WAVELET BASED INTER-FRAME VIDEO CODING

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ABSTRACT

This paper describes an effective technique for lossy inter-frame video coding sequences based on a JPEG2000 codec, especially suitable for video conferencing. This technique has increased the visual quality while preserving the target bit rate. In this proposed method, firstly a predicted frame is obtained by subtraction the current frame from the reference frame and then the difference frame becomes the input image to a JPEG2000 encoder for coding. Simulation results show the effectiveness of this method.

1   INTRODUCTION

There is a new wavelet based compression standard for video coding, the Motion JPEG2000, which has been introduced in 2001 on the market. Video streams are organized by ordering image streams encoded by JPEG2000 in order of time. Motion JPEG2000, however, does not reduce inter-frame correlation, so that its compression rate is lower than inter-frame compressions with motion prediction. Mentioned above implies following solution, a method which enhances video quality of Motion JPEG2000 proposed in this paper.

2   VIDEO CODING USING JPEG2000 CODEC

2.1   THE IDEA

Each frame of the video sequence is encoded independently on previous or next frame in Motion JPEG2000 [1]. It is called pure intra-frame coding which is a great advantage for video editing techniques, but it is not perfect choice in video compression. Video sequence is sequence of video frames, which are often very similar. For example: moving object on the background scene. In video conferences, we do not expect much of the motion in the scene. Typically, a head and arms are the only moving objects on still background. First idea is to try subtracting the second frame from the first and to code the differential frame at the encoder side. Thus the first frame will be transmitted intra-frame coded and the second one as a differential frame. On the decoder side, first frame will be received, decoded and displayed. Then differential frame will be added to the first frame and the result will be displayed.

2.2 CODING SCHEME

Each frame of a video is encoded to produce a coded picture. There are two types of pictures:

- I-picture is intra-coded and is used as a reference for further predicted pictures.

- P-picture is inter-coded using motion-compensated prediction from a reference picture (I-picture preceding the current P-picture). Hence a P-picture is predicted using forward prediction.
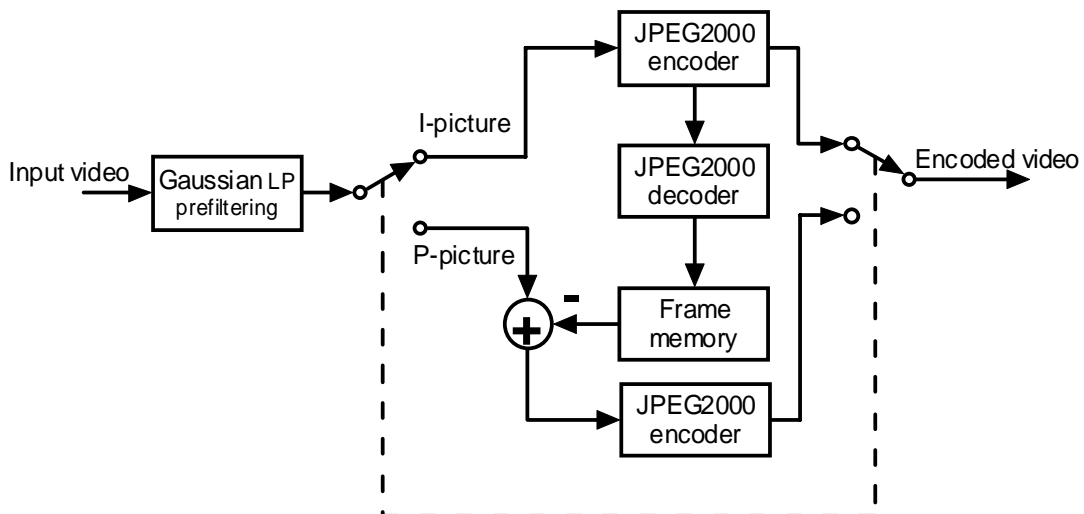
JPEG2000 codec is used for encoding and decoding the I and P-pictures. The differential P-pictures contain fewer details because only differences of moving parts are present. So the I-picture must be encoded with higher bit rate than the P-pictures to obtain constant image quality. One I-picture and nine P-pictures create Group of Pictures (GOP), see fig. 1. The GOPs are arranged sequentially in the video sequence.
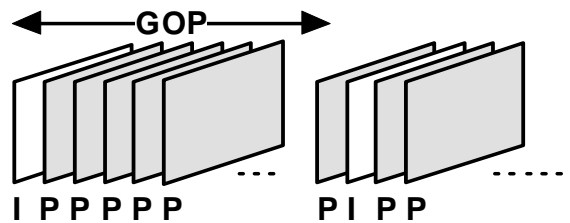
Fig. 1:   *One I-picture and several P-pictures construct GOP.*

More P-pictures in GOP should be used in a scene with low motion objects whereas fewer P-pictures should be used in a scene with high and complex motion objects. Therefore choice of nine P-pictures in the GOP is a trade-off between compression efficiency and growth of compression distortion with growing distance of an actual P-picture and reference I-picture.

Proposed coding scheme is on fig. 2. Each video sequence begins with I-picture. P-picture is differential image between current frame and stored I-picture. Each input frame is filtered by Gaussian low-pass filter. It is useful for reducing high frequency details in the image for better coding efficiency.

Fig. 2:   *Block diagram of the proposed coding scheme*

2.3   USED SOFTWARE

The Kakadu software JPEG2000 codec version 4.2 has been used for encoding to JPEG2000 [2]. It is a full implementation of JPEG2000 standard ISO/IEC 15444-1.

3   PERFORMANCE

The testing has been carried out on testing video sequence "aykio.yuv" in CIF resolution with a frame rate of 10 frames per second. Target average bit rates have been chosen in range from 0.05 b/pxl to 0.4 b/pxl. The encoding bit rates of I and P-pictures are presented in Tab. 1. For comparison with this coding technique, it has been chosen commercial Motion JPEG2000 codec version 2 developed by Morgan Multimedia. It can be clearly seen that objective and subjective visual quality has been rapidly increased, see Fig. 3 and Fig. 4.

Avg. bit rate	I-picture	P-picture
	Bit rate	Bit rate
[b/pxl]	[b/pxl]	[b/pxl]
0.05	0.13	0.04
0.1	0.16	0.09
0.15	0.23	0.14
0.2	0.28	0.18
0.3	0.38	0.28
0.4	0.48	0.38

Tab. 1:   *Bit rates of I and P-pictures*
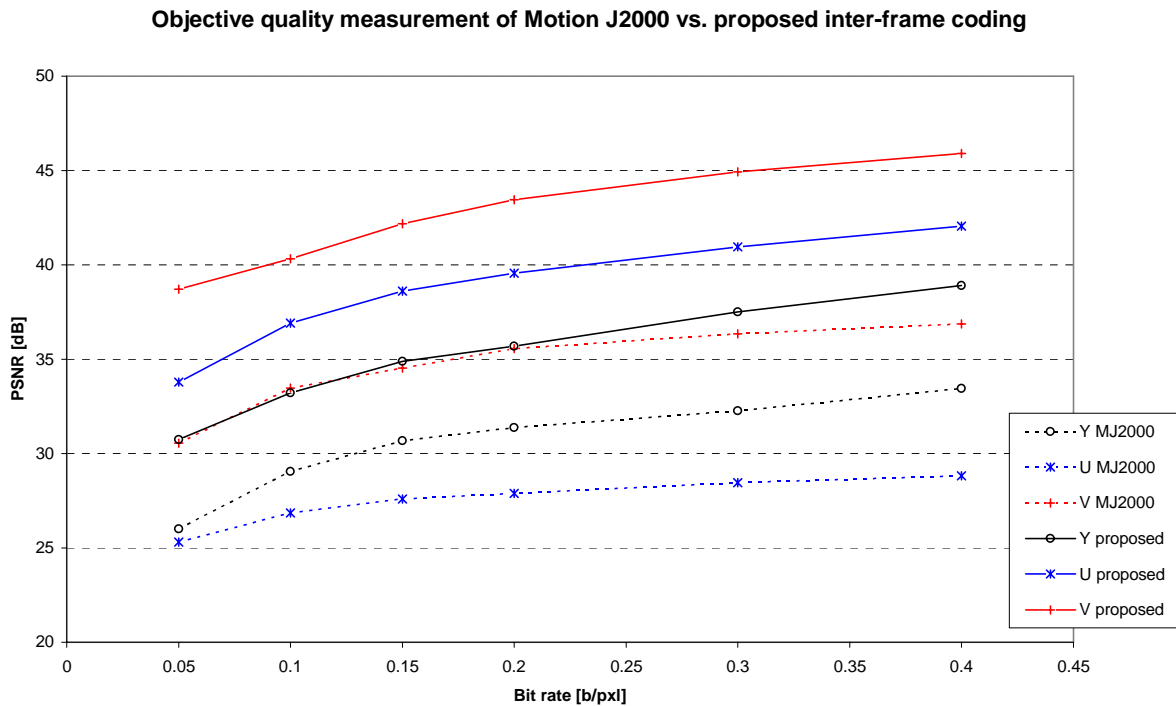
Fig. 3:   *Objective quality measurement of YUV components.*
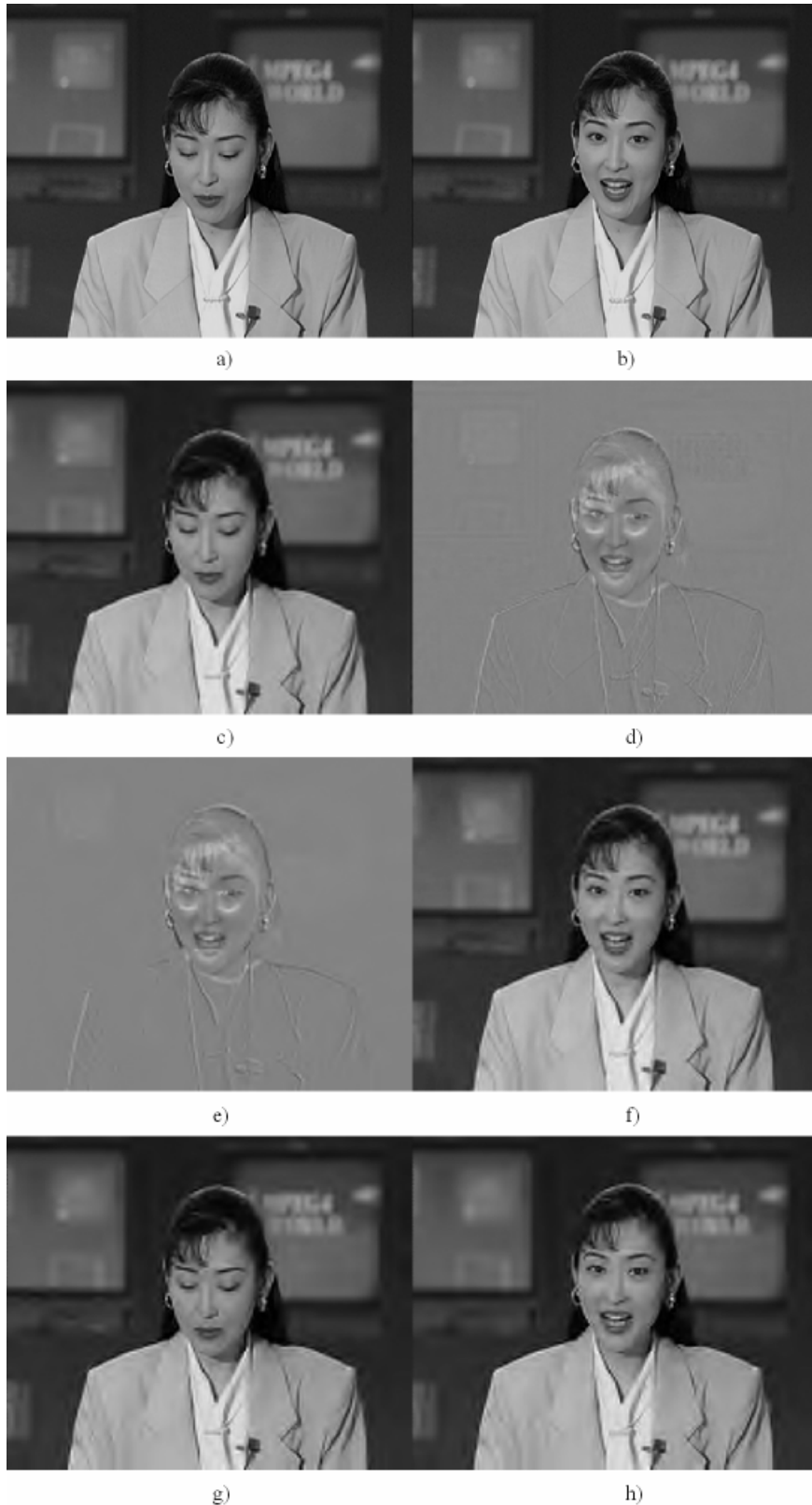
Fig. 4: *Visual quality evaluation: a) original 21st frame; b) original 26th frame; c) I-picture (0.23 b/pxl); d) differential frame ("b)" – "c)"); e) encoded differential frame (0.14 b/pxl); f) compressed 26th frame ("c)" + "e)"); g) 21st frame encoded with Motion JPEG2000 (0.15 b/pxl); h) 26th frame encoded with Motion JPEG2000 (0.15 b/pxl)*

4   CONCLUSION

Differential coding has been implemented for increasing coding efficiency. The goal to increase the visual quality and preserve the target bit rate has been met. The improvement in the proposed coding scheme is around 5 dB in luminance component at all tested bit rates in comparison with the international standard Motion JPEG2000. An adaptive GOP length with variable number of P-pictures is further step in coding efficiency improvement.

REFERENCES

[1] ISO/IEC JTC 1/SC 29/WG 1 N2117 (ITU-T SG8) Coding of Still Pictures, Motion JPEG2000 Final Committee Draft 1.0 , 27.March 2001

[2] Kakadu software homepage, URL: http://www.kakadusoftware.com

[3] Morgan Multimedia homepage, URL: http://www.morgan-multimedia.com