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DCT BASED AN EFFICIENT VIDEO COMPRESSION TECHNIQUE FOR ENDOSCOPIC IMAGE ANALYSIS

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Abstract- As the use of medical imaging in clinical practice grows, so does the magnitude of data volumes generated by various medical imaging modalities, necessitating data compression for the sharing, storage, and management of digital medical image datasets in cloud-based health centers. Several image compression standards have been proposed by international organizations over the last few decades. Our findings demonstrate the significance of compression factors in the medical field, as well as the need for compression in the domains of medical datasets and their complexity. As a result, we present a DCT-based compression technique for medical video. The results show that DCT outperformed H.264 in terms of PSNR and bit rate.

Keywords: PSNR, DCT, HEVC, Endoscopy Video, Bit Rate.

1 INTRODUCTION

In today's globalized world, images and videos are among the most important kinds of knowledge and contain critical information in the field of medical sciences, particularly in diagnosis. There are several obstacles in cloud-based health services for storing and transferring the vast volume of medical data generated by various imaging modalities. There are many distinct types of images that are based on certain physical principles and transmit various information on the structure, morphological traits, and functioning of the human body. Medical imaging is a fast growing area, with new imaging modalities constantly appearing and old modalities being developed and expanded. Medical imaging is a rapidly evolving field, with new imaging modalities emerging on a regular basis and established modalities being refined and expanded. Endoscopy is a straightforward diagnostic technique that allows the doctor to examine the lining and walls of the whole gastrointestinal tract (GI), from the oesophagus and stomach to the intestines and rectum. An endoscope is a thin, flexible tube that is put into the neck or rectum and directed into the body to examine the lining of the digestive tract. An endoscopic procedure contains a camera at the tip that allows our gastrointestinal specialist to inspect the lining for lesions, bleeding, and other issues. Endoscopic electronic medical records systems (EEMRs) are

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increasingly being used in endoscopy centres. In addition to endoscopic report production, modern EEMRs include practise management tools, picture and video clip management, inventory management, e-faxes to making reference to doctors and database support to assess the quality and patient report. From classic endoscopy to capsule-based endoscopy, each generates a massive quantity of data that must be saved for technical reference. Videos of medical endoscopy need a lot of storage space. The first and foremost reason, the films are saved just as they were captured during the intervention, with no alteration. This implies that the videos share a lot of information and have no shoot limits. Because of two factors, endoscopic video frequently contains a high number of blurred and noisy frames. For starters, because the endoscope lens has a high zoom factor, the endoscopist moves the endoscope with his hands, resulting in shaky images and motion blur. Furthermore, the area that is now out of focus cannot be viewed well due to the endoscope's camera's limited and fixed focus. The second reason is that there are several frames that include noise from flushing fluids, draining blood, or draining tissue that has been sliced by the endoscopist. Given the breadth and variety of medical imaging methods, a wholeness of all clinical imaging procedures is not possible in this section. Lossless or near-lossless compression is desirable for telemedicine or storing vast amounts of data; the bigger the data volume, the better the acquisition (ranging from 1 Tesla to 7 Tesla). As a result, as indicated in Table 1, The bound of our research focus on the most commonly used medical imaging technologies in clinical practise and their overall data compression characteristics. In general, when a doctor performs 4 sets of PET-CT medical images for a single patient, the typical requirement of storage space will be 4+ GB. When a High Definition video is recorded for duration of 1 hour, it typically requires 500 GB of storage space. Now to reduce the storage space the only alternative left is compression. Now the only solution left for the aforementioned difficulty is the picture and video compression, which makes them more feasible for storage and communication. Endoscopic video is compressed using HEVC/H.265 encoding in this study. The evaluation of quality is based on an objective examination of parameters such as PSNR and bit rate, among others. This paper also reported on the HEVC scheme and its performance with inter prediction. There is a chance of redundancy in the case of photographs and videos. The duplicate information is eliminated to maximise the usage of infrastructure for cloud-based health care. The three most frequent kinds of redundancy are geographical redundancy, temporal redundancy, and spectral redundancy. Spatial redundancy is commonly utilised to remove redundant data among surrounding pixels. When the value of a pixel is the same, temporal redundancy is used to reduce the number of bits in the image. Images are represented by distinct colour pixel correlation in spectral redundancy.

Generally, the two wide area of the compression technique is: (1) Lossy, and (2) Lossless [01]. The reconstructed picture with lossy compression technique is that the constructed image is duplicate copy of the original. The lossy compression method is employed for general-purpose photos when a small amount of information loss is acceptable [03]. The original picture is rebuilt without any information loss in lossless compression. In some fields, including health, the military, and business, any loss of knowledge is unacceptable. In the case of medical diagnostics, any loss of information might result in an inaccurate diagnosis, which can be compromised. [2][3][4].

Type of Diagnosis	Investigation	Bits depth	Storage requirement
Radiology images	Chest	10 to 16	10 MB
CT Scan	Abdomen	12 to 16	250 MB
	Brain	12 to16	150 MB
	Heart	12 to 16	1 GB
DBT	Breast	10 to 16	0.4 GB
Magnetic resonance imaging	Abdomen	12 to 16	50 MB
	Brain	12 to 16	100 MB
	Heart	12 to 16	250 MB
Ultrasound	Heart	24 color	38 MB/s
Positron Emission Tomography	Brain	256, 256, 50	6 MB
	Heart	16	1 MB
Digital Pathology	Cells	24 color	2.5 GB
PET-CT	Brain	256, 256, 50	4+ GB
Endoscopy	Abdomen	24 bit (color)	2+ GB

Table 1: A general medical dataset and file size before compression.

From the literature surveys many research finding suggest it is safe to use of lossy compression in medical imaging but many health care professional and health care centres recommends the use of lossless compression in medical practice. As the area of work research findings, we can compress medical datasets using DCT based compression technique while considering PSNR and bit rate as compression parameters in case of endoscopy video.

2 RELATED WORKS

As the medical data is production rate increases the need for the storage space is direct proportional. So compression is required for the distribution, storage, and administration of digital medical image data sets. As a result, data compression is becoming increasingly important in Cloud-Based Health Centres, Telemedicine, DICOM, and PACS (Picture Archiving and Communication System) memory. As a result, lowering picture size while keeping diagnostic information has become necessary. In this sense, medical picture compression is a technique that suggests lossy and lossless compression techniques to reduce both transmission and storage costs. Let us now look at the numerous compression strategies created and studied by various researchers in this area.

S. Ponlatha et al [2013] has noted the growth in medical imaging technologies have a significant increase in data size. The massive amount of medical information generated by various medical imaging techniques such as positron emission tomography, magnetic resonance imaging, computed tomography (CT), and single-photon emission tomography requires a huge amount of storage space.

This leads for the use of compression as key factor in medical imaging, not only reducing the transmission time of huge volume medical dataset for example high-resolution 3D-CT datasets, but also lowering data storage costs.
Digital Imaging and Communication (DICOM) in medical image compression standards still use image codecs that don't employ inter-frame redundancies which is generally used in video compression algorithms. DICOM working group-4 compression a new compression JPEG2000 which is the extension of JPEG to overcome the shortcoming. If the bit rate is focused then there is the need for compression technique which reduce the storage space requirements and maintain the quality of the video. Here JPEG2000 uses an enhanced quantization matrix called GQM by applying genetic programming. The matrix is created as a feature-based matrix, with quantization varying depending on the input block. The compression here is primarily determined by the application. As a result, the requirement may be specified as the fitness function. The main focus, as in the medical application, is on visual perception [1]

A new era of diagnosis has emerged known as video-based remote diagnosis and telemedicine application, which is based on video codec to increase transmission for massive datasets. By utilising the 3D CT datasets, the performance of JPEG, JPEG2000, and JPEG-LS still-image codecs, as well as H264, H265, Lagarith, MSU, and MLC lossless video codecs, is compared. This demonstrates that video codec performance evaluation improves JPEG and JPEG2000 compression ratios while remaining competitive with JPEG-LS. The findings point to a promising application of video codecs for lossless compression of large volumetric medical images, such as computed tomography datasets. To improve the compression and transmission of such massive multidimensional picture collections, it may improve the development of video-based telemedicine and video-based remote diagnostics [7].

Yao-Jen Chang et al. [2017] has proposed many lossless compression techniques. A generalised Intra block copy (GIBC) is used to predict the coding unit from reference block and the samples of which can be partially rebuilt. HEVC-based medical video coder (HMC) which include the the GIBC, line-coded palette coding, and Intra palette predictor without mutual conflicts based on palette coding feature distribution studies.

N. Senthilkumaran et al. [2011] present an improved backpropagation neural network technique. The existing Huffman code is now proved to be less effective compared to that of improved Backpropagation Neural Network Technique for lossless image compression with X-Ray images by considering the compression parameters such as compression ratio, transmission time, and compression performance[2].

Moustafa M. Nasralla et al. [2018] proves the H.264 has a successor as HEVC when compared in term of the performance, in the area of medical dataset. The three modes are used sfrom the JCT-VC team, namely random access, low delay, and intra configurations. The HEVC is designed as resemble to H.264 standards in order to conduct a fair comparison. In field of entertainment encoded movies from both the HEVC and H.264 standards are sent across simulated 4G networks to investigate their impact on system resource utilisation in terms of user authentication, message, data secrecy, and compression.

S P Raja et al [2019] addressed the requirement for multimedia compression and authorization since multimedia data requires a large amount of storage space. Data compression is critical in multimedia to minimise data size. The advantages of compression strategies are generally consistent, delivering benefits to enterprises working with meta size data on the cloud. The primary purpose of DICOM is to create a new framework that is suitable for encoding methods and includes multiscale transformations. Now, security is built in by combining public key cryptography with cooperative medical picture compression on the cloud.

The HEVC standard, which is used in telemedicine, can help reduce the bitrate required for coding medical footage while also improving compression efficiency and transmission performance over communication channels. According to the test outcomes, the HEVC standard reduces network bandwidth, potentially resulting in bitrate savings of 40-65 percent when compared to the compression efficiency of H.264. The second phase involves calculating a new motion complexity (MC) to determine the complexity of the motion content in a video frame so that a perceptual bit allocation for medical video compression can be proposed. H.264 is a compression standard for medical video and 3-D medical datasets.

Mohamed Uvaze Ahamed Ayoobkhan et al [2018] discovered that, with the production of a large number of medical photos, an effective compression approach that can deal with storage and transmission concerns is required. Another issue that must be addressed in medical imaging is ensuring that compression does not degrade picture and video quality. As a result, a predictive image coding method is suggested that retains the quality of the medical picture. The predictive image coding method preserves the diagnostically important region (DIR) during compression, which recovers the quality of the medical image. Using the graph-based segmentation approach, the picture is separated into two parts: one DIR and one non-DIR. Two feed-forward neural networks (FF-NNs) are employed to accomplish the prediction process, one for compression and one for decompression [11].

Thomas M. Deserno et al.[201l] investigate Kilobyte to Terabyte problems in i) management of the medical images and image data mining, ii) bio imaging, iii) virtual reality in medical visualizations, and IV neuroimaging. On the basis of graphics processing units, scalable algorithms and improved parallelization approaches have been developed. In their article, they summarized the solutions for currently addressing the Kilo to Terabyte problem, the Petabyte level is quickly approaching. While such solutions are currently dealing with the Kilo to Terabyte problem, the Petabyte level is rapidly approaching. As a result, medical image processing remains an important area of study. Now, the emphasis is on delivering telemedicine, which may be a suitable option for bridging the gap between a patient in a distant place and a medical practitioner anywhere in the globe. Telemedicine requires the medical picture to be sent over the network, which necessitates extensive storage and a significant rise in network traffic during transmission. As a result, compression has become a fundamental need for medical pictures for storage and transmission.

S Juliet et al. [2015] offer a unique medical image reduction method based on sparse representation that takes use of picture structure's geometrical regularity. The variation of the grey level on the regular basis is shown by the geometric flow. The wavelet decomposition of geometrically regularized data yields fewer significant coefficients. The goal is to compress medical pictures and find an appropriate solution for storage and transfer, to retain the information contained in the image, and to be free of during image processing. Several criteria are employed to do this, including maximum absolute error (MAE), universal image quality (UIQ), and PSNR[16].

N. Senthilkumaran et al[2011] has demonstrate that the image compression is a procedure that reduces the size of a picture file without reducing the image's quality to an unacceptable level. It also reduces the time it takes to deliver photos over the internet or download them from websites. This study presents an improved Back propagation Neural Network Technique for lossless image compression. For lossless picture compression, this research presents an improved Backpropagation Neural Network Technique. The system also shows that this technique outperforms the current Huffman Coding Technique for lossless image compression using X-Ray images and three metrics: compression ratio, transmission time, and compression performance. Table 1 summarises several compression techniques used in medical data.

No	Area of work	Algorithm/ Concepts	Remarks
1	CT Dataset comparison of Lossless Video and image [18].	H.265,H.264,Lagarith, MSU	Video codecs outperform JPEG and JPEG2000 in terms of compression ratio.
2	Innovative compression method for lossless HEVC for medical Videos [27].	The HEVC-based medical coder (HMC) combines GIBC.	Up to 13.9% and 22.3% bits for medical videos using GIBC and HMC respectively.
3	X-ray image compressed by applying the concepts of the Neural network [2].	The Markov model for compression with Feed Forward neural network.	Gravitational search provide higher PSNR values compared to Particle Swarm.
4	Medical Video compression [12].	H.264 algorithm	Gain in PSNR value up to 0.19 dB and improved video quality by using control rate scheme.
5	Medical imaging [16].	Sparse representation method that takes advantage of picture geometrical behavior patterns.	In terms of compression ratio, the proposed method outperforms DCT by 9.63%, HARR wavelet by 9.34%, contourlet by 5.14%, and JPEG by 15.41.
6	X-ray image compression [2].	Artificial Neural Network- Back Propagation neural network	Comparison of Huffman with Back Propagation. Back Propagation performs better than Huffman in

			compression ratio, transmission time and compression performance.
7	Medical image compression [28].	3-D-MRP is based on the minimum rate predictors principle (MRPs)	With an increase in more than 15% and 12% for 8 and 16-bit-depth contents respectively.
8	Medical image compression [9].	Focusing on compression using EZW, SPIHT, WDR and ASWDR	High PSNR and Low MSE values are achieved with multiscale transformations, SPIHT and ASWDR.

Table 1 Overview of various compression technique used in the of medical data set.

According to the various literature survey, it is been observed that there is the great shift in the development, use, storage, and sharing of medical dataset. From traditional storage to healthcare data digitization, the healthcare industry has come a long way in refining its data management processes. As the period of medical video application has begun, numerous compression strategies have been offered over the High-Efficiency Video Coding to actualize the medical movies, proposed several lossless compression approaches. As there is a need for greater work in the medical dataset, particularly in video compression, our suggested study focuses on the compression of endoscopic videos.

3 IMPLEMENTATION FOR DCT BASED AN EFFICIENT VIDEO COMPRESSION TECHNIQUE FOR ENDOSCOPIC IMAGE ANALYSIS

Medical endoscopic videos are utilized for research and to verify the various compression settings [17]. In the Digital Imagining and Communication in Medicine is standard which enable numerous medical applications and modalities to communicate [18]. PSNR and Bit rate is used as the two parameters for evaluating the coding performance of a video coding standard. Using HEVC intra coding [20],[21],[22],[23], which has a higher computational cost[24]. HEVC is a standard capable of outperforming older standards such as H.264 [25], So our proposed work uses the same frame work of HEVC with DCT based implementation.

In the context of implementation, the proposed work shows the efficiency, as the platform chosen for the implementation is the MATLAB, so the compression parameters such as PSNR and bit rate are compared with other techniques. AVI is the video format, and it is a raw video sample used for implementation purpose. The general working principle for the compression is codec. The working principle is that the redundant values are eliminated by specifying the color name and number of pixels for all pixels that are of same color. As a result, one pixel could represent hundreds or thousands of pixels. The image is formed and represented using the mathematical inverse transform function. Compression techniques can be evaluated in a variety of ways. We can evaluate the method's relative complexity, the amount of memory required to implement it, the speed with which the process runs on a specific system, the degree of compression, and how closely the reconstruction resembles the original. The method of encoding plays a vital role in the compression by keeping the bit rate at the lowest and maintaining the quality [19].

The terminologies used in the DCT based compression techniques are as follows: Compression Ratio (CR): The ratio of the input image and the constructed images.

$$CR=\frac{\text{Uncompressed}_{\text{image}}(\text{Bytes})}{\text{Compressed}_{\text{image}}(\text{Bytes})} \quad \ldots\ldots\ldots\ldots (1)$$

Mean Square Error (MSE) is the difference between the input image and the reconstructed image [5][6].

$$MSE=\frac{1}{axb}\sum_{i=1}^{a}\sum_{j=1}^{b} f((x,y)-g(x,y))^2 \ldots\ldots(2)$$

a and b is the size of the image, f(x,y) is the original input images and g(x,y) is the reconstructed image. When the image is degraded during the compression, this type of degeneration is highly observed by the human eye, when its MSE is low [20]. Generally, the researcher uses PSNR that is based on MSE [21].

$$PSNR = 10\log_{10}\left[\frac{\frac{1}{axb}\sum_{i=1}^{a}\sum_{j=1}^{b}(f(x,y))^2}{\frac{1}{axb}\sum_{i=1}^{a}\sum_{j=1}^{b}(f(x,y)-g(x,y))^2}\right] \ldots\ldots (3)$$

On video compression standards, the International Telecommunication Union (ITU-T) and the Moving Picture Experts Group (MPEG) collaborate. Methods and standards for video compression are used in applications such as video conferencing, video streaming, mobile TV, digital television, and DVD-Video. The video codec process consists of two steps: encoding and decoding. The sender encodes the video that will be broadcast, compressing it. The process of converting encoded data to original data before displaying it is known as decoding. In our experiment, compression is accomplished through DCT based encoding. The DCT creates a prediction model from one or more previously encoded video frames. The model is created by shifting samples in the reference frame(s).

Bitrate is a measurement of the amount of data used to encode a single frame of video in term of time seconds; thus, bitrate measurements always relate to seconds, such as megabits per second (mbps), kilobits per second (kbps), and so on. For our proposed work the result is measured in bit rate as one of the parameter in term of Mbps.

Figure 1 shows how video coding works by reducing as much duplication as feasible using intra and inter prediction. While our proposed approach, which uses data from the following frame, yields predicted results. Where are inter prediction makes use of redundancies among previously decoded frames and contributes greatly to the compression algorithm's low bitrate [26].

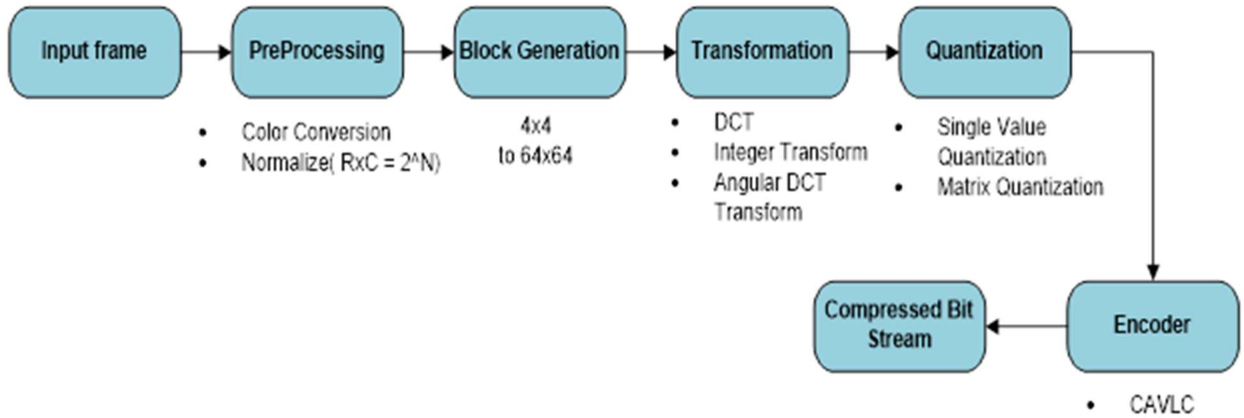


Figure 1. The Block Diagram for encoding process.

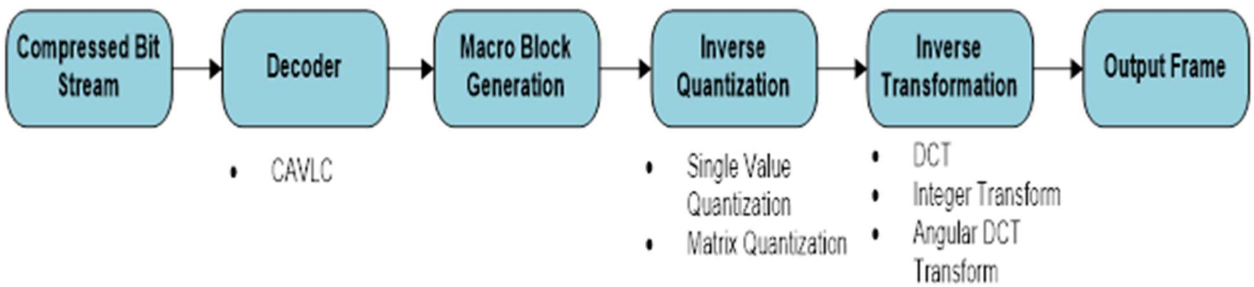


Figure 2. The Block Diagram for decoding process.

Algorithm for DCT Based an Efficient Video Compression Technique for Endoscopic video

Step1) Splitting video into frames
Step 2) Convert the frame Ycrb to Gray scale
Step 3) Creating the macro block of 4x4 to 16x16 from luma frames.
Step 4) Encoding of Macro block,
    Select first Marco block
    Apply the DCT Transition
Step 5) Perform the quantization.
Step 6) Apply the CABAC entropy
Step 7) Store the bit stream in NAL format
Step 8) Repeat 4 to 8 till all the Macro Blocks are completed.
Step 9) Measure the performance parameter (Bit Rate and PSNR)
End

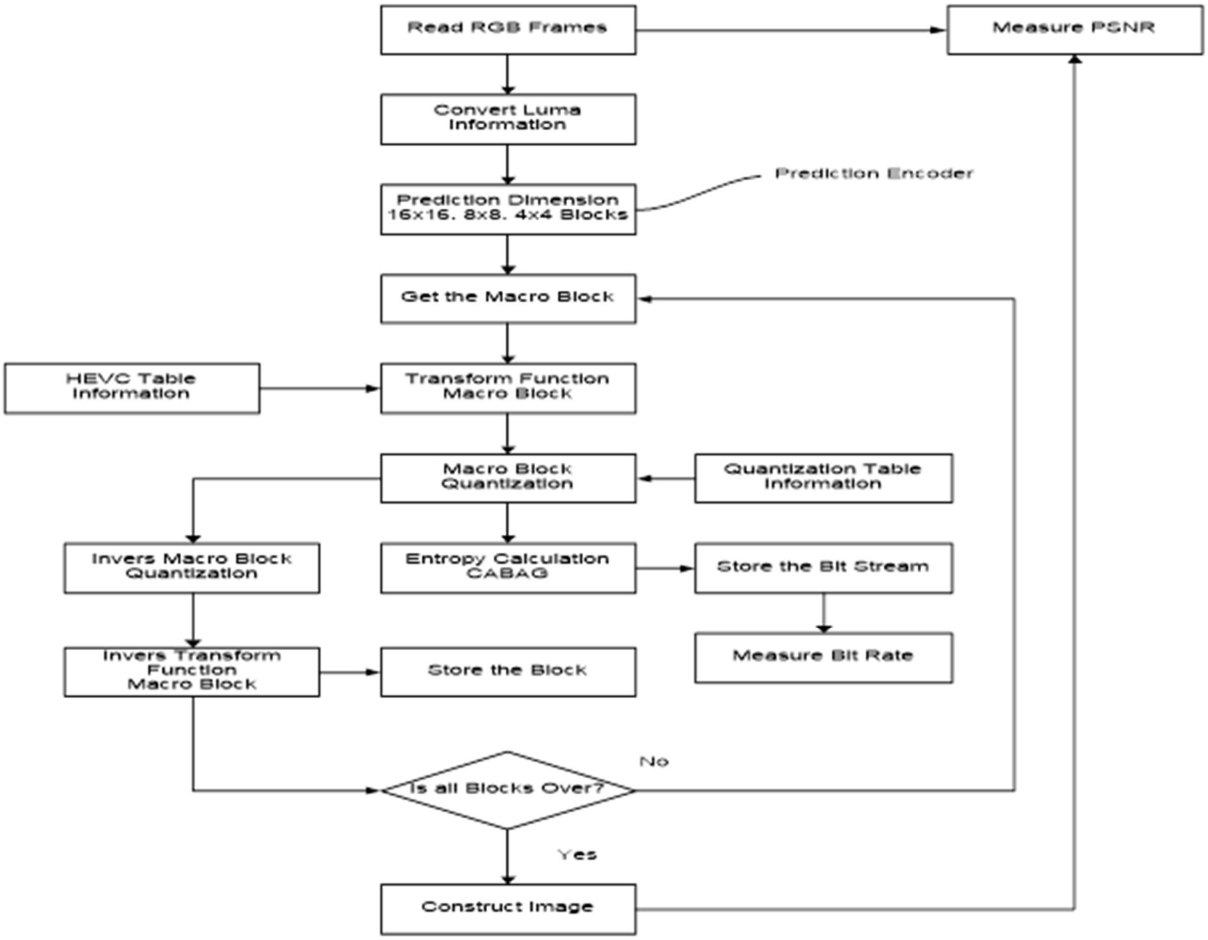


Figure 3: Flowchart of DCT Based an Efficient Video Compression Technique.

4 RESULTS AND DISCUSSION

For the implementation of the DCT based compression technique five samples of endoscopic videos are considered, with two pictorial outputs are shown as frames 1 and 2. Parameters such as PSNR and bit rate are taken into account in our implementation work. The experiment is implemented in MATLAB, the experimental results demonstrated its effectiveness.

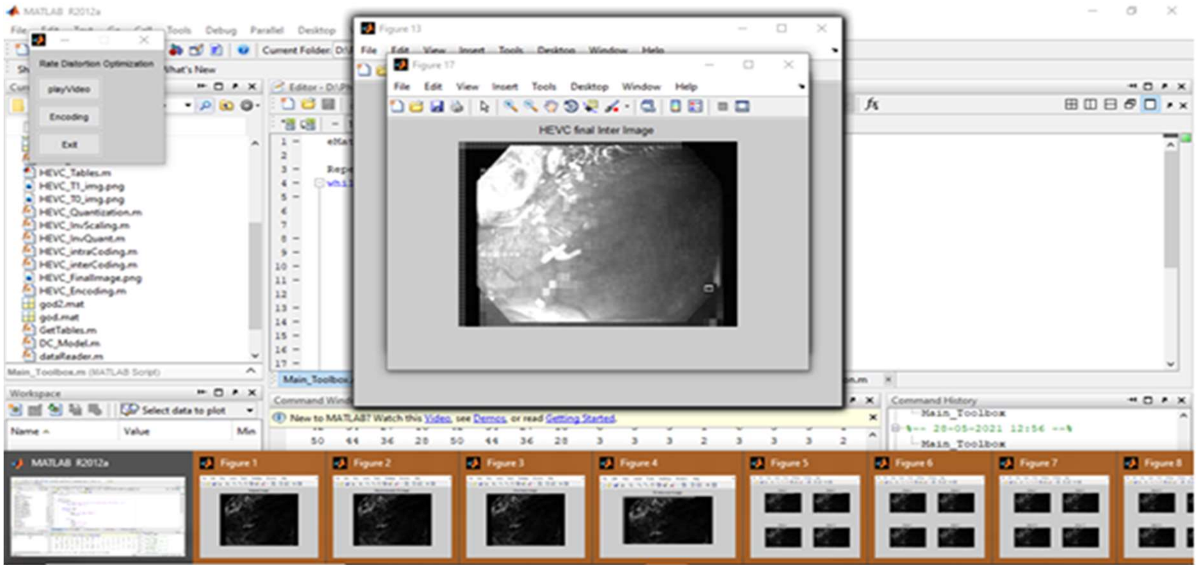
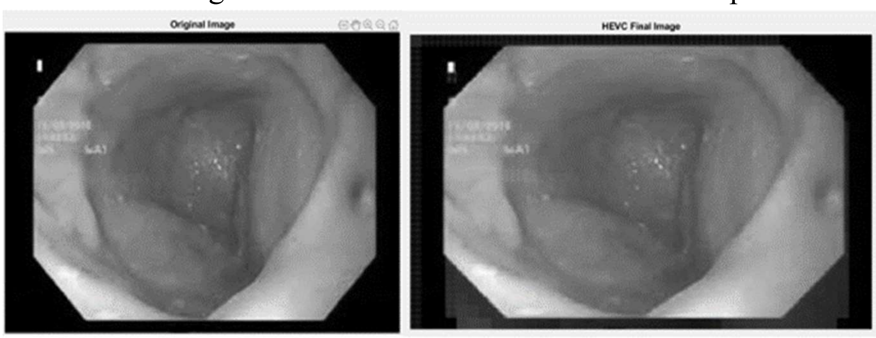
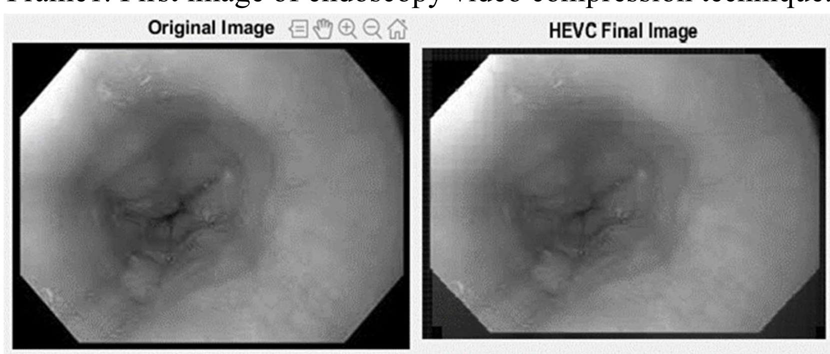


Figure 4. Video Encoding in DCT Based an Efficient Video Compression Technique.



Frame1. First image of endoscopy video compression technique.



Frame 2. Second image of endoscopy video compression technique.

Performance Result for DCT Based an Efficient Video Compression Technique.

The following table and graph shows the results of our proposed technique via the parameter PSNR and Bit Rate.

Video	PSNR (dB)	Bitrate Mbps
1	31.843216	20.489502
2	32.859194	18.054199

3	32.110804	17.993164
4	31.839371	20.562744
5	32.110804	17.993164

Table 3. PSNR and Bit rate for DCT Based C

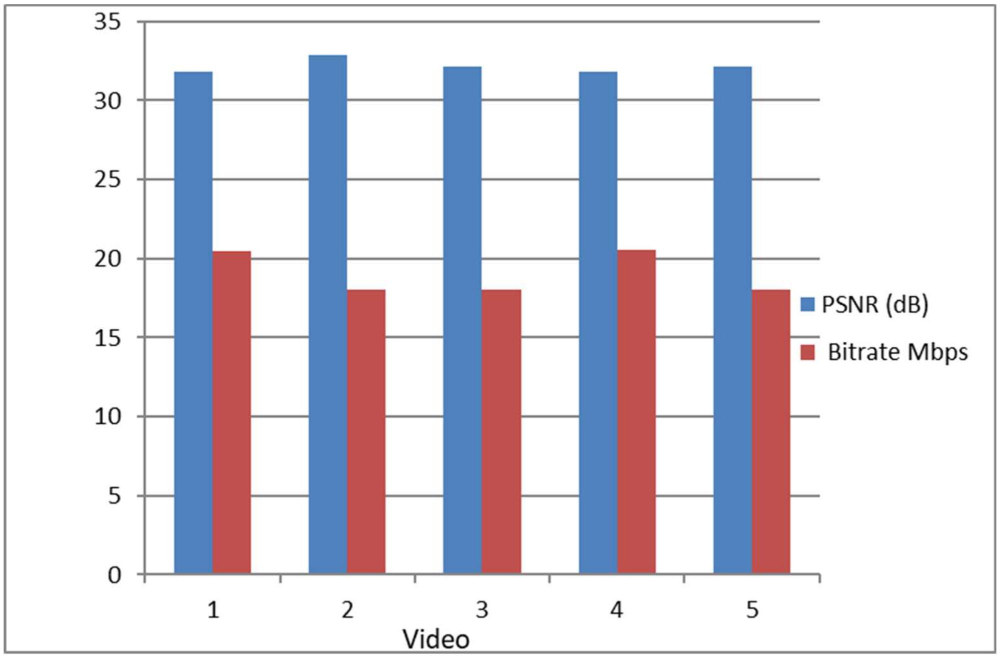


Figure 5: PSNR and Bit rate for Endoscopic video

The graph shown in Figure 5 is bit rate and PSNR of five endoscopic videos so on average the proposed system generate a bit rate of 19.08 mbps and 32.15 dB.

CONCLUSION

As the compression has become the key factor in the medical field, our proposed a DCT-based approach for endoscopic video compression. As one of the challenges in cloud-based health centers is storage space which is addressed in term of bit rate reduction and low network bandwidth utilization. DCT compression technique reduces the amount of storage space which leads for low bandwidth utilization also. According to the experimental results, the proposed technique can achieve an average 19.08 mbps and 32.15 dB. Other parameters, such as the Structured Similarity Index (SSI), will be investigated in a cloud-based environment in the next phase of work.

FUTURE DIRECTIONS

Despite the extensive research in compression techniques, there are still several open research issues, related to telemedicine and cloud-based health centers. In telemedicine and cloud-based health centers, medical video transmission is the key to successful deployment. Cloud-based health service mainly focuses on the storage and transmission of data which can be in huge volume, so compression is the key concept to its success Possible the research scopes are: (1) To design and develop this novel compression technique using the Map Reduce technique for video data transmission in cloud-based health centers. (2) To achieve lossless compression in transferring the medical video data in the cloud-based health center by maintaining the quality of the video. (3) Any type of medical image and video can be transmitted in cloud-based health centers. (4) To verify the developed compression technique using the parameters as PSNR, bit rate, compression ratio and compression time, etc. To verify the developed technique using analytical and simulation models.

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