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H.264 Video Transmission with High Quality and Low Bitrate over Wireless Network

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Abstract: This paper propose a video modeling based on h.264 with the ability of streaming video over wireless network at high quality and low bitrate .such application can support users inside houses as well as outside through walking. The bit rate adaptation, buffering optimization and error resilience are used base on the most effective tools in h.264. The system operation will explain the optimal usage of coder and decoder tools to make bit rate compatible with channel capabilities.JM packet is used to test the suggested H.264 configuration.

Keyword: H.264, rate control, GOP, buffer.

I. INTRODUCTION

The popularity of IP-based video streaming over the Internet is continuously growing, with hundreds of new subscribers registered daily. In addition, existing and emerging wireless systems such as 3G, 4G as well WLAN enable IP-based multimedia transmission and reception at any place and time at reasonable and sufficient data rates. Video transmission for mobile terminals is likely to be a major application in future mobile systems and maybe a key factor to their success[1]. Nevertheless, bitrate will always be a limited bandwidth in wireless transmission environments due to physical bandwidth and power limitations and thus efficient video compression is required. Nowadays H.264 andMPEG4 –part 10 are the candidate of such task. H.264/AVC have a features makes it the perfect standard from the previous ones[2]. H.264/AVC gain the effective enhancement on the compression ratio based on the term peak signal to noise ratio.it is support conversational and non-conversational applications. The rest of paper is expressed as follows, Section 2 represents H.264 configuration work flow, Section 3 illustrates the proposed model while Section 4 deal with the experiments and results and section 5 the conclusion of the proposed system.

II. H.264 CONFIGURATION

H.264/AVC codec basically contains many new features that enable it to achieve a significant improvement in terms of compression efficiency. This is the main reason of why H.264/AVC will be very attractive for use in wireless environments, these parameters are Multi-frame motion-compensated prediction, adaptive block size for motion compensation, generalized B-Pictures concept, quarter-pixel motion accuracy, intra coding utilizing prediction in the spatial domain, in-loop deblocking filters, and efficient entropy coding methods[3]. In our work two formats (SDTV, HDTV) as the input to the encoder are used. The video will divide into frames (I, P, B) and each frame divide into slices consists of a number of macroblockes each macroblock contain a number of blocks and each block contain a number of pixels, figure (1) Explain the sequence of the video

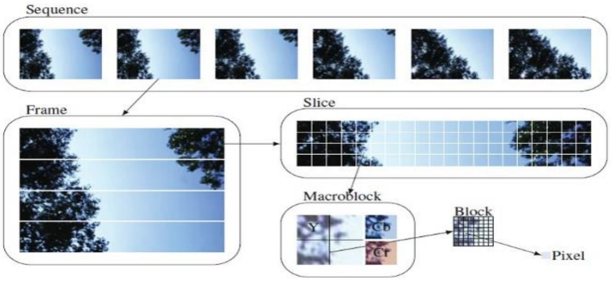
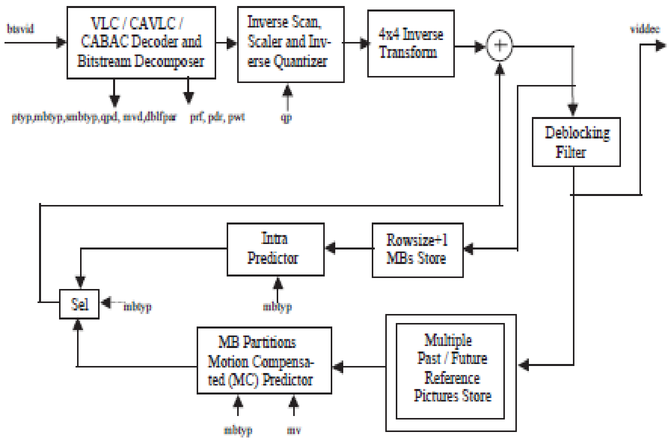
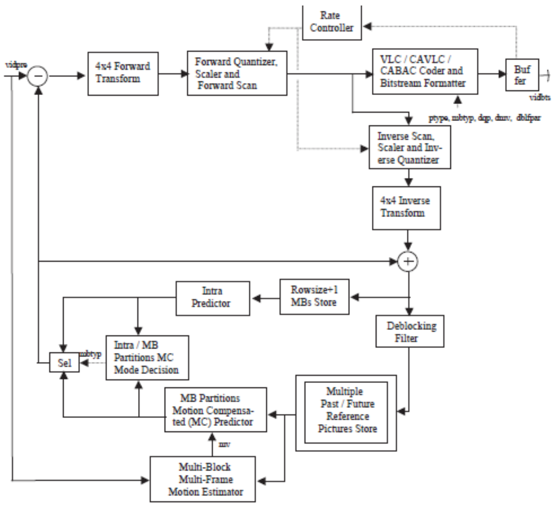


Figure (1) video sequences

When transmit the video it is send as a bitstream as well as the syntax and semantics of the bitstream. The elements that are transmit processed by H.264 codec called Network Abstraction Layer (NAL) which can easily be encapsulated into different transport protocols and file formats. There are two types of NAL units, Video Coding Layer (VCL) NAL units and non-VCL NAL units[4]. One VCL NAL unit type is dedicated for a slice in an instantaneous decoding refresh (IDR) picture. A non-VCL NAL unit contains supplemental enhancement information (SEI), parameter sets, picture delimiter, or filler data. Therefore the proposed encoder implementation is responsible for appropriately selecting a combination of different Encoding parameters, so-called operational coder control. When using a standard with a completely specified decoder, parameters in the encoder should be selected such that good rate distortion performance is achieved. For a video coder like H.264/AVC, the encoder for proposed model must select parameters, such as motion vectors, macroblock modes, quantization parameters, reference frames, and spatial and temporal resolution, to provide good quality under given rate and delay constraints. Figure (2a & b) explain the working of h.264 coder and decoder respectively.



(a)



(b)

Figure 2 (a&b) explain h.264 encoder and decoder

III. THE PROPOSED MODEL

The proposed model consists of 2 parts (encoder and controller).We proposed rate adaption technique by transcoding video sequence to transmission over wireless Channel. The proposed model will demonstrates a full encoder_channel_decoder layout operation through a mechanism at making the bitrate of video to be compatible with the available channel bitrate. By estimating the channel bandwidth capacity, we can determine the channel bit streaming. Such control is using the effective tools like quantization parameter, skip frames, Group of picture (GOP) and so on, we reduce the output rate video by adjusting quantization parameter to meet the requirement .the encoder send a request of bitrate change through a received feedback encoder buffer signal, then the compressed bits will

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encapsulated in packet as syntax to be transmitted through the channel. Figure (3) explain the sequential process of the proposed model.

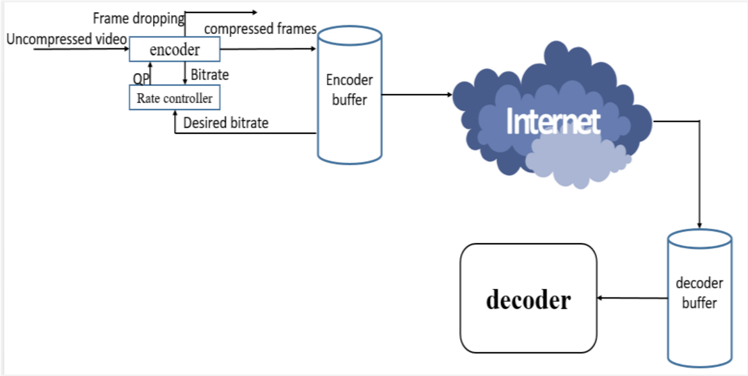

Figure 3: proposed system workflow

The encoder: we will use transcoding technique based on the most effective tools for H.264 standard like quantization parameter, skip frames, Group of Picture (GOP), for pre-encoded video sequence as we will state in the following:

Frame dropping

We use the frame dropping filter to reduce the data rate of a video stream by discarding a number of frames and transmitting the remaining frames at a lower rate. Before removing the temporal redundancy from the current Inter-frame, it's compared with the previous frame and the difference is measured between them. If we transmit 30 fps, and for example in the encoder side we discard two frames, then in the receiver side the number of frames that will be displayed are 32frame, because the system was design to transmit 30fps. We use random Frame Skipping algorithm.

- A random number R is uniformly generated
- The frame is transcoded when the random number is larger than the buffer occupancy
- Otherwise frame drop

Group of picture

The efficiency of the H.264/AVC coding depends directly on the GOP size and on its internal structure. Most available H.264/AVC encoders use a static size for the group of pictures (GOP) to encode video sequences. The GOP size can assume different values, however, after a given GOP size is selected, the whole coding process uses the same size. Where the video sequence consist of cycle begin with Intra (I) frame and following by numbers of B and P frames finally end with Intra frame. The sequence and type of frames have effected role of the bitrate and quality of video. We propose the sequence (IPBBPBB …) which has great enhancement for video quality. Also cycle length or Group of picture length has significant effect on bitrate and quality for video. We use in our work different GOP length to explain which one is the appropriate for our target bitrate and quality.

SP SI frames and errors resilient

H.264, reflects the increasing need for video streaming solutions which adapt to varying network conditions. So in our model we use the new picture types SP and SI which are one of these features, they are the solution for error resilience, bit stream switching and random access. This allows drift-free bit stream switching applications such as refreshing a prediction chain or switching between different quality streams. Figure (4) show the working of the SP, SI.

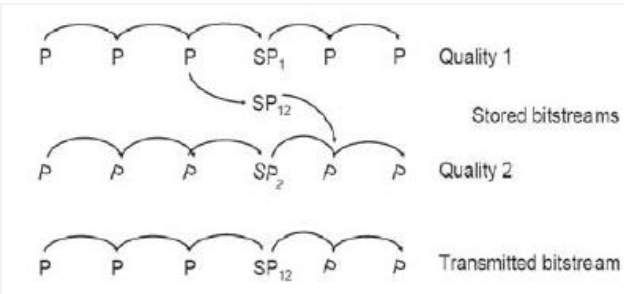

Figure (4) SP&SI working

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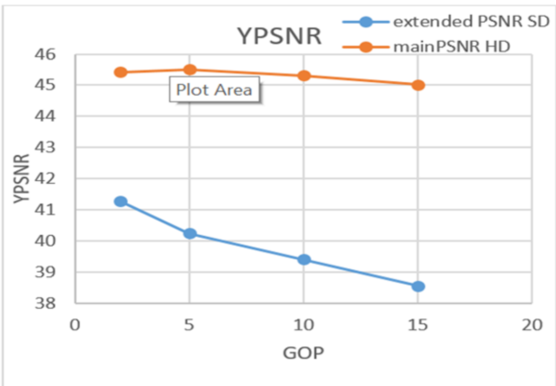
In case of an error in transmission on a previously received picture, the decoded image with the not appropriate values will be stored in the decoder buffer and this frame will be an erroneous reference for next pictures. If only P frames are sent, this error will propagate without any stop, resulting a not desirable situation for the application users. This error propagation can be solved by using I frames, they exploit spatial prediction. The reason why not all the frames sent are I frames is that its size is much bigger than the size of a P frame for a comparable quality. Thus sending one I frame cuts the temporal referencing and it is equivalent to clearing the buffer. The two new frame types of H.264/AVC standard, SI and SP, make also use of spatial and temporal prediction respectively. Thus SI frames are perfect to be applied to switch between different video sequences. In case of a no error situations frames are sent while the SI frame is transmitted when an error occurred SI frames are able to stop error propagation as I frames do, its size is much bigger than the size of an SP frame. We take two different sequence one with p & sp frames and another with p & si frames. show the rate distortion of frames effected by two type of quantization parameters are : (QP‹ P , QP‹ SP OR QP SI).we take different values for two types of quantization parameter (20 ,22,25,28,30) for Quantization P ,(18,20,22,25) for Quantization SP frame for first sequence and (20 ,22,25,28) for Quantization P and(16 ,18 ,20,22,25) for Quantization SI which will be applied for extended profile. Which show the effect of the (SP, SI) frames upon the efficiency of the encoding (high quality and low bitrate).

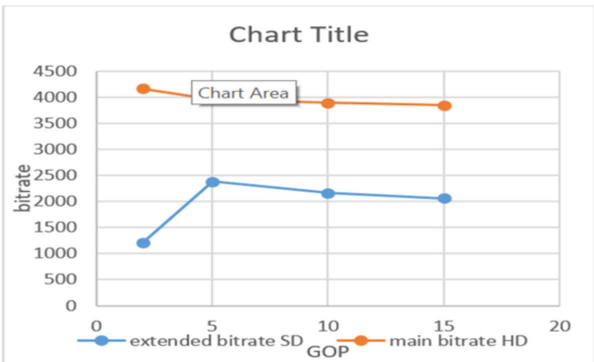
The controller:-
Compressed video sequences are variable bitrate, we put the buffer between the video encoder and the transmission channel to smooth out the rate variation problem. Also the buffer constraint that used in our model will prevent the delay and over flow and under flow in the buffer. Our method is prevent the over flow and under flow in the encoder buffer when streaming the current frame to the buffer, if frame's bits arrive to the critical value (over_critical_value) the rate control will increase the QP to reduce the bitrate of the frame, in contrast (when arrive to the under_critical_value) will decrease the QP value to prevent the under flow. We design buffer with matlab and use video sequence with HD, SD format for transmission over WIFI channel without buffer overflow and under flow.

IV. EXPERIMENTS AND RESULTS

Our testing explains the effect of GOP on the bitrate and quality of the video.when increasing the size of GOP leads to decreasing in the quality and bitrate. we implement the compression in two profiles of the h.264 (main and extended) for two formats HD and SD consequently, figure (5) (a) and (b) explains the effect of the GOP on the quality andthe bitrate.



(a)



(b)

Figure (5) effect the change of the GOP value a) quality b) bitrate

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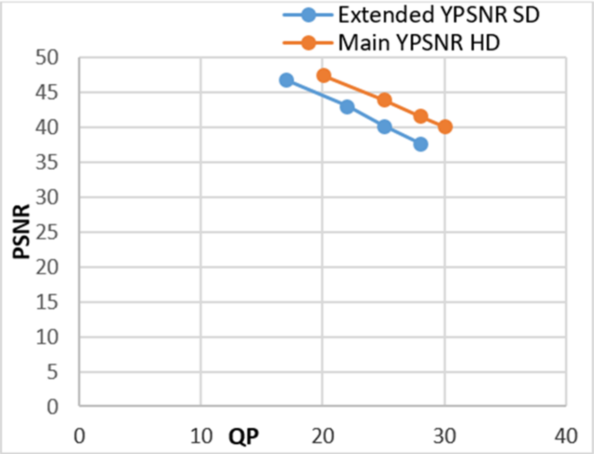
The QP is another parameter that give a noticeable impact on the bitrate and quality. The QP is more important parameter in the rate control .figure 6 show the impact of the QP on the a) PSNR and b) bitrate in the main and extended profiles for HD and SD formats consequently, with different values as appear.



(a)

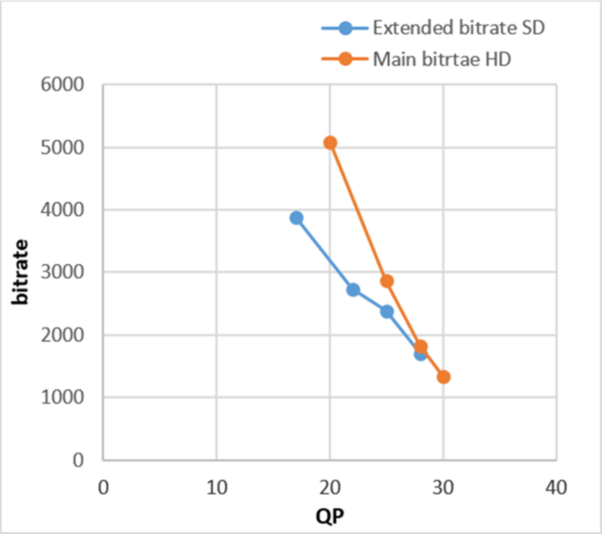
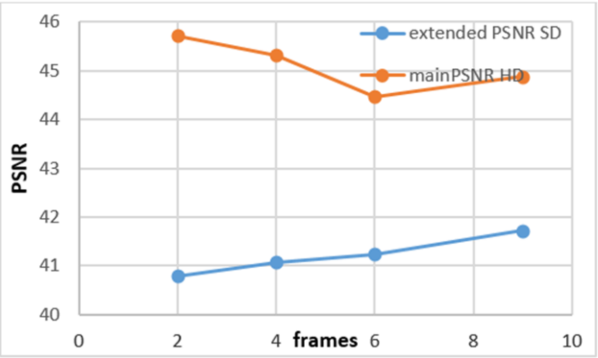


Figure (6) the effect of QP on the a) PSNR and b) Bitrate

Another parameter that effect on the bitrate and the quality is the skipping of the frames. The skip frame help to save or increasing of quality when using QP that cause decreasing in the quality when using it in the rate controller. Figure (7) explain the influence of skip frame on the a) PSNR and b) bitrate of the video in both main and extended profiles.



(a)

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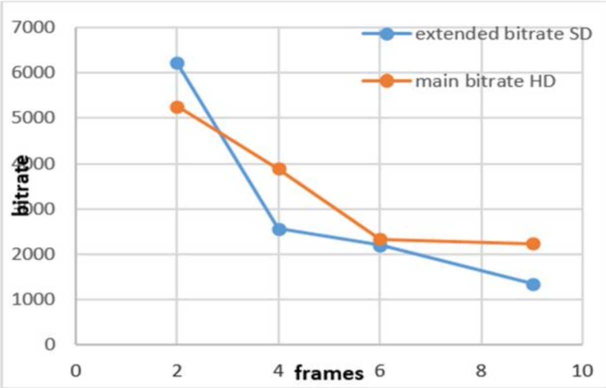
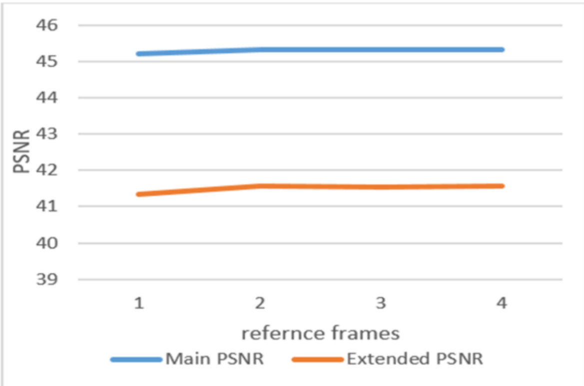
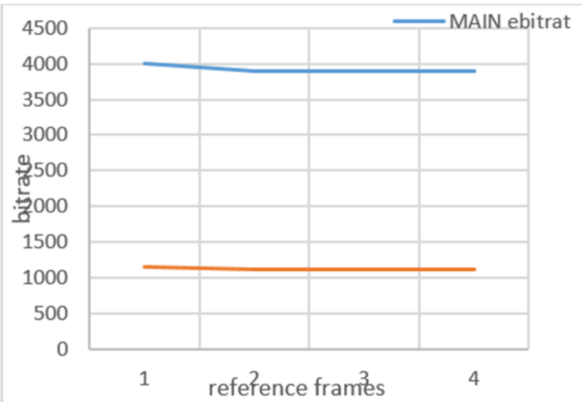


(b)

One of the measurements that can checked within this measured is the references frames it is effect on the quality of picture and on the bitrate.it is produce noticeable change when give different values figure (8) explain the effect of the reference frame on the PSNR and the bitrate.



(a)



(b)

Figure (8) effect of the reference frames on The a) PSNR and b) bitrate

Sub-pixel motion

The Sub-pixel motion compensation of the reference region pixels are interpolated to half-pixel positions and it may be possible to find a better match for the current macro block by searching the interpolated samples is achieved.

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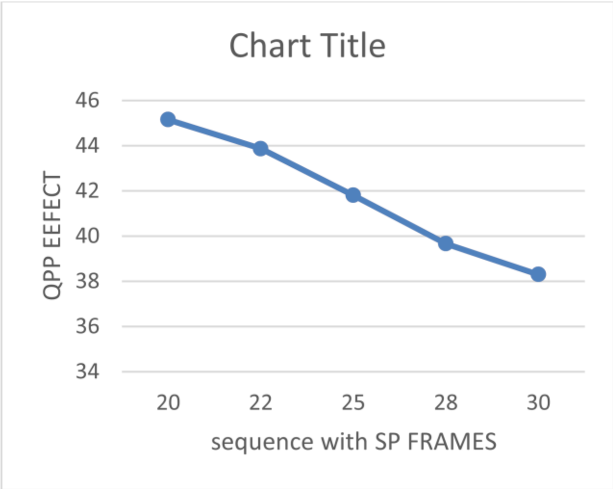
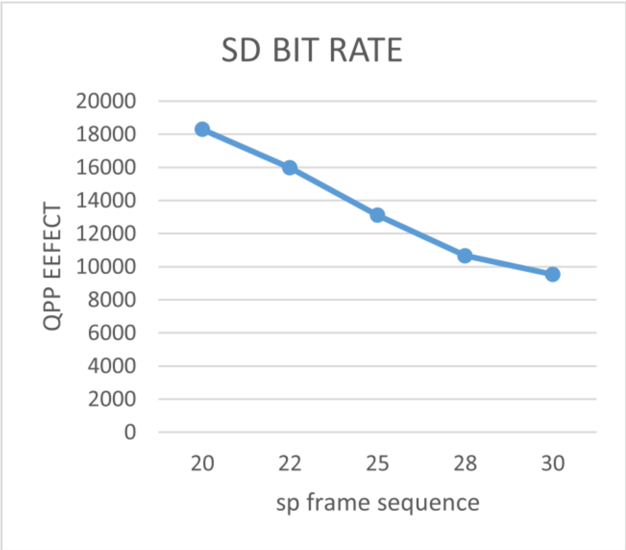
Table (1) the impact of subpixel on the quality and bitrate

subpixel	profiles	PSNR	bitrate
With subpixel	Main HD	45.239	4106.24
	Extended SD	41.543	1108.27
Without subpixel	Main HD	45.317	3889.27
	Extended SD	41.558	1108.32

The figures (9 & 10) show which show the effect of the (SP, SI) frames upon the efficiency of the encoding (high quality and low bitrate).



(a)



(b)

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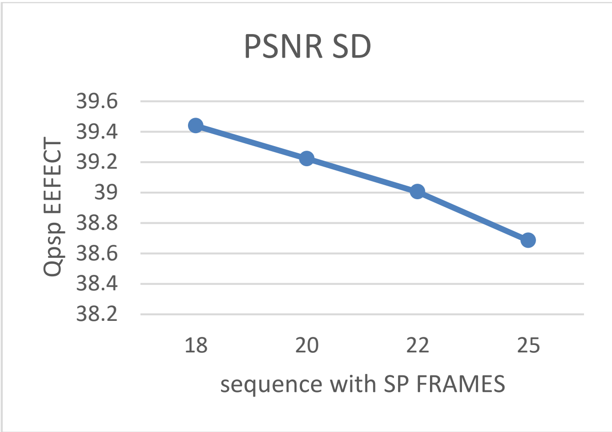
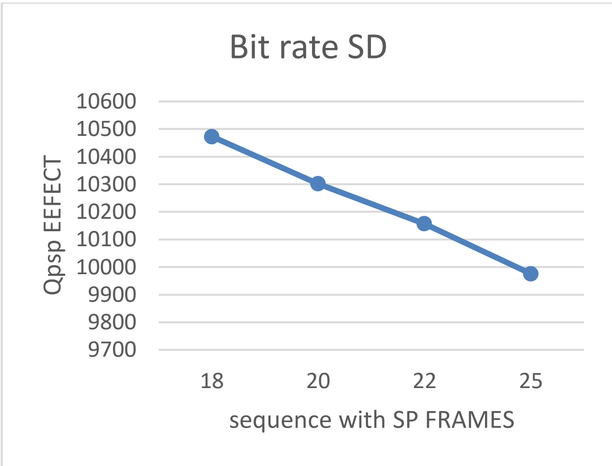
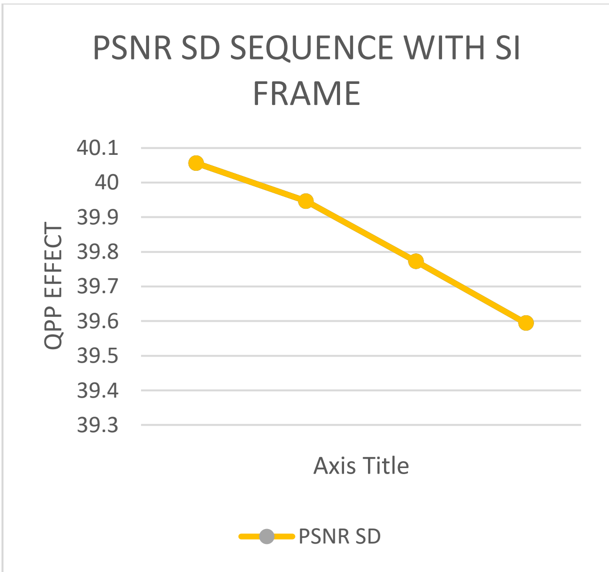


(c)



(d)

Figure (9) (a,b,c ,d): show the influence of QP on the PSNR and bitrate for SP sequence.



(a)

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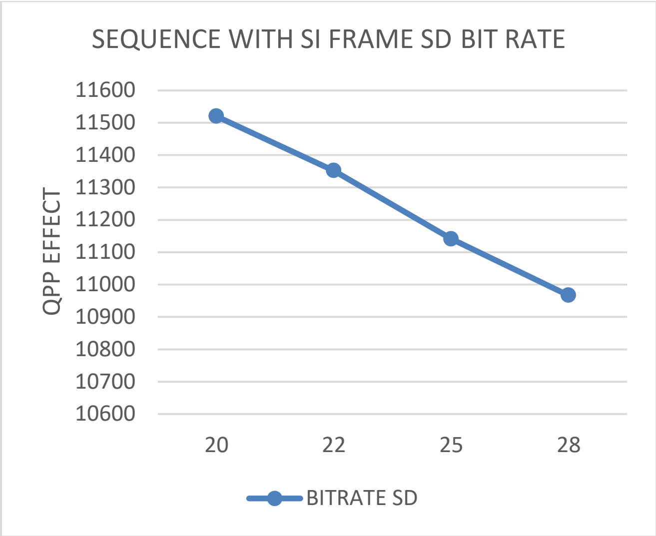
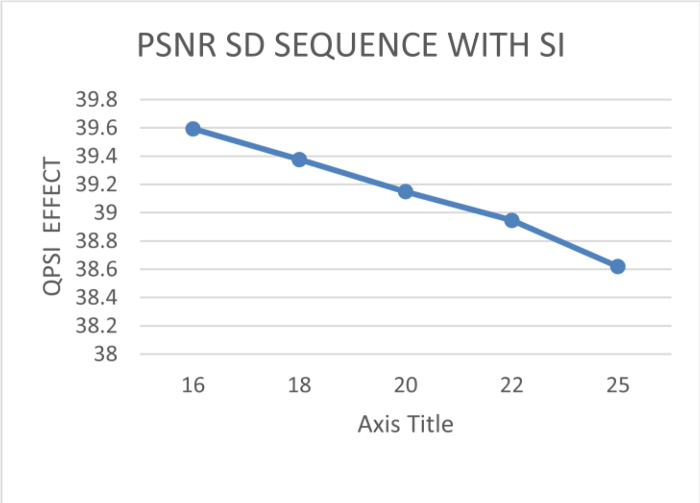
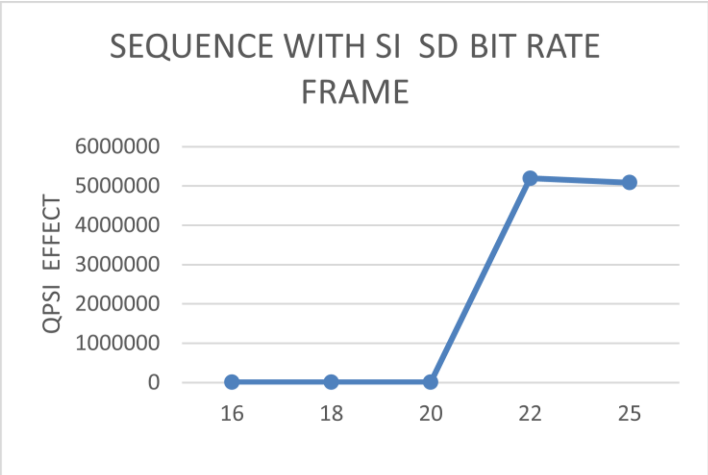


(b)



(c)



(d)

Figure (10) (a,b,c,d): showthe influence of the QP of the P & SP on the PSNR and bitrate in the SI sequence

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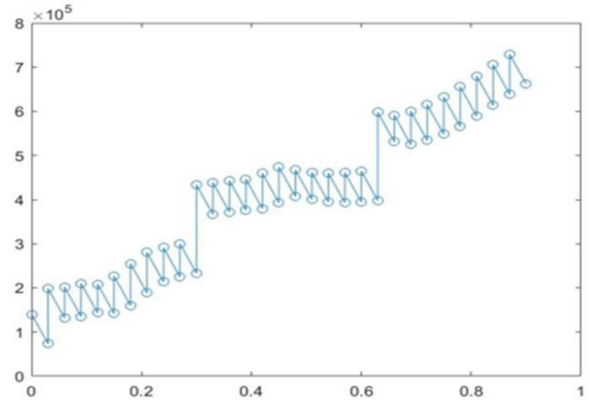
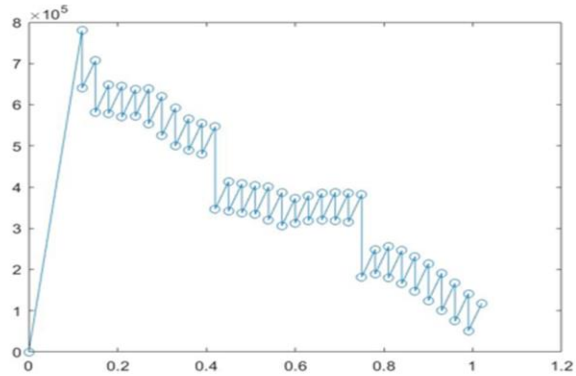
For the control part a test of the designed buffer will be expressed in the figure(10). the buffer scheme is designed according to HD level in the main profile for 3G channel indoor, 2000 Kbps, with 30 frames per second and with QP= 20. Therefore the interval time between each frame and another is 33 ms and transmission rate between encoder buffer to the decoder buffer through the channel is in arrange of 66,666 kbit frame this will receive from the decoder buffer too.



(a)



(b)

Figure (11) a) encoder buffer without over flow b) decoder buffer without under flow

The syntax elements that are used in the encoding process are very important for explain what we use in the encoding the table below table (2) explain an example of the sequence parameter set that have the profile ID, level ID, number of reference frames, picture width

Table (2) example of sequence parameter set

Parameter	Binary code	symbol
Profile ID	01001101	77main profile
Level ID	00101000	Level 4
num_ref_frames	011	From0-3
pic_width_in_mbs	0000001111000	119
pic_height_in_mbs	0000001000100	67

In the table (3) an example of the picture parameter set that contain the picture ID, types of entropy coding (CABAC, CAVLC).

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Table (3) example of PPS

Parameter	Binary code	symbol
Pic.parameter set ID	1	0PPS
Seq.parameter set ID	1	0SPS
Entropy coding mode flag	1	1 CABAC

The table (4) an example of the slice layer, This layer contain information of the I frames.

Table (4) example of slice header, Intra frame 0

Parameter	Binary code	Symbol
first mb in slice	1	First mb at position
slice type	1000	7 I slice
Pic. parameter set ID	1	Use PPS
frame num.	0	0 frame
Pic. Order cnt. Lsb.	0	picture 1

In the table (5) explain the slice header details in the Inter frame 1 have information like Intra frame

Table (5) example of slice header Inter frame 1

Parameter	Binary code	Symbol
first mb in slice	1	First mb at position 0
slice type	110	5 p slice
Pic. parameter set ID	1	Use PPS
frame num.	1	1 frame
Pic. Order cnt. Lsb.	10	picture 2

CONCLUSION

The main conclusions in our study is the QP, GOP, skip frames, sub pixel motion estimation, reference frames are used for control on the bitrate and quality we see that when increasing the number of GOP and QP the bitrate and quality will decrease.Increasing the number of reference frames from 1 to 15 (at fixed QP) in main profile leads to decrease the bitrate.H.264 main profile provides lower bit ratedue tothe existence of B frames (bidirectional prediction) and efficient CABAC coding, but it has less quality magnitude (PSNR) compared tobaseline profile, due to B-frames that has less decoded picture quality. While the extended profile provide high quality by using the SP, SI parameters that are prevent the loss of the pictures through the transmission.

BIOGRAPHIES

Kadhim Hayyawi Flayyih ,born in Al Qadisiyahin 1985 and graduated from the University of Qadisiyah / College of Science at Computer Science Department at 2006– 2007 , I worked as a staff member in Al QadisiyahGovernorate Council (2010-2011) and teacher at Al - Taji Mixed School..In 2016 - 2017 I begin the study of a Master in computer science from Iraqi Commission for Computers and Information / Informatics Institute for Postgraduate Studies.

Mahmood abdul hakeem abbood , born in April 1989 and graduated from Anbar university / computer collage and programmer in ministry of science and technology/ information technology office,I have ICDL certificate and worked in the Iraq E-portal now study masterin computer science in the Iraqi Commission for Computers and Information / Informatics Institute for Postgraduate Studies.

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