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# Error-Resilient Video Communication Using AVC Over Wireless Networks

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## ABSTRACT

*In this work an effective video communication for the wireless transmission of medical ultrasound video using H.264 has been described. The objective of the proposed project is to develop a unifying structure for the error-resilient communication of video over emerging wireless network that is suitable for emergency clinical analysis and treatment. We exhibit how our proposed work allow for the transmission of high resolution medical ultrasound video that is encoded and compressed at the medical acquirement resolution and can be decoded with low packet loss. And also represent the effect of quantization parameter on PSNR and bitrate. To substantiate performance, we organize a wireless network in MATLAB Simulink and encode the medical ultrasound videos using h.264 video codec encoder resulting into high PSNR and low bitrate. It is expected that the combined system will help in establishing mobile-health (m-health) medical video communication systems in regular clinical training.*

**Keywords: ultrasound video, error-resilient, high resolution, quantization parameter, PSNR, bitrate, h.264 video codec encoder**

## 1. INTRODUCTION

Rapid development in the field of telemedicine along with enormous availability of wireless network infrastructures create the opportunities for the emerging technologies that are required to support m-health video communication tools in clinical practice. Over the past decade there is a growing demand for mobile health systems development in the same will lead to responsive emergency telemetry, remote diagnosis and treatment, medical education as well as for mass population screening. Development in mobile health systems are more probable to bring socioeconomic benefits leading to the improvement in quality of life of patients with mobility problem, the old aged people and people who are staying in remote areas, by enhancing their contact to emergency care like hospitals or doctor. Undoubtedly it will be life saving in life threatening emergency cases.

Related work [2] covers a study of recent e-emergency systems, including the wireless technologies used, as well as the data transmitted (electronic patient record, bio-signals, medical images and video, subject video, and other). Furthermore, emerging wireless video systems for reliable communications in these applications are presented. They estimated that m-health e-emergency systems will significantly affect the delivery of healthcare however; their utilization in daily practice still remains to be attained. [3] Compares the performance of the emerging high efficiency video coding (HEVC) standard to the current H.264/AVC standard. The experimental results, based on five atherosclerotic plaque ultrasound videos encoded at QCIF, CIF, and 4CIF resolutions demonstrates that 50% reductions in bitrate requirements is possible for equivalent clinical quality[1].

## 2. PROPOSED SYSTEM

Figure1 represents the block diagram of the basic components required for transmission of medical ultrasound video. This procedure consists of four steps firstly raw ultrasound video is pre-processed so that it can be encoded easily. This step consists of video resolution as well as video de-noising wherever required. Secondly the pre-processed video is compressed using H.264 video encoder [5]. Thirdly the ultrasound video is transmitted across the wireless medium. At the destination reverse procedure is followed for decoding and post-processing.

## 3. METHODOLOGY

The steps carried out for the proposed system can be explained in following sections.

### 3.1 Pre-processing

This step typically involves changing the video resolution of the raw ultrasound medical video to the CIF resolution so as to carry out the encoding process easily [1]. And also the RGB video is converted into gray scale video so that memory consumed is less.

### 3.2 H.264 Codec Video Encoder

The block diagram for H.264 video codec encoder is shown in Fig2. An input video frame is given for encoding. Every frame is converted into units called macro block of size 16x16 or 8X8pixels. Each macro-block undergoes encoding using intra-prediction modes [6]. In this proposed system we are using intra-prediction modes in which prediction block is formed using pixels of current frame and also frames which are previously encoded and reconstructed [6]. When prediction block is subtracted from the current block it produces Residual block. Residual block further undergoes transformation using discrete cosine transform [7]. If the input matrix is represented by P[x, y] and the transformed matrix by F[i, j] the DCT of each 8x8 block of values is computed using the expression.

$$F[i,j] = \frac{1}{4} C(i)C(j) \sum_{\substack{0 \le x \le 7 \\ 0 < y < 7}} P(x,y) \cos\frac{(2x+1)i\pi}{16} \cos\frac{(2y+1)i\pi}{16}$$

Where C(i) and C(j) = $1/\sqrt{2}$ for i, j=0

= 1 for all values of i and j

And x, y, and i, j vary from 0 through 7

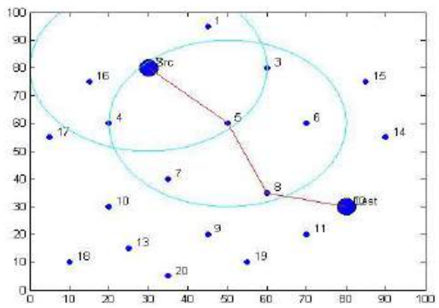
The output of the transform is a block of transform coefficients, is further quantized, i.e. each coefficient is divided by an integer value. Quantization reduces the accuracy of the transform coefficients according to a quantization parameter (QP) [6].Resulting in a block in which most of the coefficients is zero, with a few non-zero coefficients. Setting QP to a high value means that more coefficients are set to zero, resulting in high compression at the expense of poor decoded image quality. Setting QP to a low value means that more non-zero coefficients remain after quantization, resulting in better decoded image quality but lower compression. Then quantized macro block coefficients are decoded to reconstruct a frame for encoding of further macro-blocks. Later on they undergo inverse transform to produce a difference macro block when added with prediction block produces reconstructed block. De-blocking filter is applied to this reconstructed block to improve the quality of video frames. The video frames can also be encoded using motion estimation and motion compensation in order to achieve 10% or more compression [2]. Table 3.2 represents the different intra-prediction modes.

**3.2 Different intra-prediction modes.**

| Number | 4x4 intra-prediction modes |
|---|---|
| 0 | Vertical |
| 1 | Horizontal |
| 2 | DC |
| 3 | Diagonal down left |
| 4 | Diagonal down right |
| 5 | Vertical right |
| 6 | Horizontal down |
| 7 | Vertical left |
| 8 | Horizontal up |

### 3.3 Video Transmission

Wireless Network is deployed using MATLAB Simulink in which number of nodes is placed in the given space as shown in below figure. Each node is given unique identity. User can select the required source node and destination node to which video is to be transmitted. The routing problem of finding paths from a traffic source to a traffic destination through a series of intermediate forwarding nodes is particularly challenging [5]. Such network requires a responsive routing algorithm that finds valid routes quickly. Greedy Perimeter Stateless Routing, GPSR is a responsive and efficient routing protocol for mobile, wireless networks. GPSR exploits the correspondence between geographic position and connectivity in a wireless network, by using the position of nodes to make packet forwarding decisions [5].



**Wireless Network**

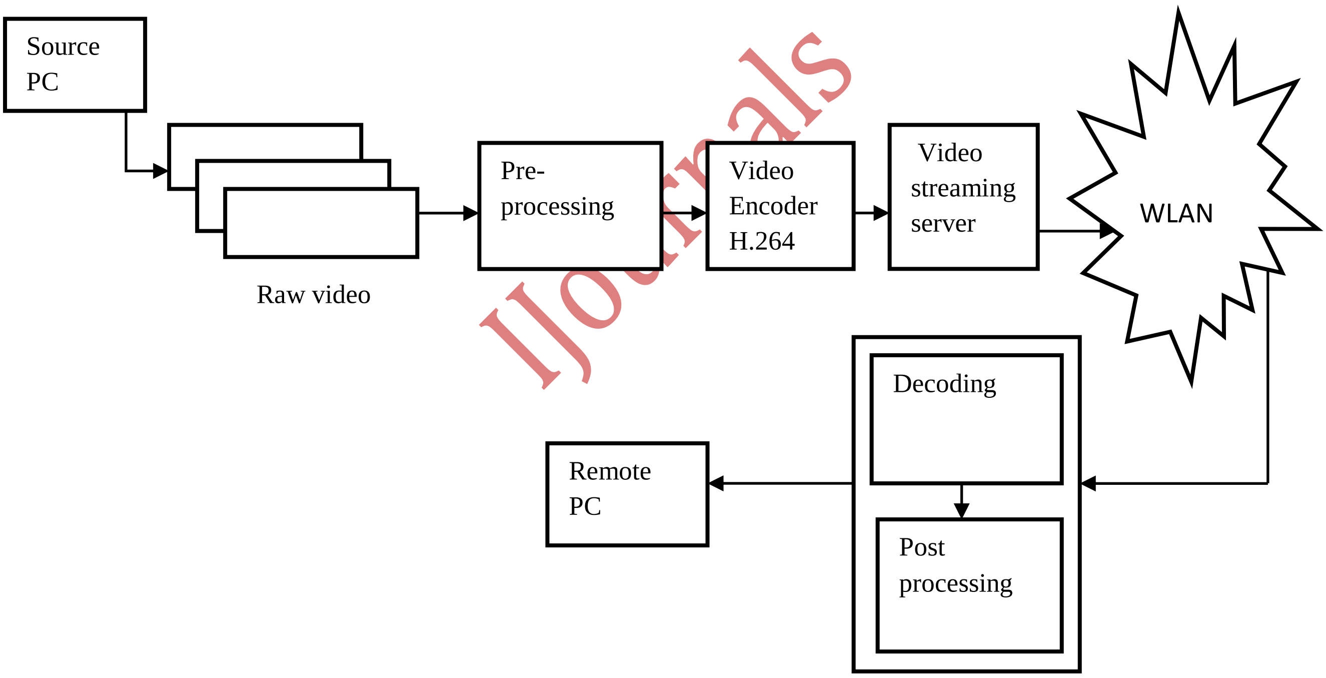



**Fig 1: Block diagram of the proposed system.**

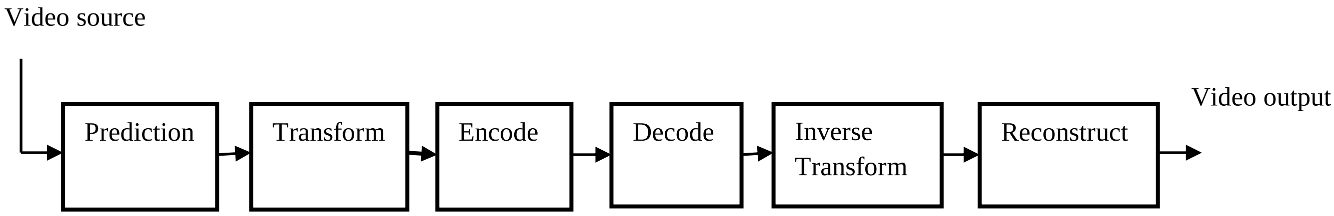



**Fig 2: Block diagram of H.264 Standard**

## 4. SIMULATION RESULTS

After implementation of H.264/AVC Encoder in MATLAB for all the nine modes of Intra-prediction. The simulations were performed for different QP values. For each mode, the reconstructed frame Quality (PSNR) and Compression were computed. Using the following equations

$$PSNR = Mean\left(20 * \log 10\left(\frac{255}{\sqrt{mean(mean(rgbframe - deblocked\ frame)^2)}}\right)\right)$$

$$Compression\ ratio = \frac{(((320*240*3*8) - bytes\ used)*100)}{(320*240*3*8)}$$

$$Bitrate = \frac{(bytes\ used * 25)}{(1024*1024*1)}$$

The table 4.1 shows the calculations for different quantization parameters and intra-prediction modes. The nine modes of Intra-prediction have been implemented [6]. Of these, Vertical Mode (Mode 0), Horizontal Mode (Mode 1) and Horizontal up Mode (Mode 8) offers the highest compression (about 12 to 30), without sacrificing on the quality of the reconstructed picture (PSNR achieved is of about 30 dB to 35 dB).



**Table 4.1**

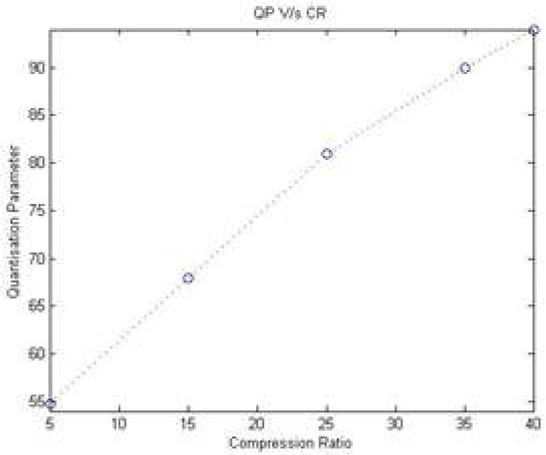
| Intra-prediction mode | QP | PSNR in DB | Compression Ratio (CR) | Bitrate |
|---|---|---|---|---|
| 0 | 24 | 26.00 | 99.92 | 0.05 |
| 1 | 28 | 30.17 | 99.93 | 0.04 |
| 2 | 29 | 30.33 | 99.94 | 0.04 |
| 4 | 30 | 30.48 | 99.94 | 0.03 |
| 8 | 32 | 32.17 | 99.94 | 0.03 |


**Fig 3 Original Frame**

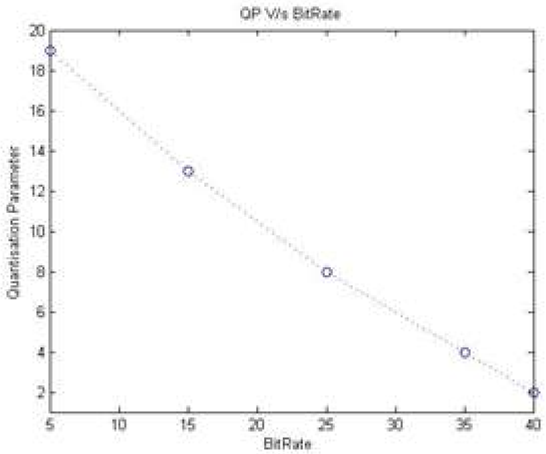

**Fig4 Reconstructed Frame with De-blocking filter**

## 4.1 Effect of Quantization parameter (QP) on Bitrate and PSNR

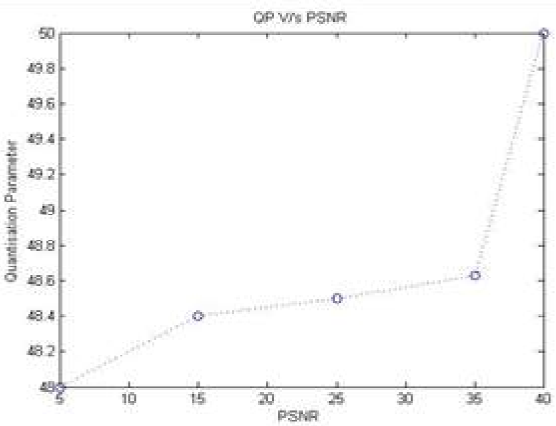
*4.1.1 QP versus Compression Ratio*




.QP versus Bitrate




*4.1.1.2 QP versus PSNR*




4.1.1 curve represents that as QP increases compression also increases. 4.1.1.1 Curve represents decrease in bitrate with increase in QP. 4.1.1.2 Represents the curve where maximum PSNR is achieved with increase in QP

## 5. CONCLUSION

In this work medical video transmission using h.264 is exhibited. It is also verified that as QP value increases, the compression also increases. However, high value of QP (beyond 32) degrades the quality of reconstructed picture. In this paper maximum PSNR is achieved with low bitrate which leads to bandwidth efficiency. In future work can be done using HEVC which is more efficient video coder compared to H.264.

## 6. ACKNOWLEDGEMENT

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