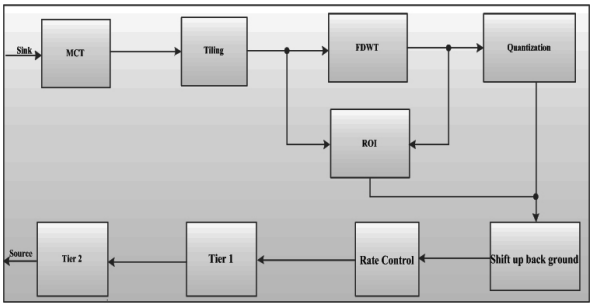

Figure 1. Block diagram of jpeg2000 system.

II. DESCRIPTIONROI ROI (REGION OF INTEREST)

1. ROI mask principle

There are three methods dive ROI mask presented in [1], such as: S, S+P, TT.The following table compares three methods for calculating the ROI mask.

Table 1. *Lossless bit-rate for the various images*

	S+P	S	TT
Aerial2	1.91	1.96	1.92
Bik	2.62	2.69	2.62
Café	2.03	2.11	2.03
Target	1.04	0.99	

In the implementation of FPGA, S+P is chosen. Because this method result and memory small easily on hardware.

The S+P method is utilizedin this paper. The key equation of this method is presented as follow:

$$M(x,y) = \begin{cases} 1, & \text{The wavelet coefficient x y should be transmitted exactly} \\ 0, & \text{Accuracy on x y can be sacrificed without affecting ROI} \end{cases} \quad (1)$$

For all n in [0:N/2-1]

$$p(n) = OR\{X_m(2n), X_m(2n+1)\} \quad (2)$$

$$H_n(n) = \begin{cases} 1 & if\ P(n) \\ 0 & otherwise \end{cases} \quad (3)$$

$$L_n(n) = \begin{cases} 1 & if\ \ OR\{P(n-1), P(n), P(+1n)\} \\ 0 & otherwise \end{cases} \quad (4)$$

The algorithm of S + P method as follows:

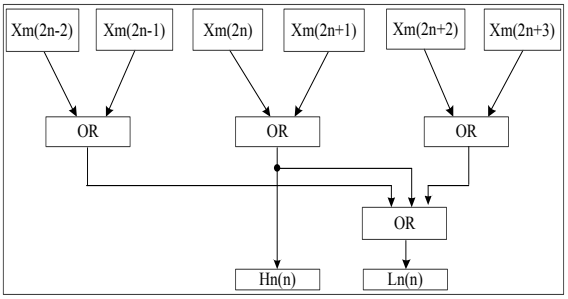

Figure 2.Lossless mask operation for S+P.

ROI mask area is divided in each sub-band which is similar to wavelet (Figure 2).

To divide one level should be carried out as follows:

Step 1: Dividing "tiling" into 2 parts vertically which are H (n) and L (n)

Step 2: Getting two parts are broken above to divide horizontally.we will gain 1 level. We have fourparts that are the same size. If the level increases, LL area will turn back to step 1. The level 2 is illustrated in Figure 3.

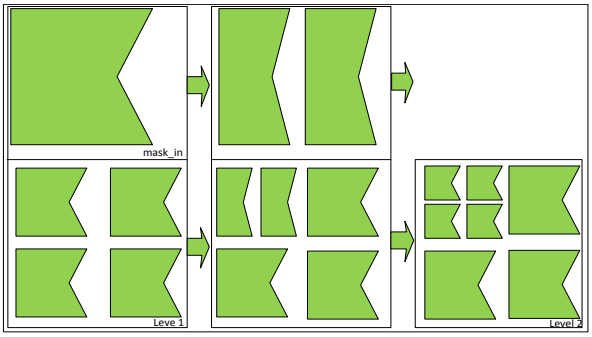

Figure 3.Calculating the lossless mask.

2. The proposed architecture ROI mask

The hardware architecture of two methods:

S + P method and Shift up background is shown in Figure 4.

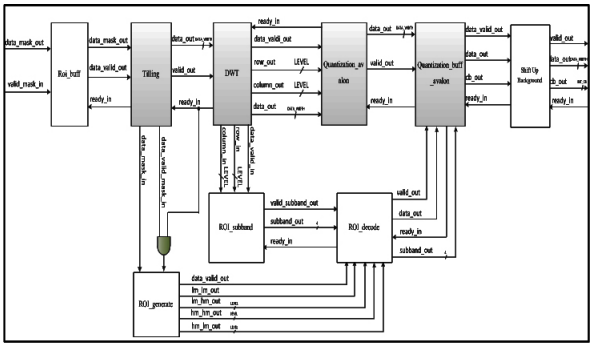

Figure 4. Architectureof S+P method.

The pixel datais transmitted sequentially in each frame. Each data has one bit width. To reduce the storage, we include multiple data into one data, one data is included normally from16, 32 data to store on the FPGA. In this paper the author include 32 pixel data in to one 32 pixel datawhich is shown in Figure 5:

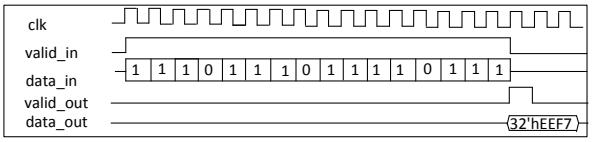

Figure 5.Shift 32 data complete 1 data.

The architecture ROI mask have got include 3 the module:**ROI_Generate** module, **ROI_ decode** module, and **ROI_subband**module.

The structure of **"ROI_generate"**module as follows:

Data is used by first applying 1-D row (to produce L and H sub-bands in each row) and then 1-D column as shown in Figure 6

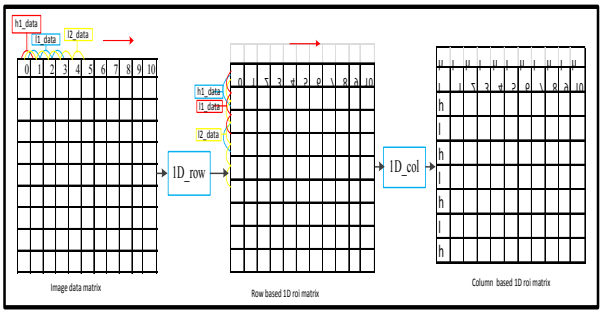

Figure 6. Flow of transformed data in 1 level.

If we want to divide higher level, the data of LL part is reselected to continue dividing (see Figure 7).

After dividing row part minimum 4 data rows, dividing the column is ready. In order to save data of 6 rows well, the idea given is grouping 32 data pixel into 1 data. Using 6 rows to save data in RAM to avoid data lost, the size of RAM is (6xtiling_width/32), where 6 is the minimum number of lines to save data, tiling_width is the length of tiling, which is configured parameter value, and 32 is the number of data which is shifted into one data. After reading data, we overwrite data which is read to save entire data. The structure of the generate_roi block is shown in Figure 7.

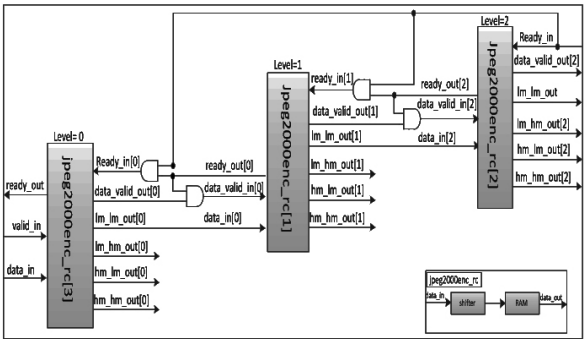

Figure 7.Architecture of OI generate module.

The Architecture of **ROI_subband**module Based on the numbers of row and column in FDWT (Forward discrete wavelet transform) block, sub-band is encoded (see Figure 8).

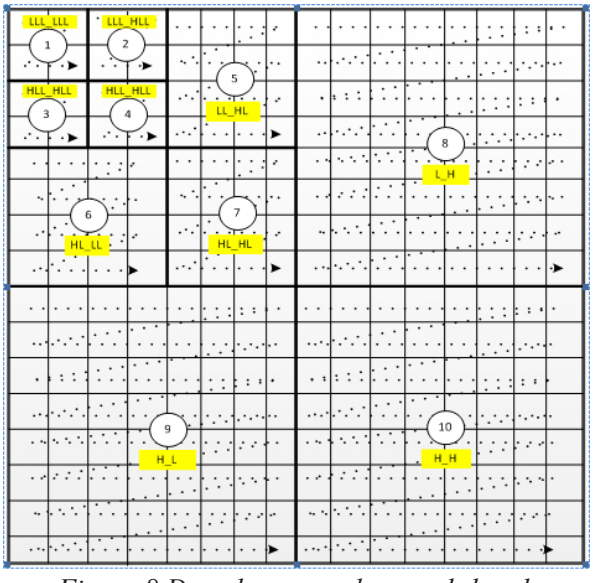

Figure 8.Decoder row column sub-band.

TheArchitectureof **ROI_Decoder**module**:**

Pixel Dataafter saving in the FIFO while waiting to read. Reading should coincide with the data in the quantization module even the location of pixel. The structure of this module is shown in Figure 9.

Hardware Architecture of the data way when performing ROI block

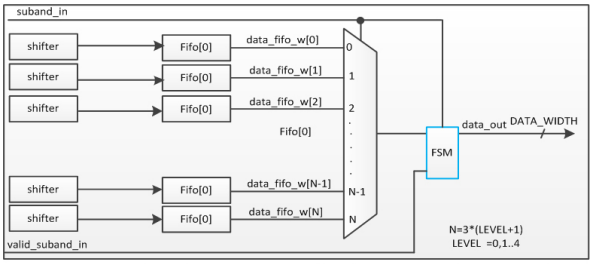

Figure 9. Architecture of ROi_decoder module.

III. DESCRIPTIONROI SHIFT UP BACKGROUND

1. Theoretical Shift up background method

There are three methods to reduce data outside the ROI and unchanged data in the ROI: Generic scaling based method, Maxshift method and Shift up Background method.

Maxshift method

Maxshift method has an advantage of simple calculation to perform but it has some weaknesses. The width of bit is shifted greater 2 times than bit width data. The result of that is storage and computation of the after blocks are difficult in terms of speed and data stored in the RAM. RAM memory on the hardware is only good at 32-bit size. To overcome this problem, Generic scaling based method is proposed.

Generic Scaling method

GenericScaling based method is proposed to decrease bit width of the output but s parameter appears. To find this value that means we find the maximum of meaningful bit width in each block. Then, shifting ROI area with s parameter which we identify above. It is really hard and complex job because we have to find a large of data in jpeg2000 standard with 32x32 and 64x64 code block. In this processing, we have to save 1 code block image to find s.

Shift Up Background method

Shift UpBackground method solves easily in hardware to increase processing speed. In this method, the outside of the ROI is shifted a range maxconfig_in. The range maxconfig_ in value is taken out for the user choose configuration to decrease data outside of ROI.

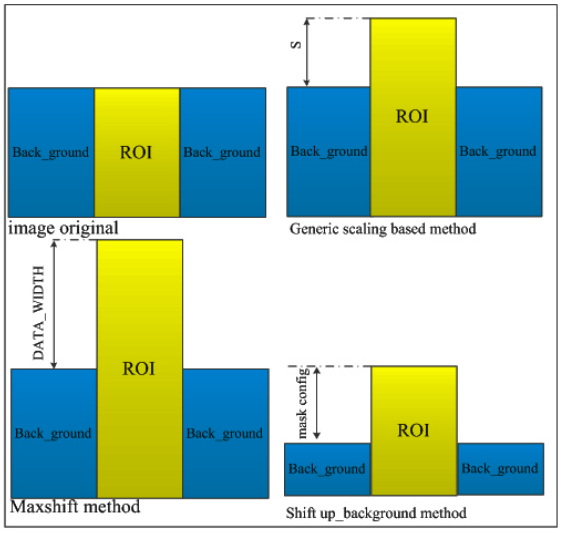

Figure 10.Some method active ROI.

With this proposed method, we can make faster speed, less material of system. Some methods can be used to reduce the image in outside the ROI. Figure 10 is shown the idea of Shift up background method.This solution is small memory and resources when active FPGA(Field-programmable gate array).

The table compares the bit width of some ROI methods in image processing

Table 2. *Comparison DATA WIDTH three method ROI*

No	ROI method	Length bit width data out the module ROI
1	Generic scaling based method	DATA _WIDTH+S
2	Maxshift method	≥2 x DATA _WIDTH
3	Shift upback-ground method	DATA_WIDTH

Table 3. *The data_bitwidth operations of proposed architecture*

Architecture	Before ROI	After ROI
9/7 DWT filter		
Our architecture	DATA_ WIDTH	DATA_WIDTH
Zhou Wang[6]	DATA_ WIDTH	DATA_ WIDTH+S
Osamu Watanabe [7]	DATA_ WIDTH	2*DATA_ WIDTH

2. Arithmetic Shift up background method

Decoder is used to recognize exactly which are the ROI and the background to shift up a maxhift_config range. This value is selected by the user. If this value is selected larger, the greater part will be greatly reduced background and the greater the image compression is increased and vice versa. The given structure is shown in Figure 11:

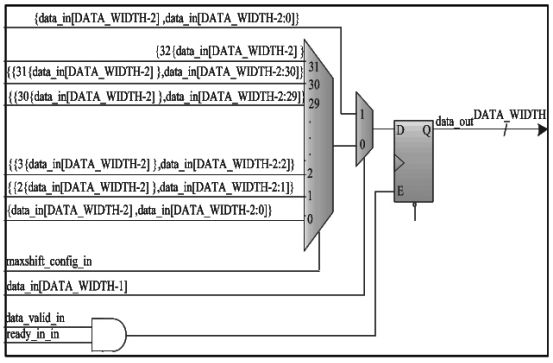

Figure 11. Architecture of Shift upbackground method.

The numeric results of ROI method are performedon FPGA.

When data find out data in a round ROI mask,the image background will be shift up to an approximately maxconfig but keep first data pixel because this is the sign bit of the data quantization.

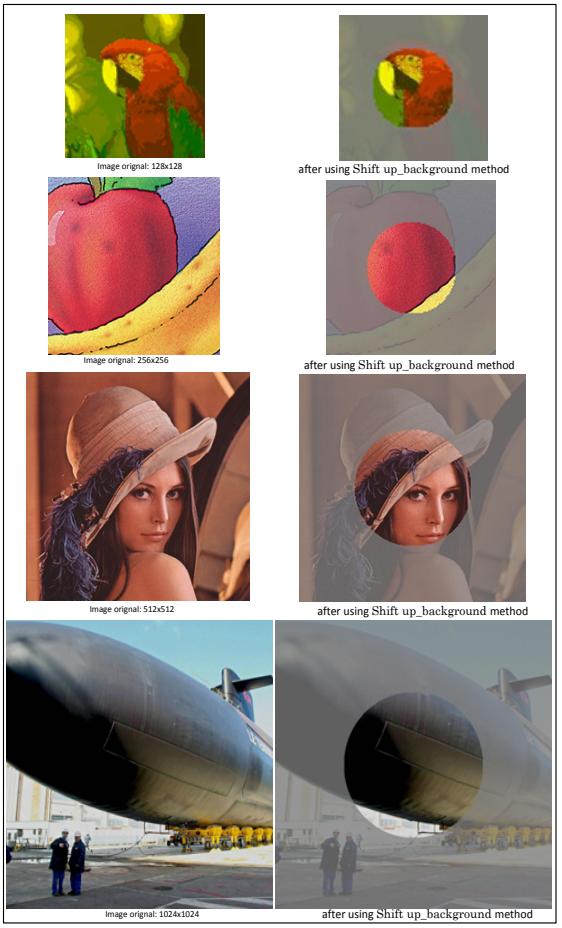

Figure 12.Simulation results FPGA.

IV. RESULT ANALYSIS

The paper is a comparison Province compression ratio-using shift up background method. The table 3 some image size test used ROI.

Table 4. *Compression image after jpeg2000endcoder using ROI*

Size image	Image Original	Image encoder	Compression ratio
128x 128	49206	10154	4.8
256x 256	196664	59197	3.3
512x 512	786486	166882	4.7
1024x 1024	3145784	563814	5.6
2048x 2048	12582968	1133991	11.1

V. CONCLUSIONS

1. Advantages

Data bit widths unchanged in the shift up background method. This method makes sex press computational and resources. Data go out easy for a small data blocks after implementation.

2. Disadvantages

Designers need to add the code so that it can strip decoding method shift up background. This method pressing data input one pixel, the module computing competed quickly than FDWT should have saved a large amount of data in the FIFO and RAM.

The method designs module decoder row and column in the FDWF module completed sub-band.

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