CHAPTER 2

FUNDAMENTAL ASPECTS OF MULTIMEDIA COMPRESSION AND REVIEW OF LITERATURE

Although the preceding chapter, more or less discusses the overview of the overall research track along with the research goals formulated for the proposed study, this chapter brings an insight into the fundamental concepts of multimedia compression where the more emphasize has been given on the video coding or video compression. However, this chapter discusses specific theoretical and methodical aspects towards fundamental features of multimedia compression and its future needs for improving video coding standards in real-time communications. It also depicts an extensive review pertaining extracting substantive findings such as objectifying their theoretical and methodological contribution on video coding, from the conventional studies. Initially, this chapter includes objectifying the fundamental need of multimedia compression and its standard design methodologies. Further, it aims to highlights most significant research studies carried out till date by the prominent researchers. Further, the sequential flow of the manuscript will also discuss the existing research issues and design complexities of the conventional video coding protocols.

2.1 INTRODUCTION

The recent advancement in the field of Multimedia Networking and Coding extends its larger scope of applicability into various fields such as live streaming of real-time audio, video and image by assuring effective data transmission. The current demand of transmitting encoded multimedia files over a wireless network as well as online video streaming thereby, creating lots of business for fast growing online video sharing industries e.g. You Tube, Vimeo etc. However, it has also extended its full support to facilitate the users with the large demand for accessing high-quality video streaming on-line with less end to end communication delay. This chapter briefly introduces the fundamental concepts associated with the multimedia video compression techniques, and its extensive design issues which are needed to be addressed. It also represents the significant research works carried out on enhancing the quality of the video signals while transmitting through wireless medium. Moreover, the focus mostly lies towards minimizing the inherent nature of video contents by
performing efficient compression which reduces the number of bits in a bit stream. The process thereby enhances peer-to-peer video streaming by utilizing sufficient bandwidth and adequate network resources. The further segments of the proposed study discusses about the multimedia compression and its impact on futuristic collaborative network applications from a theoretical perspective. It also reviews some of the significant studies and their contribution towards enhancing perceptual quality of encoded video streams using H.265 standard. It also performs an in-depth investigation to find out the most recent benchmark technique, which can be utilized further to formulate an integrated framework for the purpose of achieving better perceptual quality while processing real-time video coding in a less traffic condition in mobile communications. However, this chapter also shows the research works being referred to support each and every objective of the proposed study (i.e. highlighted in the prior chapter).

In last two decades, several multimedia compression techniques have been witnessed which typically includes audio, image and video compressions. The evolution of still image compression to the current trends to assess video compressions considering motion estimation and compensation postures the demand of compression on successful data transmission over a network. Multimedia files require pre-processing of vast amounts of data and the need of video compression lies on the following two statements such as

✓ Low network bandwidth doesn’t allow real time video data transmission.
✓ Relatively Slow storage devices such as low CD-ROM transfer rate, don’t consider fast play back of an uncompressed multimedia streaming.

In support to the above mentioned scenarios the following Table 2.1 show the storage requirements of several uncompressed multimedia files.
Table 2.1: Storage requirements of several uncompressed multimedia files

<table>
<thead>
<tr>
<th>Object type</th>
<th>Text</th>
<th>Image</th>
<th>Audio</th>
<th>Animation</th>
<th>Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCII - BCDIC</td>
<td>- bit mapped Graphics</td>
<td>- still photos</td>
<td>Non-coded stream of digitized audio or voice</td>
<td>Synched image and audio stream at 15-19 frames/s</td>
<td>TV analog or digital image with synched streams at 24-30 frames/s</td>
</tr>
<tr>
<td>Size and bandwidth</td>
<td>2kB per page</td>
<td>- simple (greyscale) 77kB/image (320x240x8bits)</td>
<td>Voice/phone 8kHz/8 bits (mono) 6-44 KB/s</td>
<td>16 bit colour 16 frames/s 6.5MB/s (320x640x16bitsx16frames/s)</td>
<td>24 bit colour 30 frames/s 27.6 MB/s (640x480x24bitsx30frames/s)</td>
</tr>
</tbody>
</table>

These data must be compressed efficiently without any information loss. Therefore, to address the above stated issues several multimedia compression mechanisms to reduce the storage and bandwidth requirements are being adopted in the current scenario. The following are the different types of multimedia compressions adopted in several conventional studies.

2.1.1 Audio Compression

Audio compression represents lossless compression of CD-quality audio data by considering sampling of each stereo channel (i.e. audio signal components) at 44.1 kHz. Moreover, each sample is represented with 16 bits. This shows how significantly an audio compression by implying Huffman coder can transmit enormous CD-quality data without affecting the bandwidth or channel capacity. The conventional audio compression approaches such as MPEG techniques, VOC File Compression, linear predictive coding etc. mostly worked on meeting the following requirements during the pre-processing of the audio signal such as

- Less bandwidth utilization
- Less storage consumption during streaming
- Making decoded signal more precise as the input signal
- Robustness and Scalability
The following Figure 2.1 explicitly shows standard interactive audio compression methodological procedures based on MUSI-Compress Theory to reduce storage consumptions and streaming.

![Diagram of audio compression algorithm]

**Figure 2.1 a lossless audio compression algorithm**

The MPEG compression technique is used to perform data synchronization to aggregate bit rate of 1.5 Mbit/sec. Several MPEG audio features are encountered such as:

- No assumptions are taken to determine the nature of the audio signal.
- Remove the perceptually irrelevant parts of an audio signal during the compression operations.
- However, the process offers a sampling rate of 32, 44.1 and 48 kHz.
- It also offers computation in three independent layers by allowing single chip real-time decoder implementations.
- It also includes the features of random access, audio fast forwarding along with audio reverse operations and enables the Cyclic Redundancy Check (CRC).

**2.1.2 Image Compression**

The increasing demand for the multimedia products implicates a scenario subjected to the insufficient bandwidth of a network as well as storage constraints. Therefore, a need
arises to develop efficient compression algorithms which involve saving hardware space and transmission bandwidth by minimizing redundant bits of a multimedia file. However, image compression (i.e. an application data compression), is a process of encoding an original image by reducing its redundant bits for the ease of computation, transmission and storage. The algorithms also aim to display the decoded image in the monitor as similar as the original one. The basic flow of an image compression coding depicts that it requires one encoder module to convert original image into a stream of bits (*compact form*), which is further processed through a decoder to produce a decoded image. However, after receiving the decoded image at the receiver side the systems computes the compression ratio by measuring the total quantity of the received bit stream and the total quantity of the original image. If the quantity of the received bit stream is lesser than the quantity of the original image then it is called image compression. The compression ratio can be defined considering the following eq. 2.1.

\[
\text{Comp}_\text{ratio} = \frac{\eta}{\beta}
\]

Where \( \eta = \text{Size of Original Image (Width*Height*Number of Colour planes*bit-depth)/8 (bytes)} \), \( \beta = \text{Size of compressed image = size in bytes} \).

The performance of an image compression can be measured by two common measurements which are computation of Mean Square Error (MSE) and PSNR respectively. The MSE and PSNR can be commutated by evaluating the following equations.

\[
MSE = \frac{1}{HW} \sum_{i=1}^{W-1} \sum_{j=1}^{H-1} (|\mu(i, j) - \mu'(i, j)|)^2
\]

\[
\text{PSNR(dB)} = 10 \times \log\left(\frac{255^2}{\text{MSE}}\right)
\]

The MSE and PSNR is the two error matrix utilized to look at picture compression quality. MSE signifies the increasing squared error amongst the compressed and the unique image, while PSNR signifies an amount of peak errors present in an image. In the above eq. 2.2 \( \mu(i, j) \) and \( \mu'(i, j) \) signifies the pixel values of the original and the decoded image respectively. The next segment of this manuscript discusses about the video compression and its significant impact on reducing errors.
2.1.3 Fundamental Aspects of Video Compression

The recent decades witnessed subsequent and substantial growth in the field of video broadcasting and streaming of real-time video frames over wireless channels. The ease of real-time video streaming also extended its applicability where a user can view online videos on any hand-held devices irrespective of any bandwidth or storage constraints. Video coding determines effective compression on real-time entertainment videos and also collaborate mobile communication scenario to access the modest video frames of specific dimensions. It basically reduces the amount of data required to represent a video frame without affecting its quality in a larger extent. It is more likely to say that most of the conventional video encoding standards such as H.264, H.263 perform compression of video frames before transmitting it to the network. The complementary operations take place in the receiver end where decompression is carried out to retrieve the original bit stream of a video sequence. Usually heavier multimedia files such as high-quality video data tend to acquire more storage and network resources thus there is a need for performing compression to make the file as compact as possible. The compression reduces redundant information from a video object prior to the transmission and makes it suitable for utilizing fewer amounts of channel capacity as well as storage space. The receiver unit recovers the original bits sequence from an encoded representation. Therefore, it can be said that video coding is an essential procedure needed to run through any video enabled applications where storage and transmission bandwidth are constrained. In other words, the process of video coding, also intends to extract redundant information from a raw video stream to make it suitable for transmitting through network as efficiently as possible. The time taken by an encoder to extract the overall redundant bits from an entire video stream prior to transmission is termed as encoding latency in live broadcasting. However, the process also involves standardizing the encoded video at the receiver side. It tries to re-generate a sequential stream of bits representing a video object as similar as the original one. The scope of the standardization to enhance the quality of the encoded video frames (such as UHD, SD, HD, etc.) lies in the decoder segment which leads to producing a quality video stream at the display panel.

Existing state of the art studies reveals that different compression standards such as MPEG-2, AVC and HEVC access different bit rates to achieve their respective quality level of encoded video stream. The hardware components embedded in the handheld devices intend to detect the decoder path for the purpose of achieving interoperability and decoding the coded bit stream. The design strategies of an encoder can be interpreted based on their capability of
processing different set of information as per the market needs. Hence, on the other hand it can be said that the implementation strategies for the different encoder varies due to its need to assess different set of tools which is defined by the specific standard. The following figure shows overview of a video compression procedure where, it also depicts the scope of standardization lies into the decoding segment.

Figure 2.2 Scope of video compression standardization

Several runtime environment setups recommended for implementing encoder precisely depends on the market requirement for processing a particular type of video. Hence, there exist certain designs complexities associated with encoder where several compatibility issues and decision making challenges arise.

2.1.3.1 Classification of Video Frames

Usually, the streaming video frames are classified into three different types such as I-frames, P-frames, and B-frames. Each type of encoder enables performing compression to reduce bit rates of a video sequence involving the combinational use of the above stated three frames. However, it performs subsequent intra-prediction and inter-prediction encoding to discard spatial and temporal redundancies exists within these frames. Thus, the addition of intellectual encoding operations (i.e. Intra-prediction) within each frame, thereby computes the number repeated blocks or pixel entities formed by encoded bit stream and reduce the redundancies to make the file as compact as possible (i.e. reduction in file size) for the ease of transmission and computing. The replacement of replicated blocks with different pixel
entities makes it more worthy for achieving high-quality video frames with very less amount of bit rates. In real time video streaming motion of objects in between consecutive frames play a very crucial role than non-moving frames thus it is important to interpret the moving frames precisely. Thereby, most of the state of art compression algorithms uses motion compensation strategic process which leads to objectifying the motion vectors within frames utilized in the encoding process. However, detection of the movement of objects in between various frame structures resulting in the moving vector which plays an essential role in the encoding process and predicting the motion of objects. An I-frame of Intra-frame is always acting as an initial frame in a streaming video sequence. The frame mainly serves as a reference frame for the future prediction of moving objects. Unlike other frames, it is more likely to be a self-reliant frame as it doesn’t refer any other frames and can be independently decoded. The initial phase of the encoding process concerns compressing I-frame structure (i.e. the start frame) without complying any reference links where it also act as initiator in case the video bit stream is found to have significant error. Once the initial frames get encoded it uses further reference frames for the ease of prediction. During the video encoding process when a new frame comes the old encoded frames are used to predict the motion sequence of the objects be inherent in the new frames. If the process finds repetition of non-moving object blocks in the next frame then it replaces the blocks with encoded block of data of preceding frame to avoid redundancy in the bit stream. In the intermediary process, P-frame acts as a reference frame in between I-frame and another P-frame sequence for implementing the encoding process subsequently. Although the encoding of I-frame takes significant number of storage units and transmission bandwidth, as it doesn’t impose referencing scheme but a proper encoded I-frame leads to produce number of encoded data/frames very efficiently without affecting the storage and bandwidth constraints. If a block contains movable objects which are entirely traceable in a video frame sequence, on the other hand, if the coordinate of a block entity is moved, then it can be further represented by initiating motion vectors. The motion vector only considers fewer bits of the encoded block to replace it with the repeated blocks rather using entire coded bits. Hence, in this way the encoder can save a significant amount of transmission bandwidth and storage space. In the case of P-frames, as it act as predictive inter frame and depends on the initial frames for the purpose of encoding of an image but these frames are claimed to be error prone for their explicit dependencies on others. Instead of having the flaws as mentioned above, P-frames follows particular advantage by considering very less number of bits during encoding process as compared to the I-frame. Another frame sequence namely B-frame can be witnessed more
likely during video coding. Unlike P-frames, B-frames formulate prediction results from referring both its initial and succeeding frames. While the P-frames only utilize the prediction results of its previous encoded frames. Although B-frames achieve takes very less amount of bits during encoding in comparison with the I-frame and P-frames, but it also produces errors during the encoding process. A P-frame is claimed to refer only its preceding I-frames and P-frame sequence while B-frames refer the prediction results of both preceding and succeeding I-frames and P-frames for the purpose of achieving better resolution of video at the receiver side. However, the next segment further highlights the existing video coding standards, and their potential features deliberately acted as a catalyst for the evolution of video coding standards over time.

2.1.3.2 Classification of Existing Video Coding Standards

- **Advance Video Coding (AVC):** AVC is one of the efficient video coding standards developed by the ISO/IEC MPEG and the ITU-T’s VCEG. The initiation of designing the AVC protocol was a joint effort in between the above-stated audio, video compression communities. However, the draft version of the joint implementation of AVC protocol completed in the year of 2003. The concept of H.264/MPEG-4 AVC video coding is based on blocks and motion compensation oriented where the idea initially developed by the joint partnership effort of ITU-T VCEG and ISO/IEC JTC1 MPEG community.

- **H.264 Video Coding Standard:** Another noticeable video coding standard is perhaps known as H.264 which plays a significant role in processing blue-ray videos considering Blu-ray disc. However, the extensive analysis of H.264 in the context of finding its major contribution in the past reveals the vast applicability on processing bulk streaming applications from online content sharing companies such as YouTube, iTunes Stores, Microsoft Silver light, etc. It is also claimed to be processed HDTV contents over terrestrial (ATSC, ISDB-T, DVB-T or DVB-T2) broadcasting, cable (i.e. DVB-C) and satellite communications (i.e. DVB-S and DVB-S2). The most recent H.264 standard is an extension evolved since 1997. It was a part of an ongoing project activity named as H.26L, perhaps initiated by JVT, an association formed to simplify the video coding processes by network adoption. This video coding standard significantly performs better than the ISO MPEG-4 Part 2, ITU-T Recommendation H.263 in terms of various catalyst factors such as compression,
network adoption/interoperability and error robustness. Due to the simplex design and implementation procedure along with platform independent features, it enhances the performance in lossy environments such as the internet or wireless networks.

- **Overview of H.265 Video Coding Standard:** The current research trends of video coding and compression on networking environments mostly inclined into the design standards of HEVC encoding standard which is also known as H.265. The substantial growth of conventional HEVC standard is found to significantly reduce the bit rate of a video sequence by almost 50% as compared to the AVC without affecting the video quality. The design goals of HEVC intended to achieve the following objectives with the purpose of evolving video coding standards to a greater possible extent.

  - The prime purpose of the HEVC is to process a video object by balancing the compression ratio and quality. Moreover, it mostly focuses on enhancing the video quality while assessing constant bit rate.

  - Standardization of compression features such as extensibility of processing 8/10 bit per colour in a less complex form leads to simplification of implementation process and enhances interoperability. However it also achieves significant video quality by imposing standardization of blocks with respect to 8-bit and 10 bit 4:2:0 compression ratios. H.265 only supports three different profiles to maintain the video quality such as Main, Main10, and Main Still Picture, which further leads to optimize the computational complexities during implementation scenario.

  - Another most significant characteristic of HEVC is transmitting video frames over the network by consuming less amount of bit rate. Which also have an impact on reducing the traffic over IPTV, satellite or cable networks by achieving higher quality transmitted frame. There exist two different levels in the design methodology of HEVC which includes Level-1 i.e. Main (1-3.1) and Level-2 i.e. High (4-6.2). The main profile of HEVC usually supports 8bit/colour while main10 can process 8 or 10 bit/colour. The application impact also reveals the fact that HEVC further extended with the unique levels 6, 6.1 and 6.2 for supporting the 8K resolution of UHD, high definition standard videos over transmission medium. The extensibility also minimizes the cost of transmission and achieves optimal trade-off by improving QOE of OTT services to match the requirements of standard broadcast delivery systems.
The further segment represents the relevant studies mostly focused on H.264 video compression protocol and extracts the substantial design issues associated with conventional H.264 in performing video compression. It also presents an in-depth investigational analysis to segregate the studies, had useful contribution in the past together with highlighting significant research gaps.

2.2 REVIEW OF LITERATURES

This section explicitly reviews the conventional studies pertaining to the utilization of H.265 video coding standard as per the objectives being stated in the prior Chapter-1. However, the primary goal of most digital video coding standards is to optimize coding efficiency by initiating the ability to minimize the bit rate necessary for representation of video content to reach a significant level of video quality. On the other hand video coding is perhaps formulated to maximize the video quality achievable within a given available bit rate. Hence, the exponential growth in video traffic over various networks in the past years has created tremendous opportunities and challenges for video technology developers to produce high performance video codec’s that can largely reduce the bandwidth of video streams while maintaining their integrity and quality. The most recent milestone in video codec development is the new MPEG-H/H.265 HEVC technique, which has just passed the stage of standardization approval in 2013, but has already been quickly distributed in the industry. Essentially all state-of-the-art video compression coding protocols, comprising HEVC as well as the currently controlling MPEG-4/H.264 AVC standard, can be summarized by a hybrid framework of motion-handling and picture-coding, with a Rate-Distortion Optimization (RDO) technique to minimize the distortion subjected to a constraint on Bit Rate (BR). The proposed research track has referred some of the significant studies during the evaluation of each and every phase. Therefore to support the first objective (Objective-1) of the proposed research work namely,

“To perform an in-depth investigational study on understanding various existing challenges of video compression and its significant impact on perceptual quality and traffic rate in mobile communication”.

A survey work has been carried out. However, few of the most recent research works for video compression and broadcasting, thereby discussed in this context. In order to accomplish the above stated objective of the study a prior investigational phase has been
carried out. This is achieved through publishing two survey papers. It mostly objectifies various related works specific towards H.265 video codec’s for performing effective compression during peak traffic conditions in mobile communications [31][32]. The following are the manuscripts referred during investigational phase of the study.

Wigand et al. [18] elaborated an overview as well as specific technical feature of H.264/AVC. It is also explained that the profiles along with the specific applications for the ISO standard, and the history of the regulation processes. It indicates the general type of video encoding and decoding method. In the circumstance of ITU-T as well as ISO/IEC the video coding is standardized, when only the central decoders are standardized, by commanding on bit stream and syntax. The decoding process of elements obeys the standard and produces the same type of output. This limitation of standards allows maximal freedom to implementation in appropriate applications by balancing the quality of an image, cost of the processes, time etc.

An investigational study has been initiated by Chen et al. [19]; furthermore it presented a decoder on the principle of H.265 utilizing equipment based design with supportability of the parallel processing to simplify the video compression process. However, the experimental outcomes of the study, obtained concerning decoding speed further reveals that it exhibits the current baselines by deciphering 8K UHD video frame within a shorter range of period.

Dias et al. [20] have presented a review by incorporating the concept of H.265 for improving the quantization with a help of rate distortion hypothesis. The implemented work has utilized spatial-based approach to improve the visual quality of the signal. The review further acknowledged with mean assessment score and multimedia quality.

The comparative course of work by embracing rate-contortion hypothesis has been executed by Nguyen and Marpe [21]. Here, the author thereby utilized the image as information to further perform dimension of data using H.265 protocol. The review result found that mean of bit rate utilizing JPEG is very high contrasted with other decompression method together with H.265 protocol.

Panayides et al. [22] have introduced a review of state of art literatures, further that also concerned relative examination of different existing video compression standard
protocols. However, the study also considers contextual analysis of medicinal video dataset by taking H.265 into consideration.

Trzcianowski [23] has demonstrated a similar kind of video coding methods and introduced a novel video coding technique for legacy protocol.

An extremely fascinating and interesting review was conducted by Ye et al. [49] where they have explicitly highlighted the utilization of UHD documents and its administration over the systems. To address this requirement for adaptability and flexibility, the H.264/AVC configuration covers a Video Coding Layer (VCL), which is intended to productively communicate to the video content, and a Network Abstraction Layer (NAL), which arranges the VCL interpretation of the video and gives header data in a way suitable for movement by an assortment of transport layers or capacity media (see Figure 2.3).

![Figure 2.3 Structure of proposed H.264/AVC video encoder](image)

Apart from highlighting the above context, the researchers also discuss that the use of H.265 can attain around 64% of the bit rate when experimented with top quality and standard definition videos.

He et al. [24] have introduced another estimate procedure for handling UHD contents where real attentiveness lies into limiting computational unpredictability relating to search techniques for ideal coefficients of resolutions. The approach was executed on equipment based approach over VLSI framework.
Ahn et al. [25] have talked about different improvement procedures utilizing H.265 with usage of parallel processing. Moreover, the researcher has likewise exhibited a task scheduling system together with slicing procedure in parallelization over multicores utilizing H.265. On the other hand the study of Blasi et al. [26] has exhibited a system for exploiting the many-sided quality identified with movement compensation.

Diaset et al. [27] have demonstrated a FPGA-based technique for performing video compression utilizing H.265 convention. It also utilizes a coordinated plan of productive computational process along with the process of 2D transforms.

Mu et al. [28] have exhibited a hybrid system for legacy protocols e.g. H.264/AVC and was subjected to H.265 encoding procedure to remove the encoding coefficients. The attention was laid on upgrading the speed of coding tree unit. Subsequently, there are different reviews that have been concentrated on utilizing video compression calculation. The procedures are related with favourable circumstances and also constraint. The phase-1 of the study has been carried out to support the (Objective-2) which is precisely stated as

“To design a framework of novel video compression scheme for evaluating peak traffic condition on mobile devices using H.265”

In the previous chapter, therefore, a framework for efficiently dealing with peak network traffic conditions while assessing video compression on demand has been introduced. The study also considers objectifying the design complexities and implementation flaws of existing compression standards for mobile communication. However, few of the significant studies are referred, which have explicitly addressed the issues of bandwidth optimization and on-demand video compression during peak traffic. Some of the existing studies are discussed below.

The study of Ponchet et al. [29] introduced a Video Compression Scheme (VCS) subjected to perform encoding in a lossy environment based on various source coding hypothesis. Moreover, the proposed model usually performs encoding considering the self-contained information to effectively encode the unusual frame entities and edges using turbo codes as well as different wavelet transformation.

A study of Sullivan et al. [30] represented the features of HEVC video coding standard and also highlighted its wide applicability into various fields such as bit depth enhancement, embedded bit stream scalability and 3D video enhancement etc. The study also
depicted the overview of HEVC first edition design specification from a theoretical perspective followed by different range extension and scalability extension. The architectural overview of the hybrid video encoder for HEVC is presented below.

![Figure2.4 Hybrid HEVC video encoder](image)

It also depicted the facts that how the standardization of extensions lead to the enhancement of the conventional HEVC and also broadens its applicability. As highlighted above in the Figure2.4, HEVC imposes a similar square based ‘hybrid’ approach for both intra-prediction coding and 2D variation coding. It is further integrated with design principles of video compression scheme H.261. However, the above Figure2.4 also shows the hybrid approach of HEVC encoding to make a sequence of multimedia frames as compact as possible to a certain possible extent.

The study also performed an in-depth analysis of H.264/MPEG-4 AVC standard from the core of its design features and specifications. It depicts the temporal motion vector prediction in 3D-HEVC video sequence followed by a descriptive analysis of Inter-view motion prediction, inter-view Residual Prediction and Illumination Compensation.

The study focuses on the advancement of residual prediction structure from all the technical aspects, collaboratively with both the ITU-T VCEG and ISO/IEC MPEG associations. Further, HEVC validates an amount of improvements in video coding technologies. Its video coding layer design is based on conservative block-based motion compensated hybrid video coding perceptions, however with several important differences
comparative to prior standards. Much of the technological advancements presented in the 
manuscript were considered for further extension of HEVC standard.

In the study of Parker and Tummala [31] an integrated framework of H.263 
comprising a Traffic model has been introduced. As heavy VBR traffic led to a scenario, 
where maintaining QoS as well as efficient utilization of network resources become highly 
challenging. Thus, the study aimed to achieve very low bit rate video traffic on tactical video 
processing applications. It thereby, introduced a traffic model for H.263 which uses multi-
state Markov chain to accurately capture the behaviour of videoconference traces. The study 
also incorporates a statistical multiplexing in the VBR model which ensures effective 
utilization of bandwidth during peak-traffic conditions. The following Figure 2.5 shows the 
Markov chain model for accessing VBR video frame sequence.

![Markov Chain Model for VBR Video Sequence](image)

**Figure 2.5 Markov Chain Model for VBR Video Sequence**

The highlighted figure depicts that the video sequence is uniformly quantized into 
eight bit rates or bins, which then further vary from one frame to another frame. The process 
is assumed to have a memory less transition where the proposed model is subject to give rise 
to discrete time sequence oriented Markov model as depicted in the above Figure 2.5. Here, 
$\Delta i$ denotes the arrival rate of cells at a particular state of $i$. Further the Markov chain also 
simplifies the process by modulating the underlying Poisson procedure.

A review was demonstrated by Borsos [32] on which video traffic had well-
separable time balances. Based on the outcomes obtained by the review another model got 
in introduced, which is capable of catching the real properties of VBR video.

The study was addresses by Motta and Carpentieri [33] on addressing various 
problems of determining an input video sequence. Finding the minimal number of the frames 
as well as the correct places of the edges is very essential in order to achieve predetermined 
bit rate. However, the study introduced an algorithmic approach which uses dynamic 
programming in the low bandwidth applications. The algorithm initiates some look-ahead
capability to optimize the encoding complexity. The asymptotic analysis on the performance of the proposed algorithm reveals that the time complexity is claimed to be linear with respect to the number of frames being encoded. The proposed framework poses its ease of applicability into several existing video coders along with rate-distortion optimized macro-block layer rate controls.

The review was conducted by Khan and Ansari [34] on the Performance comparison of H.263 video coder with its advanced version H.264 video coder. The performance of H.263 and H.264 are evaluated and analysed for various advanced options such as Syntax Based Arithmetic Coding(SBAC), Deblocking Filter, Advanced Prediction Mode (APM), Unrestricted Motion Vector Mode(UMVM), Rate control etc. for H.263 video coder and Integer transform, Context Adaptive Binary Arithmetic Coding(CABAC), advance deblocking filter etc.

A paper was presented by Carrillo et al. [35] where the authors introduced concept of a density algorithm and its autonomous solution which enable privacy protection in video surveillance applications. The author also presented an approach utilizes permutation-based encryption in the pixel area to hide identity informative features.

The review discussed by Soyak et al. [36] on the different advancements shows that the combination of different video coding standards exclusively can be utilised to execute iTRAC framework. Individually, the proposed framework has been witnessed to achieve a high end compression of video frames along with saving the required bit rate up to 75% during the transmission scenario. The model also observes the movement of objects in a video sequence very precisely which is more or less equivalent to standard quality being video sequence when processed by robotized operations. In real time applications enabling robotized operations to some extent reduce the bit rates required by frameworks utilizing iTRAC. It could also be conveyed over existing 3G or WiMAX remote connections, permitting universal scope at affordable cost of implementation.

Biswa [37] presented a framework aiming to test H.264 video stream transmission over network. The work carried out considering different simulation set ups by the means of estimating delay and loss of video frames through NS-2. The framework currently supports H.264/AVC video streaming applications; however it may be simply extended to address another video codec(s). A PSNR based quality measurement has been introduced which was
convenient for shorter, as well as longer video sequences. It was successfully tested with Windows and Linux.

A closer look into the survey work of Cheung et al. [38] gives an insight into the study which reveals that it proposed a video compression algorithm with uncertainty on decoder predictor for the purpose of tackling the viewpoint switching problem in MVC. However, the proposed encoding algorithm also integrates macro block mode and significance coding in the Distributed Source Coding (DSC) framework to improve coding efficiency. They demonstrated the proposed algorithm can achieve better coding performance as compared with other methods based on intra coding or Closed Loop Prediction (CLP).

Farrugia et al. [39] presented a novel solution which improves the error detection and localization abilities of standard decoders through the submission of a Probabilistic Neural Network (PNN). The proposed solution outperforms additional error detection mechanisms present in this paper, as it controls to improve the usual decoder’s error detection rate by up to 95.74%. The phase-2 of the study has been carried out to support the (Objective-3) which is precisely stated as

“To adopt graph theory for to perform video compression compatible for HEVC standards to compress HD videos”.

Suring the evaluation of phase 2 a novel graph based technique for the purpose of enhancing HEVC video compression algorithm. The proposed model thereby adopts the concept of graph theory along with Lagrangian theorem. The experimental outcomes reveal the effectiveness of the proposed algorithm by comparing it with existing research works pertaining H.264. It also shows how the proposed system excels the performance of the video compression by achieving significant and acceptable PSNR range as well as minimum bit rate required for video processing. It also accesses HD videos by maintaining its superior quality. Some of the studies referred during the progress of phase 2 development are discussed below.

Hung et al. [40] presented a technique to perform interpolation for the purpose of accomplishing better video compression. The authors have used a bilateral filter to accomplish the task using maximising a posterior estimation. The study has considered the case study of performing compression on HDTV system using standard transcoding.
Kim et al. [41] carried out the study in minimizing the size of the video using H.264/AVC standards. The authors aimed to accomplish minimal complexity while performing compression. The study has also adopted the use of standard motion vectors as well as reference frames for enhancing the rate-distortion performance. Study of division of macro-blocks was carried out by Geng et al. [60].

![Image of the Proposed Framework](image)

**Figure 2.6 Overview of the Proposed Framework**

As appeared in Figure 2.6, FP-BGT comprises of the accompanying modules: the Background Modelling module that is utilized to create the foundation outline, the MB Classification module that groups MBs into BMs, FMs and FBMss, the Candidate References Frame Selection module that goes for reducing the quantity of reference coverings, the Motion Search Range Calculation module that is utilized to decrease movement seek extension, and the Candidate Mode Selection module that refines the mode choice method. The author segmented the initial macro-block into multiple sub-macro-blocks. The outcomes of the study were found to possess efficient compression scheme.

Wallendael et al. [43] adopted a transcoding mechanism as a tool to perform compression. The outcome of the study was efficient removal of residuals and effective control video stream regulations.

Further the study of Zhang et al. [44] applied HEVC as well as AVC scheme to testify their outcomes. Study in the similar direction was carried out by Cantos et al. [45], where the authors considered compression standards of H.264/AVC for addressing scalability issues in HD videos. Hence, it can be seen that there are various studies performed to carry out video compression, where each study has its benefits and limitations.
In this study a novel technique that can offer high end compression of multimedia files has been introduced. The technique also claimed to achieve cost effectiveness by reducing the computational complexities associated with the compression pipeline.

The study introduced a concept where to find the specific region of a video frame containing several blocks; a search area is defined in the reference frame structure. The search area is further placed in the middle of MB block position with the purpose of eliminating the temporal redundancy. The proposed method further computes the most appropriate match initiated within the objects projected in between the MB and sub-MBs considering the motion vectors to reduce the search area. The following Figure 2.7 depicts the proposed reduced search area of the study.

![Figure 2.7 Frameworks for Reduce Search Area.](image)

The proposed theory also utilizes the MVs computed by simulating H.264/AVC to genuinely compute the MVs of SVC search area. The outcomes of the study depicts that the concept has been adopted to enhance the performance scenario of H.265 video compression standard in maintaining the quality of higher resolution videos.

Panayides et al. [46] have introduced a review where the main focus laid on investigation of different existing flagging conventions for H.265 taking the contextual investigation of medicinal video dataset. On the other hand the study of Trzcionowski et al. [23] has additionally exhibited a review that has focussed on video coding for legacy convention, e.g. AVC.

He et al. [24] have introduced another procedure for guaranteeing handling of UHD documents with an essential concentrate lies on minimizing computational intricacy of the
proposed method for ideal coefficients of resolutions. However, the technique was actualized on the top of equipment based approach over VLSI technology.

Ahn et al. [25] have examined different advancement procedures utilizing H.265 with a guide of parallel handling. In addition, the creators have additionally exhibited a task scheduling technique along with a compression procedure in parallelization over multicores utilizing H.265. Blasi et al. [26] have demonstrated a system for limiting the unpredictability identified with movement. The work introduced by Dias et al. [20] have displayed a Field Programmable Gate Array (FPGA)-based concept for performing compression utilizing H.265 protocol, which is further embedded with the H.265 panel to achieve effective computational process alongside 2D changes. Mul et al. [47] have introduced a fell strategy for legacy protocols, e.g. H.264/AVC and was subjected to H.265 encoding process to extricate the encoding coefficients where the prime emphasis was laid on upgrading the speed of coding tree unit. The phase-3 of the study precisely emphasize on supporting the (Objective-4) which talks about

"To introduce a framework for retention of 8K resolution while performing video compression using H.265 encoder using JPEG2000 standard and transform formulations over wireless channel".

In order to accomplish the research aim design of a Multilevel Optimization based Video Coding using H.265 for the purpose of enhancing resolution as well as performing high end compression has been carried out in phase-3 [48]. A thorough investigation carried out on the conventional studies pertaining multimedia/video compression by H.265 in this context. Few of the significant studies referred in [48] are discussed below.

This area talks about the current research work being completed utilizing H.265 video coding standard. The study of Chen et al. [49] has presented a decoder by H.265 utilizing an equipment based design with supportability of the parallel processing. The experimental outcomes obtained by the review assessed on translating speed demonstrates that the proposed strategic operations takes very less amount of encoding time during the interpretation of pixel entities of 8K UHD. Hence, it also doesn’t affect the quality of the video sequence while performing encoding.

Dias et al. [20] have exhibited a review by combining H.265 convention with the conventional frameworks for improving the quantization with the help of rate
dismemberment hypothesis. The hypothesis considers utilizing spatial based answer to improve the visual perception of a video. The review has been affirmed with a considerable impact factor for extensive analysis of conventional studies and achieving significant visual quality of HD videos.

A comparative study of work by improvising rate-contortion hypothesis has been actualized by Nguyen and Marpe [21]. The creators have utilized the picture as information to be stacked for utilizing it into H.265 convention. The review results obtained from the study shows that, mean of bit rate utilizing JPEG is very high contrasted with other pressure system along with H.265.

The focus of the final objective (Objective-5) was laid on designing an efficient framework for the purpose of increasing quality of video frames for supporting 8K (UHD) resolution. It is stated in the prior chapter as follows.

"To increase the perceptual quality of video frames for supporting 8K (UHD) resolution"

In order to accomplish the goal of the final objective development of “An Efficient and Robust High Efficiency Video Coding Framework to Enhance Perceptual Quality of Real-Time Video Frames” has been carried out in phase-4 of the study [50]. This segment of the study discusses few of the literatures referred during the evaluation process of phase-4. An explicit review was carried out by Ye et al. [50] which have mostly explored about the use of UHD records and its administration over the systems. The author of the study further investigated the facts relies on the significant usage of H.265 on online multimedia video streaming and compression. The study also exploits the design issues associated with H.265 and shows that the proposed integrated H.265 achieves 64% of the bitrate along superior quality in standard definition videos.

He et al. [24] have exhibited another approach subjected to preparing of UHD documents with a noteworthy concentrate on limiting computational complexities along with achieving higher quality data with ideal coefficients of resolutions. The system was designed based on a set up and simulation environment over VLSI design. Diaset al. [27] have introduced a FPGA-based study for performing efficient video compression using H.265 convention on a video frame with the ease of achieving proficient computational performance on Video on Demand (VoD) applications. It also exhibited a procedure for legacy conventions e.g. H.264/AVC and was subjected to enhance H.265 encoding
procedure by removing multimedia coefficients. The next section discusses about the research gap extracted after reviewing the conventional studies.

2.2.1 Research Gap

This section concerns about highlighting the current research issues of implementing H.265 to a large extent by exploring the above studies.

- Standardization of HEVC Protocol: The current research scenario in the field of video compression witnesses no standard protocol implementation till date. It also does not find any potential studies towards implementing or advancing the most recently introduced HEVC (2013) by the means of cost effectiveness.

- Less Implementation of Computational Frameworks: Most of the conventional studies are found to implement the HEVC encoders on VLSI hardware components. Thus, it claimed to achieve only 50% of better compression in comparison with H.264 in VoD applications. However, no computational framework designs exist till date which can evaluate HEVC video coding efficiently regardless of any implementation complexities.

- No Evidence found in HEVC implementation on Wireless Networks: The in-depth analysis of the conventional studies found very less adoption of HEVC protocol on wireless networking platforms for processing of online video coding for real time high definition (UHD) video frames. There exist very few studies which consider balancing the dynamic network traffic while performing on-demand compression in wireless networks. Although the dynamicity of network load poses a significant impact on performance of the video compression while maintaining the quality.

- Less emphasized laid on retention of 8K UHD Videos: A closer look into the above mentioned studies reveals the fact that during online compression there is need of retention of 8K UHD data quality along with very less downloading time, while assessing the video stream on 3G network. At present no such state of art literatures got evidenced to provide such services.

2.3 CONCLUSION

The current scenario on processing online videos shows that there is a need of compression to process large quantity of video material distributed over broadcast channel
with the ease of minimum bandwidth utilization. However, this chapter carries out an explicit study of the conventional video coding standards, i.e. mostly the features of H.265 along with presenting the existing state of art studies. It also reviews the existing standards of video compression and point out substantial flaws which is further highlighted in the above section 2.2.1. The next chapter aims to discuss about the (Phase-1) where the implementation scenario of the first video coding model has been discussed.