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PRINCIPLE COMPONENT ANALYSIS FOR MEDICAL VIDEO COMPRESSION

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Master Thesis

Supervisor

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PRINCIPLE COMPONENT ANALYSIS FOR MEDICAL VIDEO COMPRESSION

by

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Signature

DEDICATION

I dedicate the fruit of my effort to the dearest and most precious person in my life, whose advice enlightened my path, to those who gave me strength and determination, to continue the path, and was a reason to continue my studies, my dear mother, and to my husband and all the honorable family and to all the friends who supported me during my studies. Whoever stood near me until I reached what Iam.

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We cannot, after completing this research, but I extend my sincere thanks and gratitude to each of Prof. Dr. Abdullah for the generous kindness in supervising this research, as he provided me with all the advice and guidance throughout the research period, and to Dr. Salwa Al-agha as a secondary supervisor for her kindness to supervise this research and honor her with my continuous advice and guidance for me, it is one of the most amazing people I have encountered in my life.

ABSTRACT

PRINCIPLE COMPONENT ANALYSIS FOR MEDICAL VIDEO COMPRESSION

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With the advancement of technology, it has become easy to use digital data, and thus medical institutions have turned to analyzing images and video content. Medical video is recorded in order to collect experimental information about the use of technologies and integrated data that consists of a series of doctors with video recording, and this leads to user interaction with computers .Using the coding methodology, the video is analyzed for a medical diagnosis that contains important information about the patient's condition with the help of computers, as well as performing surgeries in a medical environment to conduct clinical trials and diagnostics. This leads to software development, reduction in medical effort real-time quality measurement and utilization of available treatments for patient medical diagnosis Medical video has become one of the leading and most common fields, in addition to medical images for diagnosing heart and lung diseases, brain and digestive diseases, and this diagnosis is made by using ultrasound and magnetic resonance imaging in addition to a CT scan. All this helped to provide health care

Through new research methods and clinical trials. In recent times, compression techniques have developed both video and images on a large scale and using this effective compression techniques, little or no damage is achieved, the file size is reduced and the visual quality is not affected. The main goal of compression is to enable data to be better transferred or preserved for different types of compression, such as loss and non-loss of data. The aim of this study is to compress a video to reduce data redundancy and inconvenience(Principle Component Analysis)is used in this research, the main component analysis of medical video compression based on self-matrix analysis that all readers will be able to understand the (Principle Component Analysis) method .This paper presents suitable technique for medical video compression using(Principle Component Analysis) compressed the frames of medical video with eigenvalue and eigenvector techniques. Experimental results showed the efficient and quick technique for medical video frames.

Keywords: Medical video, Video Compression, PCA, Covariance Matrix, Eigenvalue, Eigenvector

ÖZET

TIBBİ VİDEO KOMPRESYONU İÇİN TEMEL BİLEŞEN ANALİZİ

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Teknolojik gelişmelerle birlikte dijital verilerin kullanımı kolaylaştı ve böylece tıp kurumları görüntüleri ve video içeriğini analiz etmeye yöneldi. Tıbbi video, teknolojilerin kullanımı hakkında deneysel bilgiler ve video kaydı olan bir dizi doktordan oluşan entegre veriler toplamak için kaydedilir ve bu, bilgisayarlarla kullanıcı etkileşimine yol açar.Kodlama metodolojisi kullanılarak video, tıbbi bir Hastanın durumu hakkında bilgisayar yardımıyla önemli bilgiler içeren teşhisin yanı sıra, klinik deneyler ve teşhisler yapmak için tıbbi bir ortamda ameliyatlar gerçekleştirin. Bu, yazılım geliştirmeye, tıbbi çabanın azalmasına ve hasta tıbbi teşhisi için mevcut tedavilerin gerçek zamanlı olarak ölçülmesine yol açar Tıbbi video, kalp ve akciğer hastalıklarının teşhisi için tıbbi görüntülere ek olarak, beyin ve sindirim hastalıkları ve bu teşhis BT taramasına ek olarak ultrason ve manyetik rezonans görüntüleme kullanılarak yapılır. Tüm bunlar, yeni araştırma yöntemleri ve klinik deneyler yoluyla sağlık hizmeti sağlamaya yardımcı oldu. Son zamanlarda, Sıkıştırma teknolojileri tarafından geliştirilen video ve görüntüler yaygın olarak kullanılmaktadır ve bu etkili sıkıştırma teknikleri kullanılarak çok az hasar elde edilmekte veya hiç sağlanmamakta, dosya boyutu küçültülmekte ve görsel kalite etkilenmemektedir, sıkıştırmanın ana hedefi verilerin elde edilmesini sağlamaktır. Kayıpsız ve kayıplı gibi çeşitli şekillerde sıkıştırma türlerini daha iyi biçimde kaydeder veya iletir. Bu çalışmanın amacı, ilgisizliği azaltmak için video filmi sıkıştırmaktır ve bu araştırmada veri ilkesi bileşen analizinin (PCA) fazlalığı kullanılmıştır, medikal video sıkıştırmanın ana bileşen analizi, tüm okuyucuların olacağı kendi matris analizine dayanır. PCA yöntemini anlayabilir. Bu makale, Prensip Bileşen Analizi kullanılarak tıbbi video sıkıştırma için uygun bir teknik sunmaktadır. PCA, tıbbi videonun karelerini özdeğer ve özvektör teknikleriyle sıkıştırmıştır. Deneysel sonuçlar, tıbbi video kareleri için verimli ve hızlı tekniği gösterdi.Anahtar Kelimeler: İris, Sınıflandırma, Biyometri, Tanıma, Derin öğrenme.

Anahtar Kelimeler: Medikal video, Video Sıkıştırma, PCA, Kovaryans Matrisi, Özdeğer, Özvektör

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LIST OF ABBREVIATIONS

PCA : Principle Component Analysis

QoE : Quality of Experience

CPR : Cardio -Pulmonary Resuscitation

SPARC: simulation for Pediatric Assessment, Resuscitation, and Communication

CT : Computed Tomography

MRI : Magnetic Resonance Image

NMRI : Nuclear Magnetic Resonance Imaging

MRT : Magnetic Resonance Tomography

OCT : Optical Coherence Tomography

EM : Electromagnetic

RGB : Red, Green, and Blue

GOP : Grop Of Picture

GOBs : Grop Of Blocks

MB : Number of Blocks

CR : Compression Ratios

CB : Chrompression Block

DCT : Discrete Cosine Techniques

FPS : Frames Per Second

JPEG : Joint Potographic Experts Group

PNG : Portable Network Graphic

GIF : Graphics Interchange Format

DVD : Digital Versatile Disk

PNSR : Peak Signal-to-Noise Ration

OBC : Orthonormal Basis Coding

MPEG-4 : A Multimedia Conding Standard

FFT : Fast Fourier Transformation

DWT :Discrete Wave Transfer

SPIHT : Partitioning Group in Hierarchical Trees

LIB : Less Important Bit

DSCQS : Double Stimulation Continuous Quality Scale

MPEG-2 : A Multimedia Conding Standard

H.264 : AVideo Coding standard

FMO : Flexible Macroblock Ordering

ROI : Region-Of-Interest

PLR : Packet –loss Rate

WSNR : Weighted SNR

MOS : Mean Opinion Scores

LSMC : L- Shaped Morphed Codec

LWT : Lifting Wavelet Transform

SPECK : set a partitioned embedded block programmer

HEVC: High-Efficiency Video Codec

VQA: Video Quality Assessment

SSIM: Structure Similarity Index

VIF   :   Visual Information Fidelity

UQI   : Universal Quality Index

SVC: Scalable Video Coding

MSE: Average Square Error Value

AVC: Advanced Video Coding

NQM: Noise Quality Measure

NIQE: Natural Image Quality

BRISQUE: Blind Reference less Image Spatial Quality Elevator

VVC: Versatile Video Codec

LIST OF SYMBOLS

V, W : Coordinates

D : Represents the resulting DCT

X : Represents the mass of the original image

C : Elements are defined for mass of an image

P,Q,R : Dimensions

VAR : Variance matrix

COV : Covariance matrix

1. INTRODUCTION

1.1 INTRODUCTION

Medical innovation affects anyone on the face of the planet, and this innovation allows for modern methods, especially in terms of medical diagnosis by means of modern and small medical devices and even medical robots. This innovation improves the level of operations to provide health care through new methods of research and clinical trials medical video has become one of the leading and most popular medical fields, as well as medical images to diagnose all diseases. Technological progress has made a major contribution to digital signals, devices, video and image compression, and networks, in new mobile health services and systems, In addition to wireless medical video transmission systems, it is made up of two important components which are the wireless infrastructure that will be used to technology and transmit medical video compression. Medical video compression needs to respond to some unique requirements associated with its intended diagnostic use[1]. Currently, the ultimate in mobile health end users and especially healthcare professionals is the ease and flexibility in their digital practices, since they have the provision to display clinical and diagnostic information regardless of display device and device location. To meet the requirement, diagnostic and multimedia content, especially medical video streaming applications, must be managed efficiently, which is a major challenge for QOE assurance. This is because video contents are subject to different degradation from capture time to pre-processing, transmission, compression, and post-processing. Each of these stages may degrade the video quality of the video [2]. Advances in video compression, computer and network technologies have contributed to the rapid growth of mobile health services and systems the latest in third generation telemedicine systems. These services and systems are expected to be widely deployed in the near future, and are expected to soon be integrated into clinical daily practice [3]. Automatic tracking of intraoperative brain surface displacements in brain tumor surgery. In brain tumor surgery soft-tissue deformation known as brain shift. These model-update methods rely on accurate intraoperative 3D brain surface displacements, this method can robustly provide 3D (Stereovision systems) brain surface measurements for use with model-based updating frameworks[4].The medical video in(Cardio pulmonary Resuscitation) is used to (Simulate the Pediatric Evaluation Resuscitation and Communication) group, within the department of pediatrics at the (university of Louisville) and was also developed to teach the college of (paediatrics colleagues) and residents how to respond to medical crises. The goal of (SPARC) is to advance the care of children and infants using simulation-based educational methodologies to improve patient safety and to promote interdisciplinary interactions between physician and patient [5]. Powerful video bronchoscopy can perform many minimally invasive chest examinations for diseases such as asthma and lung cancer. Guided by the bronchoscope's video stream, the doctor can navigate the intricate 3D airway tree to administer a patient treatment or collect patient samples [6].

1.2 PROBLEM STATEMENT

It is difficult to predict the magnitude of advances in medical imaging technology. The technological revolution in health care poses great challenges for researchers. The amount of medical images related to their storage space becomes a bottleneck for further developments, to overcome the limitations, an effective compression algorithm must be equipped. The latest advances in medical imaging technologies such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) produce a large amount of medical images / videos. To reduce the storage space these photos / videos require effective compression technology is required. Therefore, more efficient and technical methods of compressing medical images and videos are needed.

1.3 AIM AND OBJECTIVE

In our current era, along with the development of informatics and technology, more and more modern devices such as visual radiation, scanner, ultrasound, endoscopy, magnetic resonance imaging (MRI), nuclear magnetic resonance imaging (NMRI), (MRT) are being used on a large scale. In all hospitals for medical diagnosis or treatment. The videos as outputs from these devices have a large overload of time, so we can get a high percentage of compression.

The goal of video compression is to eliminate redundancy in the sequence of video frames. The main objective of this research is to create and set up a system responsible for the process of medical video compression, which reduces the amount of redundancy in the data that occurs in it, in order to store, follow up, prepare and send these medical videos to another observer, who may be a doctor or a person interested in following a patient's condition remotely. This system is based on the (PCA) method, which is a statistical approach that linearly transforms an original set of variables into a smaller set of unrelated variables which represent the largest variance from the multivariate input data. The robustness of (PCA) methods in statistics was addressed by replacing the standard estimate of the covariance matrix with a robust amount or by using projection follow-up techniques.

1.4 AREAS OF APPLICATION

The field of principle component analysis PCA with medical (image and video) plays a main role in:

A. PCA has become a powerful tool for increasing performance in data acquisition, image reconstruction and image analysis for brain, heart, angiogram, and retina images.

B. One of the primary applications was to reduce the number of measurements in dynamic imaging (time + space), this led to a decrease in the radiation dose and an increase in the imaging speed of computed tomography.

C. In addition, background separation in the low-order component resulted in an automatic background suppression for the contrast-enhanced angiography and studies.

D. PCA can also make a strong separation between individual and general information when analyzing a set of clinical data, such as functional magnetic resonance imaging and brain prevalence.

E. PCA can also detect changes in the retina as well as image alignment to reduce spots in retinal OCT images [7].

F. Principal component analysis applied to medical data to explore factors believed to be very important in increasing the risk of developing ischemic heart disease [8].

G. Apply the principal component analysis to differentiate between healthy controls and schizophrenics based on measures of partial characteristics and their variance [9].

H. Feature extraction based on the analysis of major components and the discovery of morphological edges and their localization in order to quickly identify the iris [10].

2. THE ORETICAL BACKGROUND LITERATURE REVIEW

2.1 INTRODUCTION

One of the most advanced senses is vision so images play an important role. In human perception humans use only the visible range of the electromagnetic (EM) spectrum as cameras cover almost the entire EM spectrum from gamma waves to radio waves. It is possible to work with images created with sources that humans are not used to associating with images these images include ultrasound, computer-generated images and an electron microscope. Finally, digital image processing includes a variety of these applications. Digital image processing is carried out using a digital computer .The digital image includes a limited number of elements. These elements are called picture elements pixels and peelings, each of which has a specific value and location the term most used to refer to elements of a digital image is pixel the fields of application of digital image processing are varied and capture some form of organization required for a wide range. To develop the basic concept of the field of image processing applications in the classification of images mainly for their source (for example, visible rays, infrared rays, x-rays, etc.) [11].

2.2 DIGITAL IMAGE DEFINITION

Refers to this digital image in a two-dimensional function of the form f (v , w) where x and y are plane (spatial) coordinates called any pair of gray (v, w) coordinates or density at that point of the image plane. When the (v ,w) and intensity values of f are all discrete and finite magnitudes it is called digital. The spatial value at coordinates A (v, w) is a scalar quantity whose meaning is determined by the source of the image, whose value is proportional to the energy radiated by the physical source (for example electromagnetic waves). As a result f (v, w) must be finite and non-negative

This is:

$$0 \leq f\,(v,w) < \infty \quad \text{………..…………………………………} \quad (2.1)$$

The function f (v, w) has two sources: (1) the amount of light that is reflected on objects in the scene (2) the amount of illumination incident of the source on the footage that is displayed appropriately, these are called reflection and luminance characteristics, denoted by I (v, w) And r (v, w) respectively. The two sources are united as a product to form f (v, w): [11].

$$f(v,w)= i(v,w)\, r(v,w) \quad \text{……………………………………………} \quad (2.2)$$

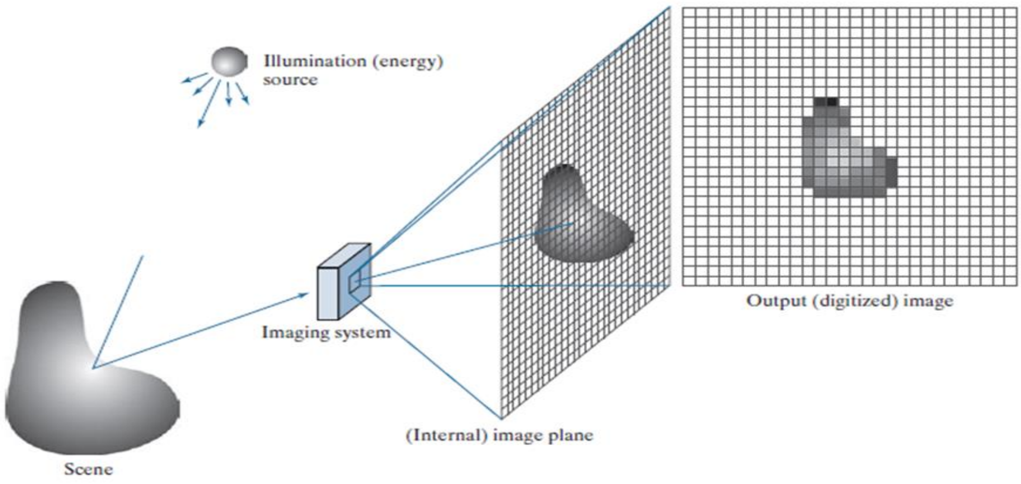


Figure 2.1: An example of digital image acquisition [11]

2.3 IMAGE SAMPLING AND QUANTIZATION

The waveform of the constant voltage is caused by most of the sensors whose spatial behavior and amplitude are related and are sensed by the physical phenomenon. To compose a digital image we need to convert the continuous sensor data into digital format this requires two processes: quantization and sample taking. If the continuous image f is transformed into a digital form, the continuous image may be related to the (v ,w) coordinates of the capacitance. For their numbering, the numbers of coordinate values are called sampling, and the numbering of the capacitance values is called quantization. As shown in Figure (2.2). the raster line shows the density differences on the line AB in the continuous image then the digital scan line is taken, samples and quantization [11].

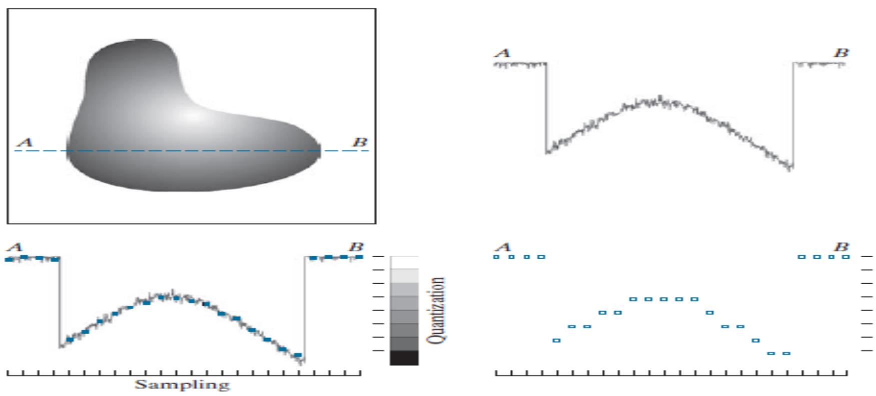


Figure 2.2: Sampling and quantization of an image [11]

Suppose f (r, s) to represent the continuous function of the image of two continuous variables r and s. To convert this function to a digital image by taking quantity and samples, suppose taking models from a continuous image of a digital image, f (v, w) includes the rows of M and the columns N (v, w) separate coordinates, using numbers with integer values these separate coordinates x = 0, 1, 2, ..., M - 1 and y = 0, 1, 2, ..., N - 1. For example, the value of the digital image at the beginning is f (0,0) its value is at the following coordinates Along the first line is f (0,1). Here, the notation (0, 1) is used to denote the second model along the first line. They are not the values of the physical coordinates when the image is sampled. Generally refers to the value of a digital image in any of the coordinates f(v,w) to v and w are integer When specific coordinates (i, j) need to be indicated the notation f (i, j) is used when the arguments are integers spatial field Divide the real plane spanning the coordinates of the image to refer to the v and w coordinates of the spatial or spatial variables. Wrote the equation in the form of a numerical matrix M * N as : [11].

$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & \cdots & f(0,N-1) \\ f(1,0) & f(1,1) & \cdots & f(1,N-1) \\ \vdots & \vdots & & \vdots \\ f(M-1,0) & f(M-1,1) & \cdots & f(M-1,N-1) \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (2.3)$$

The right part of the equation is the digital image represented by an array of real numbers. Each element in this matrix is called a pixel or pel an image element. Likewise, digital images can be

$$\mathbf{A} = \begin{bmatrix} a_{0,0} & a_{0,1} & \cdots & a_{0,N-1} \\ a_{1,0} & a_{1,1} & \cdots & a_{1,N-1} \\ \vdots & \vdots & & \vdots \\ a_{M-1,0} & a_{M-1,1} & \cdots & a_{M-1,N-1} \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (2.4)$$

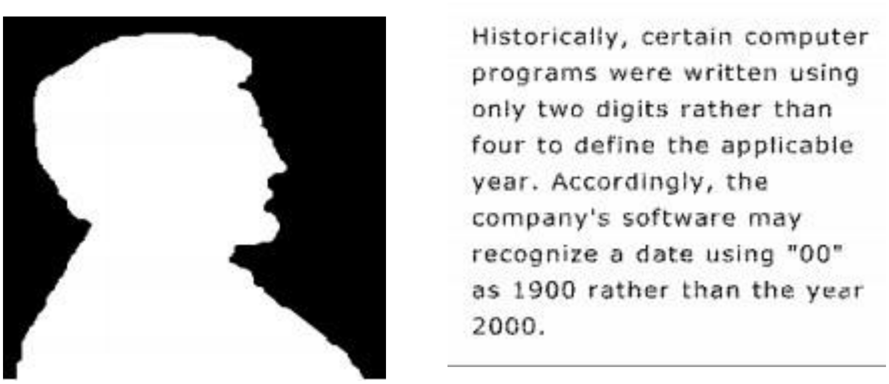
Represented by a conventional matrix clearly, aij=f (i, j) equations (3) and (4) denote congruent matrices. [11]

2.4 TYPES OF DIGITAL IMAGES

Image types are: (1) binary (2) gray scale (3) color and (4) Multispectral.

2.4.1 Binary Images

The simplest types of images are binary images, and the image usually takes two black and white values or 0 and 1 refer to the binary image as a 1-bit image because it requires one binary number to represent each of the pixels of each image. Frequently, These types of images are used in applications where the only required information in the file is an outline or layout. The creation of binary images is done from grayscale images via a file. Threshold operation and every pixel runs above the threshold value white (“1”) and those below it will turn black (“0”). In the Figure (2.3) below examples of the binary picture: [12].



(a) (b)

Figure 2.3: Binary images (a) Object outline (b) Page of text picture [12]

2.4.2 Gray-Scale Images

Monochrome and gray scale images it does not contain color information but rather gray level information, Specifies the number of various gray levels. The number of bits used per pixel. A typical gray-scale image contains 8 bit / pixel data and this allows for (256) different gray levels. The Figure (2.4) below illustrates example of gray scale images.

Figure 2.4: Examples of gray-scale images [12]

Images are used in applications such as medical imaging and astronomy as 12 or 16 bits / pixels. So those extra gray levels when small are useful .The image portion is too large to distinguish the details[12].

2.4.3 Color Images

Color images typically an image as a three-dimensional image and monochrome data. Each set of data corresponds to different colors. Information stored in digital image data Gray-level information is available in all of the spectrum color images are represented by red, green, and blue (RGB) images and a standard 8-bit monochrome file is used as the template .The corresponding color image (24 bits / pixel 8 bits) of the three ranges is (RGB). A representation of a (RGB) color typical image illustrating in the Figure (2.5) [12].

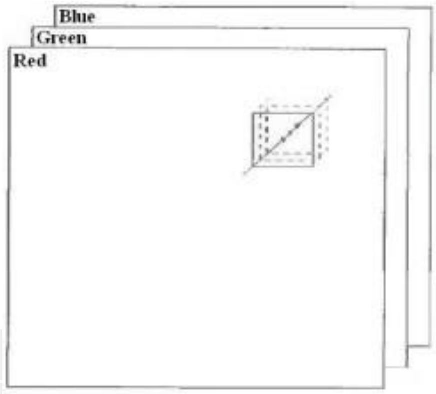


Figure 2.5: Representation of a typical RGB color image [12]

2.4.4 Multispectral Images

Multispectral images usually contain information that is outside the normal plane. The range of human perception includes ultraviolet rays, x-rays, and infrared rays or radar or audio data. Be the information represented is invisible to the human system .Often information is represented by mapping visually for different spectral bands of RGB components [12].

2.5 DIGITAL VIDEO DEFINITION

Recent advances in software, hardware and digital signal processing integrate various data streams that may include digital video, text, audio and graphics within a single platform. A simpler example is the use of simultaneous video document annotation and audio to search and browse media databases digital vector graphics and video merging, and the convergence of communications, computing, broad cast and entertainment technologies. This rapid development is due to the development of the driving force in the field with rapidly emerging multimedia applications such as multimedia databases, video conferencing, intelligent visual search engines on the desktop and audiovisual communication via the Internet. .Will have a profound impact on modern professional life, education, entertainment and healthcare [13].For decades video has become an important medium for entertainment and communications. The term video refers to visual information usually captured by a camera sequentially over time (66). The video film is initially captured and transmitted in analog. It leads to the emergence of digital integrated circuits and computers to digitizing the video and enabling video Digital revolutionizing connectivity for video and compression.

The advantages of digital video are:

A. The video is ready for merging and processing in various multimedia applications due to the video storage in memory or on digital devices.
B. Easy direct access makes the video easy for non-linear editing.
C. The benefit of repeatedly recording a video movie without degrading the picture quality.
D. Better tolerance and easier noise channel coding [14].

2.5.1 Fundamentals of Video Coding

The video sequence consists of images that are updated and at a certain rate with a number of images sometimes grouped together [image group (GOP)]. Each image consists of several sets of blocks [GOBs] sometimes called slides. Each (Grop of Blocks) contains a large number of blocks [MB] one megabyte consists of four blocks of luminance (8×8) pixels per one of them and two blocks of coloration [CB and CR] density contrast and color information. (Discrete Cosine Techniques) is applied to each block in order to convert pixel values into (DCT) parameters and to eliminate spatial redundancy. After that, the (Discrete Cosine Techniques) parameters are defined in addition to scanning them in a zig-zag pattern to a set of symbols is provided each symbol representing a number of zero parameters followed by a single non-zero parameter. These symbols are then converted into bits by means of entropy encryption. The encoder estimates the movement through the large block of the current image with the original image to obtain the motion vector that determines the best fit area. Then the residues are encoded and sent by transmission vectors, as shown in Figure (2.6): [13].

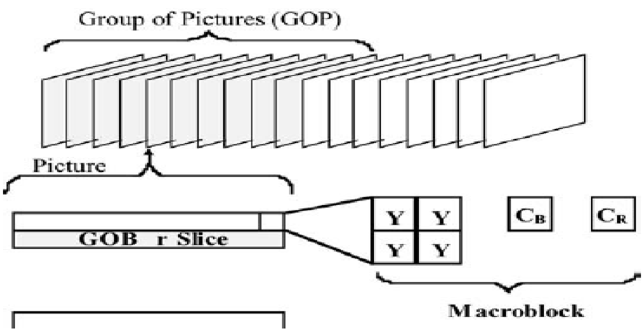


Figure 2.6: Data structure of digital video[13]

To eliminate redundancy between samples of data, transfer coding was used extensively. When transcoding first a block of data samples is linearly converted into a block of conversion parameters. The parameters are then quantified and coded (Discrete cosine Techniques), the most common conversion for video in terms of gaining subjective quality and objective coding (DCT) works well for typical image data. Express the DCT operation by multiplying the matrix by:

$$D = C^T X C \quad \text{...} \quad (2.5)$$

represents D the resulting DCT coefficients and X represents the mass of the original image. The C elements are defined for the mass of an image (8 × 8) as follows:

$$C_{mn} = k_n \cos\left[\frac{(2m+1)n\pi}{16}\right] \quad \text{where } k_n = \begin{cases} 1/(2\sqrt{2}) & \text{when } n = 0 \\ 1/2 & \text{otherwise} \end{cases} \quad \text{........} \quad (2.6)$$

The (DCT) coefficients are determined in Z after the conversion. Quantization is the loss of information and is also the main source in the system of actual stress. Quantization also depends on the available coding formats and bit rate. Then the quantum coefficients (DCT) (8 × 8) are converted into one-dimensional (1D) to encode the entropy with the rank sweep. Figure (2.4) shows the zig-zag scanning arrangement used in most of the criteria for this conversion. For typical video data most of the power concentrated in high frequency and low frequency coefficients is usually very small and often zero scale [13].

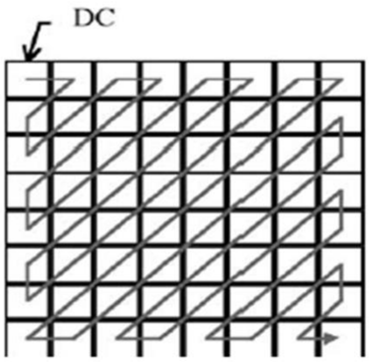


Figure 2.7: Scan order of DCT coefficients [13]

2.5.2 Frame

The frame is part of many still images that make up a complete moving image on the photographic film tape in which individual images are recorded that quickly increase in length, and each image of this tape appears as a single-frame image when examined. Fixed frame means one still image taken from a video clip or movie, and it is an animation. Still frames are also called video guide frame, freeze, misleading thumbnail, video prompt, key frame, poster frame, capture / dump / screenshot / capture. Freeze frames are widely used in video galleries and video platforms. Video platforms have several standards to display a frame at half the time of a video. The advancement of some platforms leads to individual frame works being chosen differently[15]. In animation and video frames are individual images of a group of images. For example a flash movie which can be seen on the web can play 12 frames per second to create the appearance of motion. Most of the videos are shot at 24 or 30 frames per second (FPS). It is often measured in (3D) games that are a way to check processor speed in a graphics computer [16].

2.6 COMPRESSION TECHNIQUE

Image compression is a kind of application for compressing image / data the main image will be encrypted with limited bits. The main goal of image compression is to reduce the lack of redundancy and fit of image data and is to enable it to better transfer and preserve the data. There are some algorithms that are used to perform this compression types are classified in different ways, such as compressing images without losing or losing data or dividing them into two non-contact types such as lossless and lossy compression. Losing pressure results in losing very little information in this technique, the compressed image is the same as the actual / original uncompressed image, but it is not identical to the previous image as is the case in the compression process where little information related to the image is lost a very natural image is compressed onto the image by encoding all of its information from the actual file so in the case of an example of lost compression is the Joint Photographic Experts Group (JPEG). Lossless compression if the image is decompressed again it will be exactly the same as the actual image. For examples of lossless image compression technology you can use PNG and GIF[17].

2.6.1 Lossless Compression Technique

With compression technology without any loss of data when compressing it with the decompression, it will be the same as the actual replica of the data. Binary data is compressed like executable documents etc. To reproduce exactly when decompressing again images are reversible music required that it not be created "exactly". Actual similarity for more objective images, enough problems or errors can be avoided the actual compressed image or upload it. These types of pressure are also known as noiseless because they never add noise for a picture or a reference it is also called entropy coding to use techniques Reducing redundancy / stats for removal / decomposition. They are used for some specific applications are only described with stringent needs as medical imaging (the techniques listed below represent lossless pressure:

A. Huffman encoding.
B. Arithmetic coding.
C. Dictionary Techniques.
D. Run length encoding.

(a) LZ77

(b) LZ78

(c) LZW

(d) Bit Plane coding [17].

2.6.2 Lossy Compression Technique

Lossless compression technology, reduces bits by identifying them Information is not required and deleted System for downsizing. The name data compression is usually given to a data file, despite its official name it is the source encoding that is encoded in the data source prior to transmission or store it methods for this little loss of information is acceptable. It can lead to non-essential information being dropped from the data source to the storage space methods for compressing lossy data are explored by research into how people do this use of lossy image compression technology in digital cameras to increase. The ability to store with minimal image quality drop (DVDs) use the lossless (MPEG-2) video codec for file compression. For the video when compressing the voice by loss it possesses psychoacoustic techniques it was used to eliminate inaudible or inaudible components [17].

2.7 VIDEO COMPRESSION

Video is a technology for capturing, recording, processing, sending and rearranging moving images. I rarely use an electronic signal, kinescope, or digital media. The purpose of compression / video conversion is to reduce the bit rate in the digital representation of the video signal, as well as to maintain the required level of signal quality and reduce codec complexity (encoding, decoding, and decoding). Video compression is a form of the data compression aims to reduce the size of the video file video compression refers to reducing the amount of data used to represent the digital image of a video and it is a combination of image compression space and time motion compression[18]. Video and Image compression has been a very effective field of research and development for more than 20 years and many different systems and algorithms for compression and decompression have also been proposed and developed. So in order to increase selection and competition and encourage interoperability it is necessary to define standard encoding and decoding methods to allow different products from manufacturers to communicate effectively and broadly. Video compression has two important benefits. First, digital video may be used in storage and transmission environments that do not support uncompressed ("original") video. Case in point, Current internet transfer rates are insufficient to handle uncompressed video in real time even at small frame size and low frame rates and (DVD) can only store a few seconds of original video at frame rate and TV-quality resolution after which (DVD)Video storage is practically without audio and video compression. Second, it is the most widely used and efficient video compression for Storage and transportation resources. When a high bitrate transmission channel is available it is better to send high-definition compressed video or multiple compressed video channels rather than send it all at once, at low-resolution or uncompressed. With the continuous advancements transmission and storage capacity compression is essential for multimedia services for many years to come. Signal compression can transmit information and data by removing redundancy from a signal. In a non-missing compression system, statistical duplicates are removed so that the original signal can be completely reconstructed in the future. Unfortunately, at present, lossless methods cannot achieve modest amounts of video signal compression most video compression techniques rely on a lossy compression process and a large percentage of the compression is achieved with the penalty that the decoded signal is not identical to the original. The benefit of the video compression algorithm is to achieve effective compression while minimizing distortion that results in the compression process [19].

2.8 PRINCIPLE COMPONENT ANALYSIS (PCA)

It is a mathematical and statistical method for dimensional reduction and reduction that can be used in various fields in video clips and images this method was developed and kernel PCA, 2D-PCA and it has good results. Another benefit of the mentioned method is that compressed images are rebuilt in a short time[20] .Image compression algorithm is studied in order to have better image quality and storage reduction, the compression algorithm has good PNSR value and high compression ratio[21]. The image is analyzed by PCA and the still image can be divided into three categories: “second generation waveform, fractional coding techniques” and coding techniques are aimed at compressing video and image where enough data is provided for the pictures and videos[22]. Strong through analysis to add to Low rank that sparse matrices lead to providing a framework that contains a wide range of diverse applications such as image and video processing and these applications lead to the discovery of sparse and divergent values that can be rounded to the lowest value in the matrix of image

data. The technology has received great attention in recent times as it was used in very difficult applications such as separating the introduction in video clips that were captured in a fixed or animated way as the virtual partial space is changed through a video data set or very long images to be more appropriate[7]. This method is used to reduce image size without compromising critical and medical diagnostics in image and data compression displayed using an algorithm PCA that was initially combined in the form of a row and then the algorithm is applied in relation to the image quality we can note that the performance PCA Much better than the algorithm of PCA as the compression ratio is the same [23]. Eigenvectors are based on a non-zero vector which is the concept of an orthogonal linear transformation. The matrix's dominant vector is to obtain the largest eigenvalue for that matrix.
The steps for PCA to extract eigenvectors are as follows:

1. The dataset must be organized, assume that the data has a set of **A** variables and is arranging as a set of **B** vectors. All data will be placed in one matrix **H** dimensions **A × B**.

2. The mean of the matrix **H** should be calculated:

$$\mu H= \frac{1}{B}\sum_{b=1}^{B} H[a,b] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2.7)$$

Where **μH** It's the mean (average) of the matrix **H, a = 1, 2… A** and **b = 1, 2… B.**

3. The average of each dimension is subtracted:

$$H=H-\mu H \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2.8)$$

The new matrix contains the mean data subtracted from H. Subtract the mean to preserve the first principal component and indicate the direction of maximum variance.

4. The covariance matrix is calculated:

The (covariance) formula assumes that 3-a data set contains dimensions (p, q, r), after which the covariance is measured, either between the dimensions of p, q, q, r, or r, to measure the covariance between p, p And q. Dimensions of q, r, and r give the variance values of p, q and r dimension variance is measured in only one dimension just as the variance is in different dimensions for 1-dimension:

$$\mathrm{Var}(H)=\frac{\sum_{i=1}^{B}(Hi-\mu H)(Hi-\mu H)}{B-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2.9)$$

Var is the covariance matrix of the 2-dimensional matrix **(H, I):**

$$\mathrm{COV}\ (\mathrm{H},\ \mathrm{I}) = \frac{\sum_{i=1}^{B}(Hi-\mu H)(Hi-\mu I)}{\mathrm{B}-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (2.10)$$

Cov (H, I) is the covariance matrix; **μI** another matrix mean **I**.

5. Find the eigenvectors and eigenvalues of the covariance matrix. And calculate the eigenvector matrix that makes the covariance matrix **C** diagonally:

$$\mathrm{E}\times\mathrm{Cov}\times\mathrm{E}^{-1}=\mathrm{D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (2.11)$$

The covariance matrix **E** is the matrix of all cov eigenvectors and each column has one vector **D** is the diagonal matrix of all its cov eigenvalues and along its main diagonals it is considered zero with respect to the rest [24].

2.9 COVARIANCE MATRIX

In probability and statistics theory a covariance matrix (called a covariance matrix or a covariance-covariance matrix) is a matrix whose component i-position j is the covariance between the i and j components of a random vector. Number a random variable that is in each element of the vector with a finite number of experimental values or b Infinite number of possible specified values by all random variables. A theoretical detail the probability distribution for example the covariance of a set of random points in the two-dimensional domain can be described integrally with one number and no the differences in the H and I directions have all the necessary information A(2×2) the matrix will be important to characterize all 2D covariance**.** A sample of the multivariate Gaussian distribution points is standard deviation 3 is roughly in the lower-right direction and 1 in the upper-right direction. Perpendicular direction because the components H and I are different, the variations of H are and I does not fully illustrate the distribution A (2×2) dispersion matrix is needed. The arrow directions coincide with the eigenvectors of this scattering matrix and .Their lengths are the square roots of the eigenvalues [25].

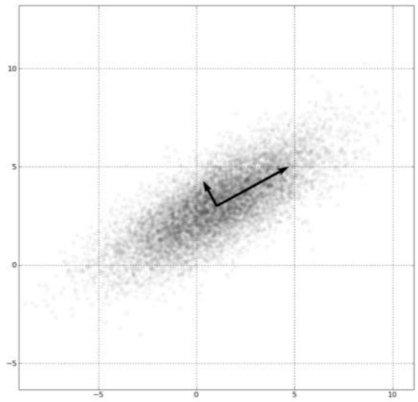


Figure 2.8: Covariance matrix [25]

Covariance is positive for the opposite cases, when large values of one variable necessarily correspond to small values of the second variable for example variants tend to exhibit opposite behaviors, and variance is negative. The covariance sign, thus, shows the slope in the linear relationship in variables. It is difficult to explain the magnitude of the covariance. The correlation coefficient is shown by relationship strength and magnitude [26].

2.10 LITERATURE REVIEW

The previous research works in video compression with PCA, and for medical video compression is given with a brief description to each one of them:

2.10.1 Video Compression with PCA

Vieux. W. E. Faces are tracked using a new system developed in robotics to follow the normalization of the video and convert it into centralized images of the face. Facial tracking allowed us to implement a PCA-based pressure scheme called Orthonormal Basis Coding (OBC).We have implemented and designed the entire video codec and face tracker in the program. The power of the backbone is in many media and complex applications and we obtain a high percentage of compression using video coding, scene coding and object recognition algorithm[27].

Schwartz. W. R**.** A method has been introduced that exploits both the temporal and spatial redundancy of the captured video clips from static compression cameras and which subsequently allows for the rapid retrieval of the moving sites of live objects from compressed data that combines two methods of coding to compress data. In the first method an eigen space (PCA) was used to model non-overlapping rectangular blocks from the image. The second method uses MPEG-4 to compress a set of misconfigured blocks by Eigen spaces (PCA) This work describes a compression technique for monitored video clips. In addition to achieving high compression ratios this technology provides a good advantage and can be used in further video processing as it is possible to provide a mapping by which to locate moving objects in the scene in an easy way in compressed data [28].

Sderstrm. U. et al., in [2011] It offered some capabilities in the main component asymmetric analysis PCA to compress the series of facial videos. It can be used with high quality decoding and to reduce coding complexity with little decrease in the quality of the reconstruction the complexity of encoding can be reduced by more than 10 times and the complexity of decoding present at the same time in which the objective quality is reduced and a slight decrease in PCA provides natural scalability in quality and spatial resolution and provides PCA with the same coding. Offers the freedom to assemble reconstructed frames and decoder differently and differently, as well as the freedom to choose variable quality for different parts of the frame. PCA plays an important role in providing natural looking video with very low bitrate and low coding and decoding as well.[29]

Mofarreh-bonab. M. et al., in 2012 there is the fact that the video is to compose a set of threaded and sequential frames, so that we can apply PCA to the frames that are highly correlated. Most other video compression methods are used to convert DCT to compression. The special PCA video compression method is analyzed. There are other methods that depend on PCA such as 2DPCA, and we have examined and showed that in addition to it has high performance in compressing a database for face but in video compression, such good performance was not apparent. The advantage of the mentioned method is the simplicity of encoding and especially in the decoder unit using only multipliers and additions in its structures that use more complex functions such as motion estimation and inverse FFT functions [20].

Kalangi. S. et al. a new approach to video compression has been proposed with the use of Discrete Wave Transfer (DWT) which greatly exploits the time redundancy and is relevant in the video to improve rigidity efficiency while reducing processing complexity. It includes converting the video from (3-dimensional) to (2-dimensional) format which allows the exploration of the chronological frequency of the videos and the use of 2-dimensional transformations. This shift converts the spatial and temporal correlation of the video signal into a high spatial correlation. Discrete Wave Transfer (DWT) converts all sets of images into just one image at the high spatial correlation end. Partitioning Group in Hierarchical Trees (SPIHT) and the properties of the transformed waveform are exploited to increase their efficiency. Whereas, the decoupling of the images produced by Discrete Wave Transfer (DWT) makes the energy efficiently compressed and thus produces a high compression ratio. Video segmentation visual change estimation and post-object tracking allow to operate a PCA based video and visualization algorithm which can be applied to compressed or raw video data[30].

Mahesh. S. et al., in 2014 The survey gives about some of the techniques and it has been reviewed and discussed by some different authors it is very useful to compare and analyze any proposed works in video compression techniques the existing works on video compression technology have been surveyed. Various video compression techniques have been analyzed for useful and effective video compression. This reduces the file size so that it does not affect the visual quality and without defect or loss.[31]

Liu.S, Gu. et al., in 2014.The goal of reaching the compressed sensor problem for sequential videos is to analyze the correlation between images and between frames and remove the conversion factors whose value are low according to the energy concentration characteristics and to analyze the main components. The paper presents a special algorithm for analyzing the main components of the video compressed sensor. The simulations are then analyzed for different measurement numbers and multiple video sequences[32].

Razali. S. S. et al., in 2014 All discuss a variable approach to video compression to optimize video frame transfer for a multimedia application they are smaller in size and without significantly affecting the video quality methods for video compression such as the frame difference method. In addition to the PCA-based method have been analyzed. From a multimedia application for the user to enjoy the video, The main benefit of video compression is to reduce expected losses transmitter bandwidth and storage memory[33].

Rajalakshmi .K. et al., in 2016 The analysis of various compression techniques such as the method based on basic (PCA) and that the group is divided into hierarchical tree algorithm and concepts are not understood. There are two types of embedding techniques such as data masking algorithms and digital photo watermarks and scanning digital watermarking techniques such as Discrete Wave Switching (DWT) and Less Important Bit (LSB). Moreover, Discrete Cosine Techniques (DCT) is analyzed for data masking such as H.264 / AVC video streams as well as MPEG videos. Through the scan results it is clear that these current technologies cannot recover the compressed image with high quality and that some pixel information is lost during transitions. In addition, current technologies have increased the complexity of time and computation. Various image compression techniques such as fuzzy concepts (Partitioning Group in Hierarchical Trees) in which the algorithm is analyzed as well as methods based on PCA are also being scanned. Digital embedding techniques such as data masking and tag algorithms are also scanned. Digital watermark[34].

Liu .Y. et al., in 2016 The method has been developed for monitoring through video with the lowest latency, as it uses the previous extracted background frames to update the background subspace of the new tires in a more effective manner. Experiments show that the adaptive CS-L1-PCA is better at operating than its non-adaptive counterpart especially when the number of frames is increasing. Video clips are captured using some fixed cameras and the main analysis is done and transferred to the processing center in the video to analyze and distinguish currents, in addition to moving objects and anomalous element [35].

2.10.2 Medical Video Compression

Nouri. N .et al., in [2010] Pay attention to determining pressure thresh holds as well as associated and acceptable bit rates as well as an assessment of the quality required in the medical video field Transitional. For evaluation of compact medical MPEG- For video quality Using Double Stimulation Continuous Quality Scale (DSCQS) The compression ratio is about the threshold pressure level Approx90: 1 compared to the original 270 Mbps Perceived quality is concerned. complete determine the optimum range of bit rates to be used in the field of remote surgery using MPEG2 compressed videos.

The lost pressure area for surgery is explored remotely.The lost pressure is achieved with coordinationour application frame has a pressure limit of 90: 1 this results in not a significant decrease in the quality of the video. Not just loss compression by transmitting medical video as well as setting a higher threshold to lose quality. This is done by using other encoding techniques, such as H.264 [36].

Panayides. A. et al., A standardized framework for transmission, effective coding and quality assessment is proposed using ultrasound video metrics are also used to assess objective video quality as well as to estimate its relevance to quality assessment. Evaluating the objective quality calculated according to the video slides gave the panel more than good correlations a novel new method is being introduced for effective wireless ultrasound video communication of error prone channels. With (FMO) type 2 the (ROI) is mapped to the video segments and coded. The (FMO) concept is type 2 It was developed to support variable quality chip coding .The video becomes encoded flexible to have wide range (PLR) ,(ROI) WSNR and PSNR gave good correlations with MOS[37].

Uma Vetri Selvi. G. et al., in 2012 effectively transforming contours and representing them in addition to that it contains a lot of sharp edges that automatic detection of areas containing important information for the diagnostic side. It is an essential component for the evaluation process in terms of compression results, the first step must be measured Image quality using a PSNR and RMS error scale. The second step seeking the help of a specialist and the third step using Calculation time [38].

Babu. D. V. et al., in 2013 the new video codec is called L- Shaped Morphed Codec (LSMC) is based on wave-up. The (LWT) transfer is proposed per frame in the video the first step is to parse the sequence into different subdomains by using Lifting Wavelet Transform (LWT) to the maximum level of degradation scan order from top to bottom and left to right if the pixels it was great this improves the distortion rate. To perform loss compression there are experimental results the (LSMC) that was proposed was shown to be superior to the standard for codecs like Set Partitioning in Hierarchical Trees (SPIHT) and Set a Partitioned Embedded Block Programmer (SPECK) for non-lost and losing pressure to lose Compression (LSMC) works well at high bit rates as well low bit rates. The average (Bits Per Pixel) required lossless pressure by (LSMC) is less than SPECK [39].

Razaak. M. et al., in 2014 we can evaluate the latest video quality standards for zip-files for a video sequence for a medical ultrasound a video quality scale includes diagnostic quality in the video by evaluating the correlation of each measure with personal opinions of expert medical doctors. Shows visual information accuracy global quality index metrics and structural similarity index check the performance of the (High-Efficiency Video Codec Video) compression standard to compress the videos for medical ultrasound. Through the test results the result showed that the use of (HEVC) coding noting the video sequence of ultrasound is diagnostically reliable compression. The medical videos were ultrasound assessed with the latest Video Quality Assessment (VQA) meters correlation between subjective and objective (VQA) measures .Dozens of experts and non-experts are used as benchmarks Indicates the efficiency of the (VQA) metrics in predicting the visual quality of the processed video and diagnosing. Through the results of the experiments it was found that (SSIM) Visual Information Fidelity (VIF) and Universal Quality Index (UQI) are among the best measures to assess the quality of the medical ultrasound video [40].

Mohan raj. R. et al., in 2015, Uses SVC performance analysis and evaluation correct wavelet conversion for medical video compression for tires Spatial, temporal, and fidelity are three features of SVC's scalability. Standard performance measures such as the pressure ratio of MSE and PSNR is evaluated.H.264 / SVC provides better compression than (AVC) medical videos form high-definition transmission at a faster rate to solve the problem during the time of emergency the diagnosis must be made as soon as possible by a doctor. A criterion must be evaluated H.264 / SVC for medical video required in medical videos H.264 / AVC for SVC are various tools to reduce the loss in coding performance for single layer coding .For effective compression using the rated pressure ratio waveform and integer peak-to-noise signal Ratio(PSNR) and average square error value (MSE) for medical videos compressed [41].

Chaabouni. A. et al., in 2016 Compression with loss is becoming increasingly important for the transfer and storage of large amounts of digital data by remote medical care. Loss of information from this type of stress can be considered to have risks in medical practice and medical applications such as diagnosis. To reduce these risks there must be a balance between what the experts recognize and the efficiency of pressure quality this is done through a personal assessment of the quality of the compressed medical data.By setting bitrate thresholds for H.264 compression, medical sequences quality assessment algorithms such as (MSSIM, NQM, MSE, SSIM, NIQE and BRISQUE) can be used and is useful for calculating realism. Pressure ratios during the initial study these results were improved and used the new HEVC video codec standard which appears to be more efficient than H.264 in terms of objective video quality. That the possibility of losing the encoding of the full HD medical video without noticing the presence of any quality loss. And with telemedicine we can compress medical videos very drastically without changing doctors' opinions and perceptions[42].

Habchi. Y. et al., in 2016 Suggest a new pressure chart for medical videos using a frame engineering system building the result of the motion is a reduction temporal / spatial redundancy as a result of correlation. The results of the experiments showed that proposed algorithm (Bandelet-SPIHT) .Compare it with PSNR and with some newer technologies especially MPEG-4 and H.264 demonstrates the high performance of the proposed medical files for charts in medical imaging at low rates. The new scheme has very interesting results this is why a candidate is serious about standardization in medical video compression [30].

Chang. Y. J. et al., in 2017 There are many methods of compression without any loss in altitude Efficient Video Codecs (HEVC) The (GIBC) version was first proposed to predict coding units. The coder suggested for the medical video is based on HEVC (HMC) which combines a line-coded GIBC board, Expect coding and onboarding without any mutual conflicts over medical video clips GIBC taps the chosen RB .And rebuild the current CU and with the help of CBP and by using Two filter blocks enclosing the joint geometry, The analysis of RPC and LPC to suggest a distinctive brand HMC, which integrates IPP, GIBC, LPC and above. Suggestions for which video compression methods through this can contribute to analyze and accelerate the realization medical video applications in the fields of mobile health systems [43].

Le. L. N. et al., in [2018**]** Grouping video frames into a collection of images (GOP) is an initial step in the video pressure to obtain a high percentage of pressure a new method for grouping video frames in a (GOP) collection based on the ideal intersection point theory. For region sand we find the relationship between the object in successive frames with the change for intersection areas experiments results that appear to suggest an effective method for videos that contain many or few objects for sudden change videos (GOP) can be obtained to adapt the (GOP) structures base on ideal cross region theory (ICR) B when we analyze any frame in the (ICR) reports to get maps of the (ICRs) in the frame. Maps are used to some extent to define GOPs are subsequently used for the compression process the compression ratio is 3 to 4 times being acceptable compression result without loss. Less detailed frame videos contain fewer (ICRs) but file space all (ICRs) have large compression ratio top of various frame videos[44].

Babu. D. V. et al., in [2018] L-shaped Morphed Codec (LSMC) using the concepts of elevating wavelet conversions have been applied in medical fields for video sequences morphology expansion is used for the resulting pixels in different sub-ranges during Analysis .Perform analysis for the (LSMC) codec on three and the clips are displayed for different medical video based on (PSNR) and with respect to different bit rate compared to(SPIHT & spot) . The compression achieved by the (LSMC) codec leads to advance in medical video clips to get the best result from standard codecs for example (SPECK) and (SPIHT). Gives (LSMC) and (SPECK) codecs better performance than(SPIHT) without any loss in medical video[45].

Beladgha. M. et al., in [2019**]** Medical video compression coding method is a well-known technology and is available benefits for higher visual quality for reduced spatial redundancy and good first video coding.

There are many complex geometric shapes in the video after describing the lifting process in the tape itself by means of quadruple tree decomposition and improvement of the visual quality of the tree .For a medical video sequence the band-based lost medical video encoding algorithm is optimized for (SPIHT) rate and encoder proposed on the one hand a medical video reconfigured by the proposed algorithm can be produced in a better way visual quality[46].

Panayides. A. S. et al., in [2020] Compare AV1 codecs and performance of emerging Versatile Video Codec (VVCs) row to row with popular (HEVC) applications are the HEVC (HM) test model and x265 together with VP9 codecs achieving suitability for medical applications it is the first performance comparison of the resulting AV1 and VVC video codecs for use in the health care field VVC outperforms all competing codecs and AV1 achieves the best performance for (HEVC) compression efficiency in all situations and with low resolution (560 x 448 @ 40Hz) for ultrasound video study using video clips video clips and a set of general purpose video data. Finally, Netflix suggests using in performance optimization an efficient compression technology it checks the performance of video encoding standards for various medical video clips [47].

3. METHODOLOGY

3.1 INTRODUCTION

video compression in order to reduce file size over storage requirements. It is the process of reducing the total number of bits required for a video sequence or image representation. The aim of this chapter is to explain and reveal a detailed description of the proposed system, namely Principle Component Analysis (PCA) for medical video compression, and to implement a reasonable solution for medical video compressed using the PCA method. The solution of medical video compression problem by PCA is done in these ways: first by dividing the video film into a group of scenes (frames), second finding the variance in each frame by calculating the covariance matrix for each frame, third calculating the eigenvalues then the eigenvectors for each frame which represent the compressed values for each frames in the medical video. This chapter explains all the algorithms and methods used to solve all medical video compression problems.

3.2 PROPOSED SYSTEM DESIGN

The proposed system which present in this study aims to compress the medical video film in an appropriate manner to obtain a suitable compression ratio for all scenes (frames) which included in this medical video. There are below the basis steps which are implementing to compress the frames by using the principle component analysis method:

3.2.1 Medical Videos Providing

In this work, there is an essential demand for providing the library of this work with the medical video films, which collecting from medical clinics specialized in this medical field such as sonar clinics, Echo cardiac clinics, as well as dental clinics, then converts the format of these video films to the (.MP4) file format.

3.2.2 Video Framing

Video framing is the preprocessing process of medical video films and this process is done for all videos using Vision Toolbox (MATLAB programming language) in order to obtain separate images (frames) for each medical video. The medical video film each contains one scene and this scene is divided into 24 frames per second, so that the number of frames for each video movie depends on the time of the video movie, for example the video that contains one second, and contains 24 frames, and the video with two seconds, in it 48 frames, and the 50-frame video will contain 2 seconds and some millisecond time This step converts all the frames of a single scene from the medical video to a set of images.

3.2.3 Frame Resizing

Resizing the size of each frame (image) for each scene for one common size like 300×300 pixel or 500×500 pixel. In this process, the size of all frames (images) is standardized to one size and for all medical video films in order to standardize the compression rate measurement for all frames (images) in all medical video films.

3.2.4 Converting Color Model

One of the most important and necessary steps in the PCA technique is converting the color model of each frame (image) for each scene for all medical video film, from RGB color model to the gray-scale color model.

3.2.5 Frame Averaging

Another important step in the PCA technique is calculating the mean (average) of each frame (image) in the medical video film.

3.2.6 Frame Centroid

In this step in order to achieve the frame centering, subtracting mean of each frame from the original frame (image) in the medical video film.

$$\text{Frame Centroid} \leftarrow (\text{Frame} - \text{Mean}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. \ (3.1)$$

3.2.7 Standard Deviation Calculating

Calculating the standard deviation (STD) of each centroid frame (image) in the medical video film.

3.2.8 Frame Normalization

In this step in order to achieve the frame normalization, calculate the normalized frame for each original frame (image) in the medical video film, this is done by dividing the centroid frame over the standard deviation (STD) of each frame (image).

$$\text{Frame Normalized} \leftarrow (\text{Frame Centroid} / \text{STD}(\text{Frame Centroid})) \quad \ldots\ldots\ldots .. \ (3.2)$$

3.2.9 Covariance Matrix Calculating

Another important step in the PCA technique, which considered as the main step, is the step of calculating the covariance matrix for each normalized frame (image) for each medical video film.

Covariance Matrix ← (Frame Normalized) …………………………….. (3.3)

3.2.10 Eigenvalues Calculating

Find the eigenvalues for each covariance matrix of the frame (image) of medical video film.

Eigenvalue ← (Covariance Matrix) …………………………………… (3.4)

For each frame (image) ordered the eigenvalues from the largest to lowest one, where the largest eigenvalues find the most variance in the frame.

3.2.11 Eigenvectors Calculating

Find the largest 30 eigenvectors of the largest 30 eigenvalues. Do a sort of eigenvectors based on eigenvalues and choose N eigenvectors with largest eigenvalues.

Eigenvector ← (Eigenvalue) ……………………………………… (3.5)

In this step, each frame is transformed into a group of eigenvector, thus reducing the size of each frame (image) in the video film and the video film in general. These eigenvectors for each medical video film are stored in a text file with (.txt) file format, which represent the compressed script for each video film.

3.2.12 Compression Ratio Calculating

Calculate the compression ratio for each medical video film and eigenvector, depending on equation below:

$$\text{Compression Ratio (CR)} \ \frac{\text{Uncompressed Size}}{\text{Compressed Size}} \ \ldots\ldots\ldots\ldots\ldots\ldots \ (3.6)$$

Size of each medical video film (in Kilobyte or Megabyte) is divided on the size of text file (in Kilobyte).

3.2.13 Decompression or Reconstruction of Frames

A decompression operation or reconstruction images is done for all the frames of 7 medical video frames. This operation is depending on equation below which multiplying the matrix of eigenvector by the inverse of eigenvector's matrix and by the normalized frame matrix, as illustrated in equation below:

$$\text{Reconstruction Frame} \leftarrow (\text{Frame Normalized} \times \text{Eigenvector} \times \text{Eigenvector}^{-1}) \ldots\ldots (3.7)$$

3.2.14 MES & PSNR Metric Calculation

After decompression operation and reconstruct all the frames for each medical video film, metric calculation must be done between original frame and reconstruction frame for all videos. The quality of the rebuilt tire pressure is measured using a set of objective measures.

The well-known objective rating of measuring frame quality called peak signal to noise ratio (PSNR) is defined as:

$$PSNR = 10\, log_{10} \left(\frac{(2^n-1)^2}{MSE}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.8)$$

Where, $(2^n - 1)$ it is the dynamic of the signal (the largest possible pixel value). In the standard case of an image where pixel components are encoded at n = 8 bits, (2 ^ n-1) = 255, this means overall high PSNR and excellent build quality.

MSE represents the Mean Square Error between two frames, namely the original frame *f (i, j)* and the recovered frame $f_{r\ (i,j)}$ of size M × N and is given by equation below:

$$MSE = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} (f(i,j) - f_r(i,j))^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.9)$$

3.3 PROPOSED SYSTEM DIAGRAM

There is a final schematic diagram of the proposed system detailing the operation of the proposed system:

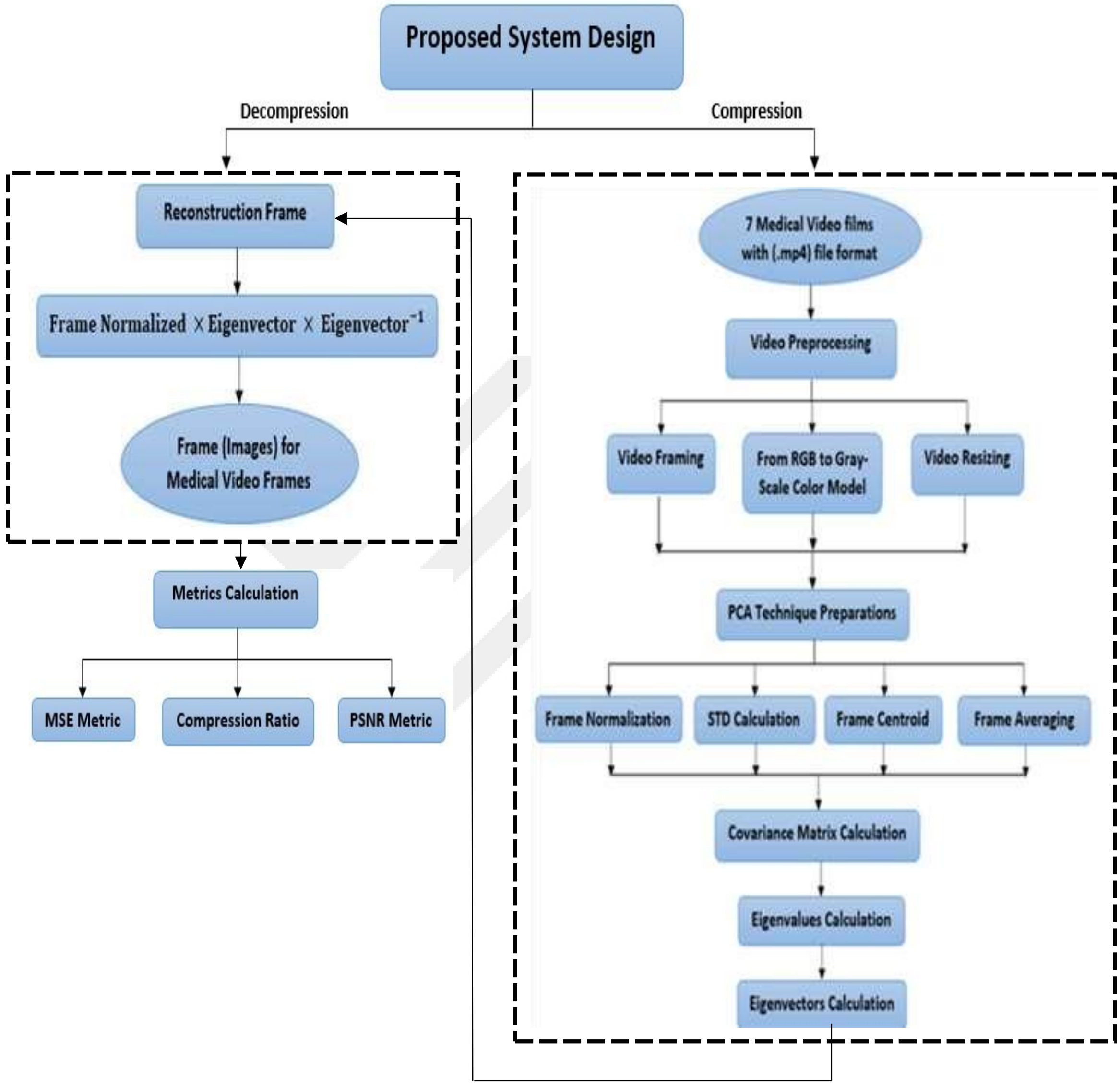


Table 3.3 : proposed system diagram

4. RESULTS OF THE PROPOSED SYSTEM

4.1 INTRODUCTION

There is a major, major and vital step in any project, research or scientific experiment that is the final results step. This chapter is dedicated to explaining and explaining all the proposed applications of PCA medical video compression and their results. This chapter explains the main parts of the implementation system and explains the experimental results obtained from the medical video. Suggested system requirements include hardware and software tools.

This proposed system is built with Matlab R2013b and its Vision Toolbox, under Windows10.This proposed system is implemented by personal computer with Intel(R) Core (TM) i7 -6600U CPU 2.60 GHz 2.81 GHz, RAM 8.00 GB.

4.2 PROPOSED SYSTEM RESULTS

In this chapter, there is a presentation and an explanation of all the results obtained. The proposed system, supported by figures describing the details of the work step by step with the results.

4.2.1 Video Preprocessing

The first operation to be executed is download 7 medical videos with (MP4) file format from the proposed system library to the program. Then video framing and resizing and converts from RGB color model to the gray-scale color model. Figure (4.1) represent some frames of medical video 1.

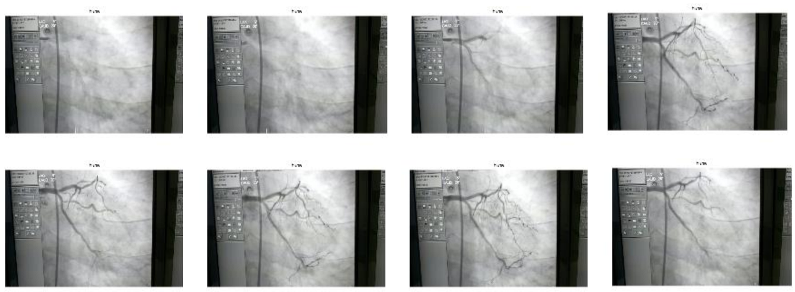


Figure 4.1: Some frames of medical video 1

Figure (4.2) represent some frames of medical video 2, Figure (4.3) represent some frames of medical video 3, Figure (4.4) represent some frames of medical video 4, Figure (4.5) represent some frames of medical video 5, Figure (4.6) represent some frames of medical video 6, and Figure (4.7) represent some frames of medical video 7.

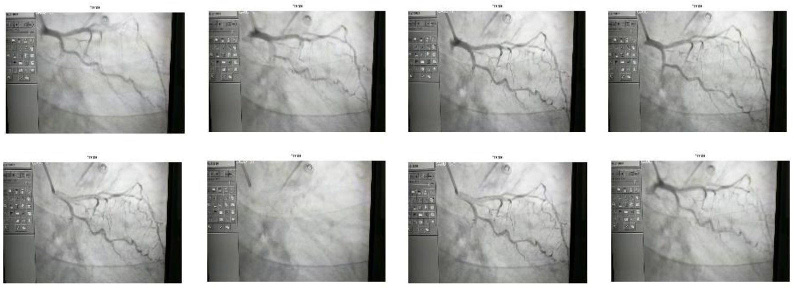


Figure 4.2: Some frames of medical video 2

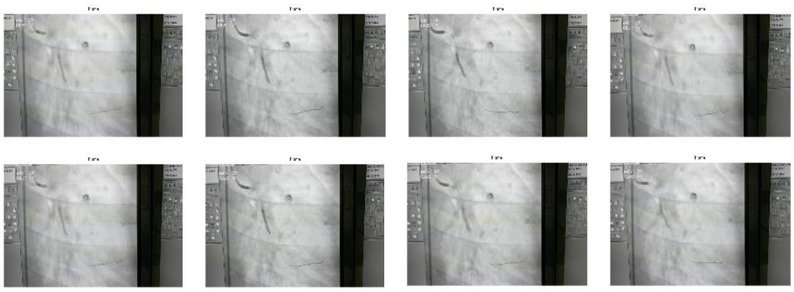


Figure 4.3: Some frames of medical video 3

Figure 4.4: Some frames of medical video 4

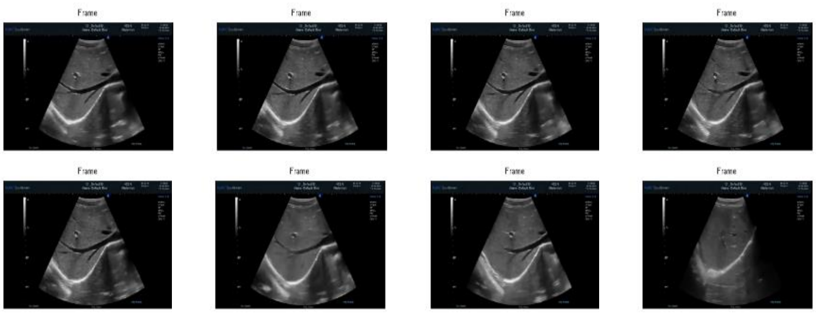


Figure 4.5: Some frames of medical video 5

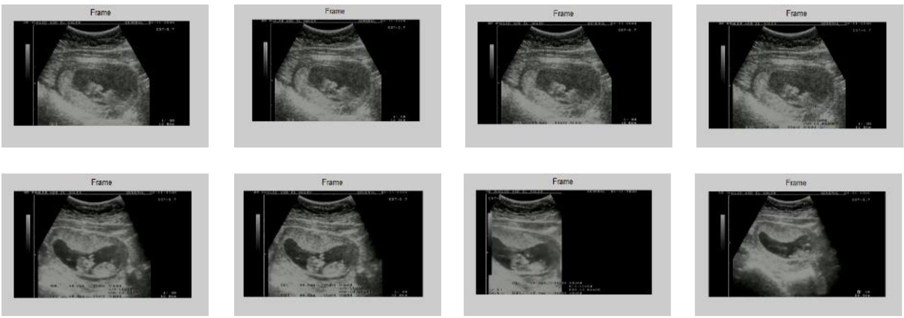


Figure 4.6: Some frames of medical video 6

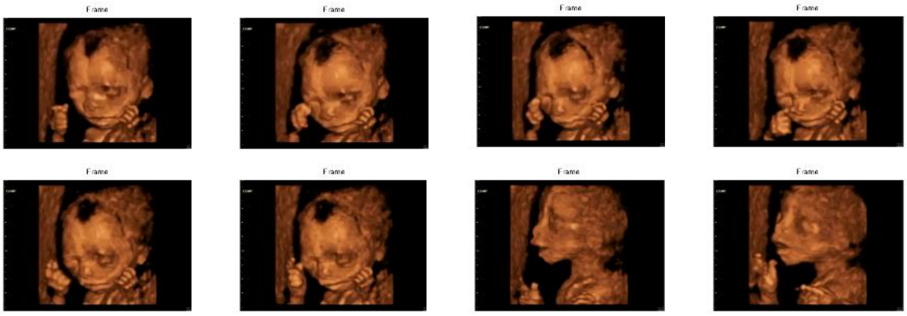


Figure 4.7: Some frames of medical video 7

4.2.2 Frame Averaging Results

Find the mean vectors for each dimension, Figure (4.8) represent the mean of each dimension are obtained for one frame for each 7 medical video films respectively.

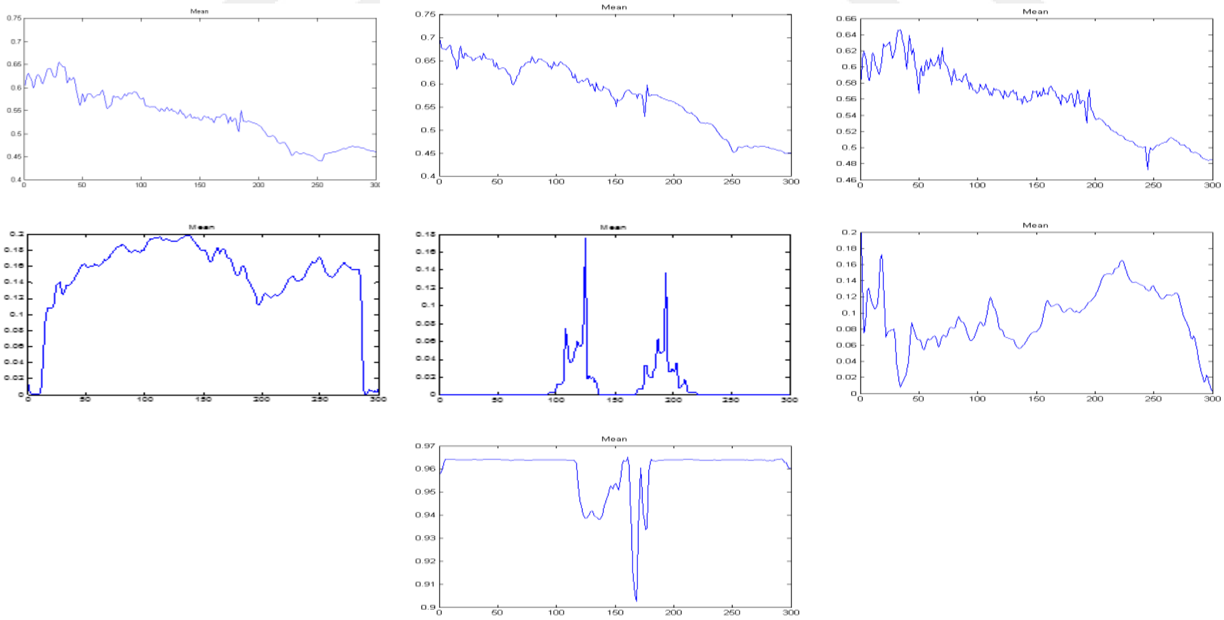


Figure 4.8: Mean of some frames for multiple medical video

4.2.3 Frame Centroid Results

Implement the subtraction operation for each frame in each medical video, Figure (4.9) represent the subtraction operation is obtained for one frame for each 7 medical video films respectively.

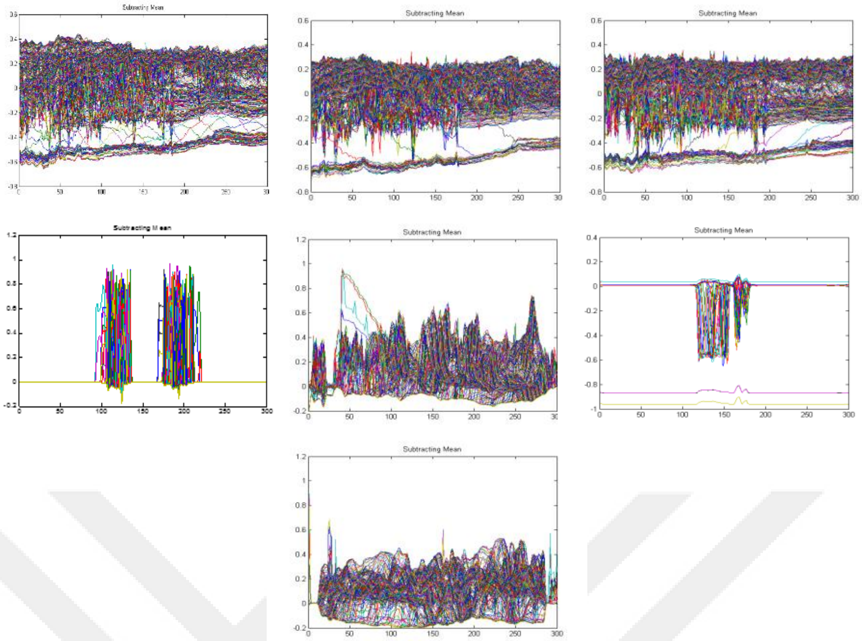


Figure 4.9: Centroid of some frames for multiple medical video

4.2.4 Frame Normalization Results

Implement the normalization operation for each frame in each medical video, Figure (4.10) represent the normalization operation is obtained for one frame for each 7 medical video films respectively.

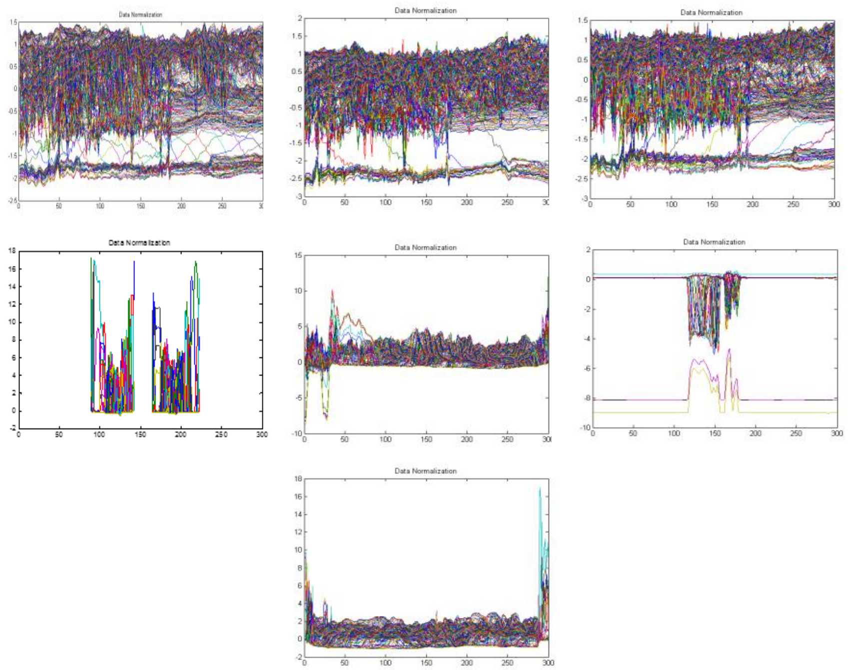


Figure 4.10: Normalization of some frames for multiple medical video

4.2.5 Covariance Matrix Results

Calculate the covariance matrix for each frame in each medical video film, Figure (4.11) represents the covariance matrix results which are obtained for one frame for each 7 medical video films respectively.

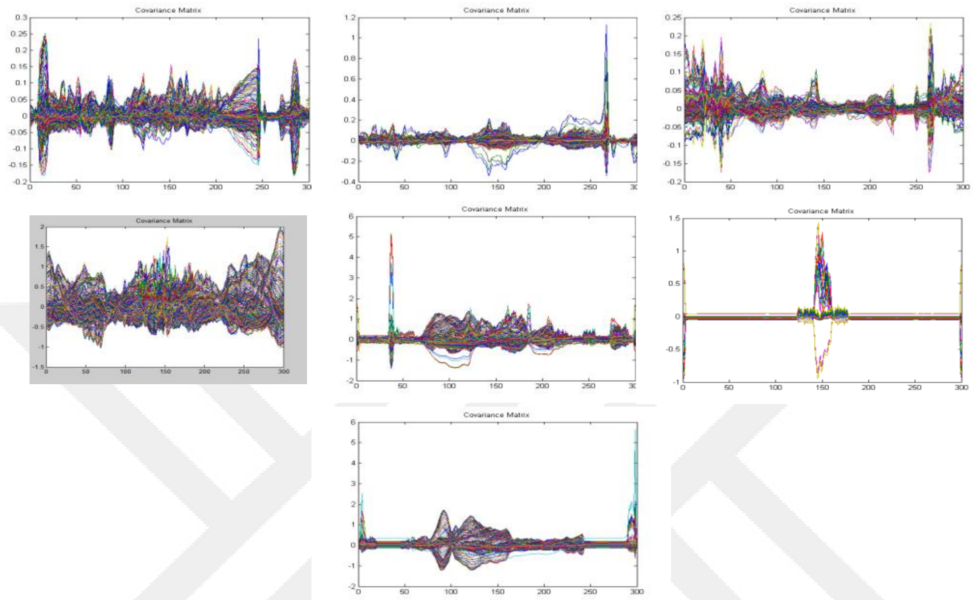


Figure 4.11: Covariance matrix of some frames for multiple medical video

4.2.6 Eigenvalue Results

Calculate the eigenvalues for each frame in each medical video film, Figure (4.12) represent the eigenvalues results which are obtained for one frame for each 7 medical video films respectively.

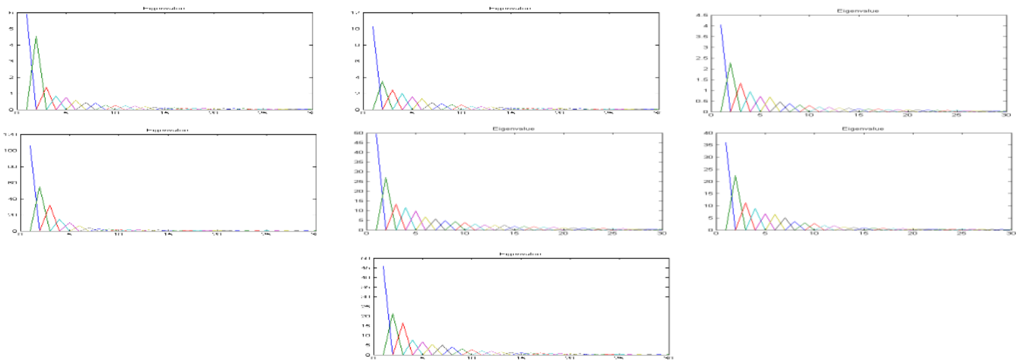


Figure 4.12: Eigenvalues of some frames for multiple medical video

4.2.7 Eigenvector Results

Calculate the eigenvectors for each frame in each medical video film, Figure (4.13) represent the eigenvectors results which are obtained for one frame for each 7 medical video films respectively. These vectors represent the vectors of compression file for medical video films.

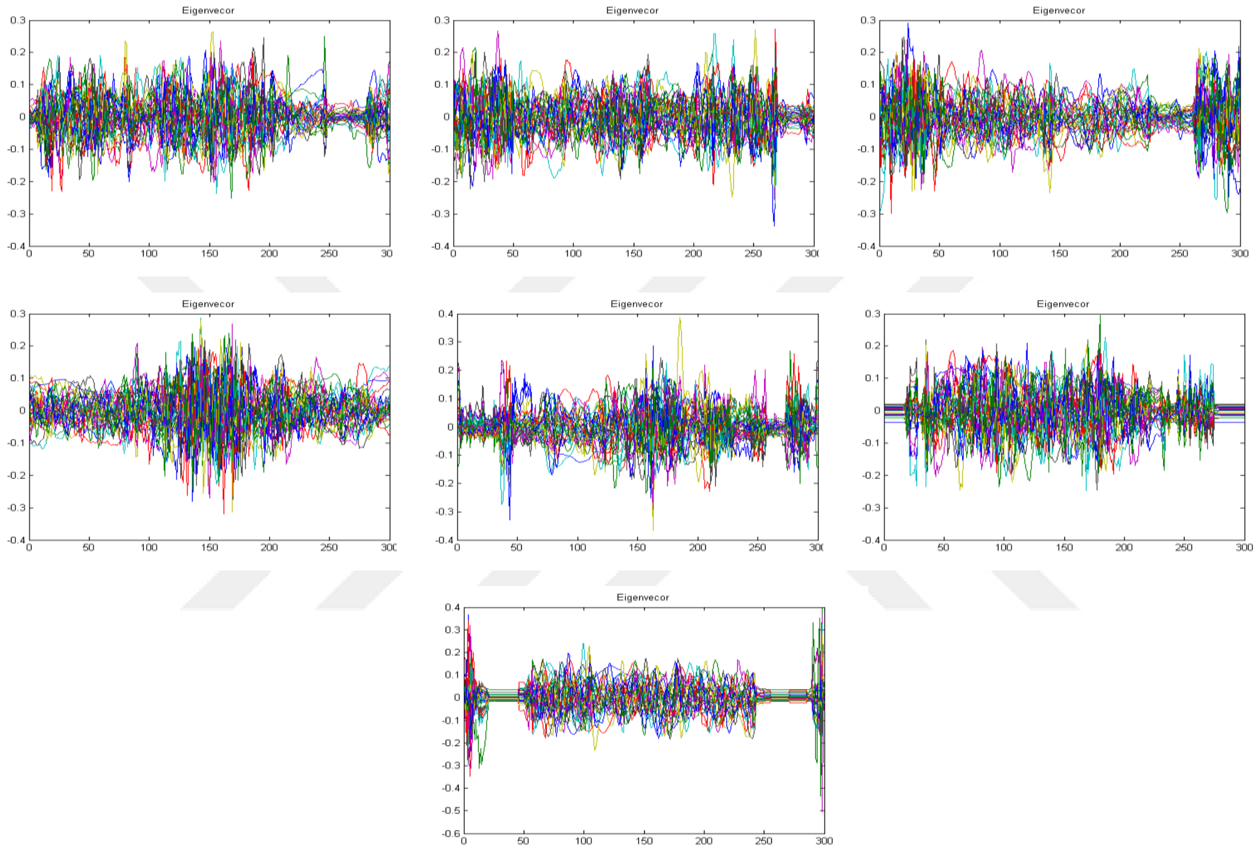


Figure 4.13: Eigenvectors of some frames for multiple medical video

4.2.8 Text File of Eigenvectors Results

The eigenvectors for each frame in each medical video film will be stored in a text file with (.txt) file format. Figure (4.14) represent the text file results for all eigenvectors which are obtained for each 7 medical video films respectively.

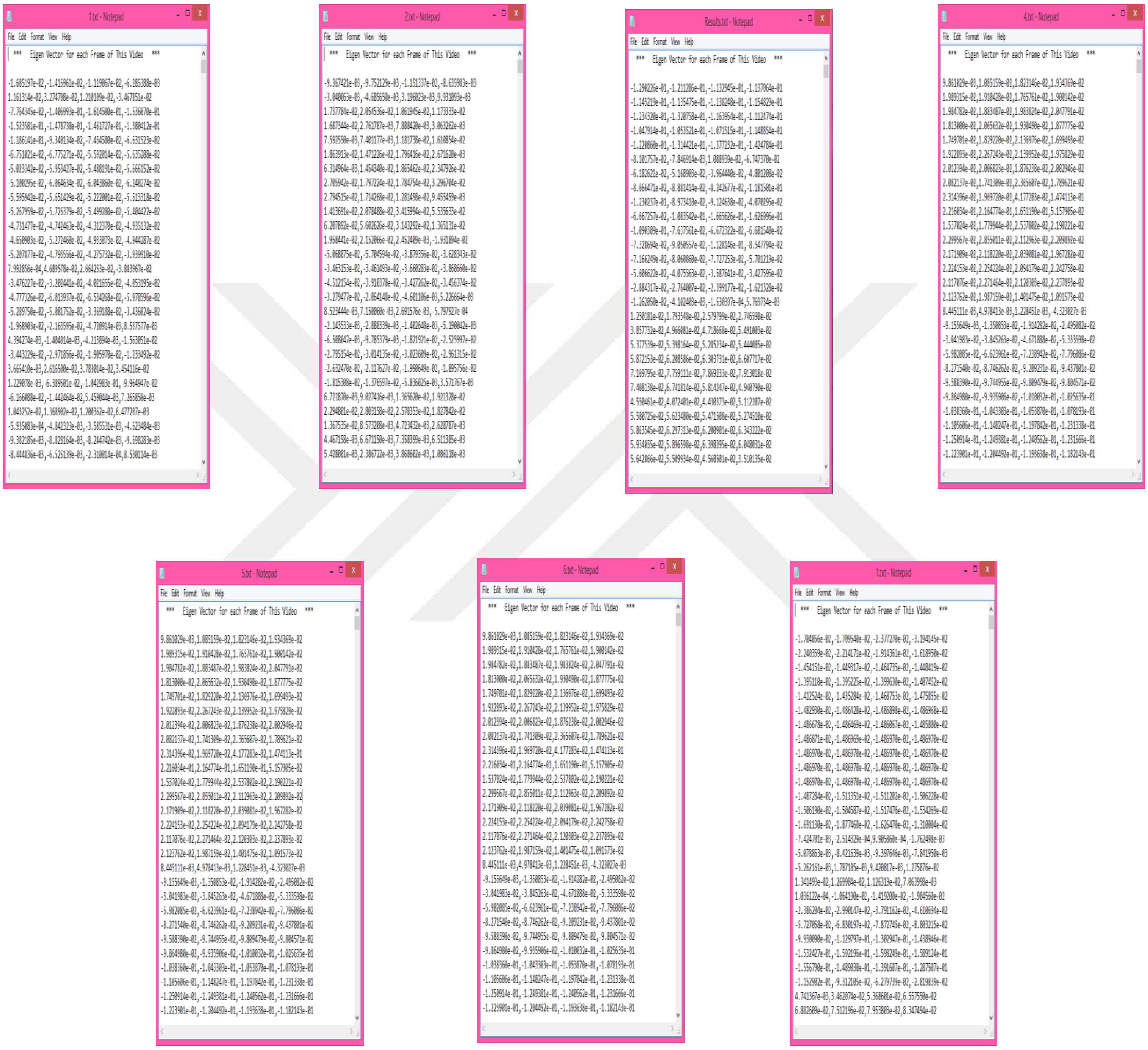


Figure 4.14: Text file for all eigenvectors for each 7 medical video films

4.2.9 Compression Ratio of Calculation Results

Calculate the compression ratio for medical video film and eigenvector, Table (1), showed the size of medical video films (uncompressed files) with size of eigenvectors values (compressed files), and the compression ratio CR for compression operation.

Table 4.1: Compression ratio of calculation results

No. of Video	Size of Video	Size of Text File of Eigenvector	Compression Ratio
1	1.46 MB	498.34 KB	3:1
2	2.58 MB	880.64 KB	3:1
3	1.20 MB	307.2 KB	4:1
4	1.20 MB	955.7 KB	3:1
5	564 KB	141 KB	4:1
6	4.83 MB	1.65 MB	3:1
7	420 KB	105 KB	4:1

4.2.10 Decompression of Frames Result

Calculates the peak signal to noise ratio (PSNR) and the square average error between the medical video and the original medical video frames decompressed for all 7 videos.Table (2), showed the number for each video, number of frames, values of PSNR and the value of MSE

Table 4.2: Compression ratio of frames result

No. of Video	No. of Frame	PSNR	MSE
1	163	133	4.1152e-09
2	295	194	3.5173e-15
3	132	144	3.2144e-10
4	643	Inf	0
5	194	Inf	0
6	1367	238	1.5790e-19
7	157	171	8.0914e-13

5. CONCLUSIONS AND FUTURE WORKS

5.1 INTRODUCTION

Video compression is a process to reduce the total number of bits required for a video sequence or to represent a specific image. Video compression is widely implemented by a program that has a specific format or algorithm, or to determine a better way to reduce the size of the data. This thesis has concentrated on compressing the medical video and reduces the amount of redundancy of the data. The statistical approach "Principle Component Analysis method" was adopted transforms an original set of variables into a smaller set of uncorrelated variables. Use all the processes described in chapter three to design the proposed system and solve all the redundancy problems present in the medical video.

5.2 CONCLUSIONS

In the fourth chapter, the implementation of the proposed system and the results obtained are presented. In this chapter, some observations and suggestions related to the performance of the proposed system are mentioned. Some important conclusions are summarized below:

A. From table (4.1) in chapter four, can observe the compression ratio for all video films ranges between [(3:1) to the (4:1)]. This indicates that this method compresses the video medical film by a quarter or a third of the film.

B. From table (4.2) in chapter four, can observe the high value of PSNR for most medical videos, this indicates the efficiency of this compression method for video films.

C. From table (4.2) in chapter four, can observe the low value of MSE for most medical videos, this also indicates the efficiency of this compression method for video films.

D. Difficulty obtaining medical video films, due to the inability to collect them from medical clinics.

E. Choose the highest 30 eigenvalues, and eigenvectors for each frame, gives the best results for the compression process.

5.3 FUTURE WORKS

There are still, however, An area in other business needs may be implemented and further developments may be made. Several suggestions can be mentioned; These suggestions can be considered as a basis for future work and also summarized as follows:

A. Use another type of dimensionality reduction, which is Linear Discriminant Analysis (LDA) is a supervised machine learning method, and make a comparison with PCA method then determine which is better for compressing the medical video films.
B. Using the PCA compression method for a larger number of medical videos (more than 50 videos) to demonstrate the efficiency of this method.
C. Developing the steps of the PCA algorithm to give better results in the compression process.
D. Using another metrics to measure the efficiency of this method in the process of compression and image retrieval, such as a Structural Similarity Index (SSIM).

Reference

[1] A. S. Viji and K. Edet Bijoy, “Advanced high-resolution, low-delay medical ultrasound video communication using H.264/AVC over LTE network,” *11th IEEE India Conf. Emerg. Trends Innov. Technol. INDICON 2014*, pp. 0–5, 2015, doi: 10.1109/INDICON.2014.7030665.

[2] I. U. Rehman, M. M. Nasralla, A. Ali, I. Maduka, and N. Y. Philip, “The influence of content and device awareness on QoE for medical video streaming over small cells : Subjective and objective quality evaluations,” *2018 Int. Conf. Innov. Intell. Informatics, Comput. Technol. 3ICT 2018*, pp. 1–7, 2018, doi: 10.1109/3ICT.2018.8855779.

[3] A. Panayides, M. S. Pattichis, C. S. Pattichis, C. N. Schizas, A. Spanias, and E. Kyriacou, “An overview of recent end-to-end wireless medical video telemedicine systems using 3G,” *2010 Annu. Int. Conf. IEEE Eng. Med. Biol. Soc. EMBC’10*, pp. 1045–1048, 2010, doi: 10.1109/IEMBS.2010.5628076.

[4] A. N. Kumar, M. I. Miga, T. S. Pheiffer, L. B. Chambless, R. C. Thompson, and B. M. Dawant, “Automatic tracking of intraoperative brain surface displacements in brain tumor surgery,” *2014 36th Annu. Int. Conf. IEEE Eng. Med. Biol. Soc. EMBC 2014*, pp. 1509–1512, 2014, doi: 10.1109/EMBC.2014.6943888.

[5] M. S. A. Panicker, H. Frigui, and A. W. Calhoun, “Identification of cardio-pulmonary resuscitation (CPR) scenes in medical simulation videos using spatio-temporal gradient orientations,” *5th Int. Conf. Image Process. Theory, Tools Appl. 2015, IPTA 2015*, pp. 365–369, 2015, doi: 10.1109/IPTA.2015.7367167.

[6] P. D. Byrnes and W. E. Higgins, “Efficient Bronchoscopic Video Summarization,” *IEEE Trans. Biomed. Eng.*, vol. 66, no. 3, pp. 848–863, 2019, doi: 10.1109/TBME.2018.2859322.

[7] T. Bouwmans, S. Javed, H. Zhang, Z. Lin, and R. Otazo, “On the Applications of Robust PCA in Image and Video Processing,” *Proc. IEEE*, vol. 106, no. 8, pp. 1427–1457, 2018, doi: 10.1109/JPROC.2018.2853589.

[8] N. A. Qureshi, V. Suthar, H. Magsi, M. J. Sheikh, M. Pathan, and B. Qureshi, “Application of Principal Component Analysis (PCA) to Medical Data,” *Indian J. Sci. Technol.*, vol. 10, no. 20, pp. 1–9, 2017, doi: 10.17485/ijst/2017/v10i20/91294.

[9] A. Caprihan, G. D. Pearlson, and V. D. Calhoun, “Application of principal component analysis to distinguish patients with schizophrenia from healthy controls based on fractional anisotropy measurements,” *Neuroimage*, vol. 42, no. 2, pp. 675–682, 2008, doi: 10.1016/j.neuroimage.2008.04.255.

[10] M. Suganthy and P. Ramamoorthy, “Principal component analysis based feature extraction, morphological edge detection and localization for fast iris recognition,” *J. Comput. Sci.*, vol. 8, no. 9, p. 1428, 2012.

[11] R. C. Gonzalez and R. E. Woods, *Digital Image Processing, 4e*. .

[12] W. N. Ibrahem, "Types of Digital Images," ©*Asst. Lec.*, pp. 1–13, 2014, [Online]. Available: http://uotechnology.edu.iq/ce/lecture 2013n/4th Image Processing _Lectures/DIP_Lecture2.pdf.

[13] M. Image, *Multimedia Image and Video Processing*. 2017.

[14] S. A. A. Alagha, "Emotion Classification Model for Audio/Video Synchronization," 2016.

[15] "5 Film frame - Wikipedia." .

[16] "6 Frame Translation." [Online]. Available: http://www.bioline.com/media/calculator/01_13.html.

[17] M. Singh, S. Kumar, S. Singh, and M. Shrivastava, "Various Image Compression Techniques: Lossy and Lossless," *Int. J. Comput. Appl.*, vol. 142, no. 6, pp. 23–26, 2016, doi: 10.5120/ijca2016909829.

[18] L. A. Fitriya, T. W. Purboyo, and A. L. Prasasti, "A review of data compression techniques," *Int. J. Appl. Eng. Res.*, vol. 12, no. 19, pp. 8956–8963, 2017.

[19] I. E. Richardson, *H. 264 and MPEG-4 video compression: video coding for next-generation multimedia*. John Wiley & Sons, 2004.

[20] M. Mofarreh-bonab, "Adaptive Video Compression using PCA Method," vol. 44, no. 21, pp. 6–11, 2012.

[21] Y. Chen, Z. Huang, H. Sun, M. Chen, and H. Tan, "Lossy image compression using PCA and contourlet transform," *MATEC Web Conf.*, vol. 54, pp. 1–5, 2016, doi: 10.1051/matecconf/20165408002.

[22] T. Ebrahimi and M. Kunt, "Visual data compression for multimedia applications," *Proc. IEEE*, vol. 86, no. 6, pp. 1109–1124, 1998, doi: 10.1109/5.687832.

[23] R. Kiran and C. Kamargaonkar, "Region based medical image compression using block-based PCA," *2016 International Conference on Computation of Power, Energy, Information and Communication, ICCPEIC 2016*. pp. 91–96, 2016, doi: 10.1109/ICCPEIC.2016.7557230.

[24] J. Kalita and K. Das, "Recognition of Facial Expression Using Eigenvector Based Distributed Features and Euclidean Distance Based Decision Making Technique," *Int. J. Adv. Comput. Sci. Appl.*, vol. 4, no. 2, pp. 196–202, 2013, doi: 10.14569/ijacsa.2013.040229.

[25] N. J. Higham, "Computing the nearest correlation matrix - A problem from finance," *IMA J. Numer. Anal.*, vol. 22, no. 3, pp. 329–343, 2002, doi: 10.1093/imanum/22.3.329.

[26] "covariance-definition." .

[27] W. E. Vieux, K. Schwerdt, and J. L. Crowley, "Face-tracking and coding for video compression," *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, vol. 1542, pp. 151–161, 1999, doi: 10.1007/3-540-49256-9_10.

[28] W. R. Schwartz, H. Pedrini, and L. S. Davis, "Video compression and retrieval of moving object

location applied to surveillance," *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, vol. 5627 LNCS, pp. 906–916, 2009, doi: 10.1007/978-3-642-02611-9_89.

[29] U. Sderstrm and H. Li, "Asymmetrical Principal Component Analysis Theory and its Applications to Facial Video Coding," *Eff. Video Coding Multimed. Appl.*, 2011, doi: 10.5772/14864.

[30] S. Kalangi, V. Maddu, and S. R. Kavuluri, "A Novel Approach of Low Complexity DWT / PCA Based Video Compression Method," vol. 2, no. 3, pp. 159–168, 2013.

[31] S. Mahesh, "A Survey: Various Techniques of Video Compression," *Int. J. Eng. Trends Technol.*, vol. 7, no. 1, pp. 10–12, 2014, doi: 10.14445/22315381/ijett-v7p207.

[32] S. Liu, M. Gu, Q. Zhang, and B. Li, "Principal component analysis algorithm in video compressed sensing," *Optik (Stuttg).*, vol. 125, no. 3, pp. 1149–1153, 2014, doi: 10.1016/j.ijleo.2013.07.120.

[33] S. S. Razali, N. M. Z. Hashim, S. Z. Yahya, K. A. A. Aziz, A. Salleh, and N. R. Mohamad, "Different Approach of VIDEO Compression Technique: A Study," *Int. J. Sci. Eng. Appl.*, vol. 3, no. 5, pp. 143–149, 2014, doi: 10.7753/ijsea0305.1005.

[34] K. Rajalakshmi and K. Mahesh, "A Review on Video Compression and Embedding Techniques," *Int. J. Comput. Appl.*, vol. 141, no. 12, pp. 32–36, 2016, doi: 10.5120/ijca2016909940.

[35] Y. Liu, D. A. Pados, and S. Member, "L 1 -PCA Video Surveillance," vol. 18, no. 3, pp. 351–363, 2016, doi: 10.1109/TMM.2016.2514848.

[36] N. Nouri, D. Abraham, J. Moureaux, M. Dufaut, C. H. U. N. Brabois, and R. Morvan, "SUBJECTIVE MPEG2 COMPRESSED VIDEO QUALITY ASSESSMENT : APPLICATION TO TELE-SURGERY Centre de Recherche en Automatique de Nancy , Nancy-Université , CNRS Centre de Recherche en Automatique de Nancy , Nancy-Université , CNRS," *Analysis*, pp. 764–767, 2010.

[37] A. Panayides, M. S. Pattichis, C. S. Pattichis, C. P. Loizou, M. Pantziaris, and A. Pitsillides, "Atherosclerotic plaque ultrasound video encoding, wireless transmission, and quality assessment using H.264," *IEEE Trans. Inf. Technol. Biomed.*, vol. 15, no. 3, pp. 387–397, 2011, doi: 10.1109/TITB.2011.2105882.

[38] G. Uma Vetri Selvi and R. Nadarajan, "Coronary angiogram video compression using wavelet-based contourlet transform andregion-of-interest technique," *IET Image Process.*, vol. 6, no. 8, pp. 1049–1056, 2012, doi: 10.1049/iet-ipr.2011.0284.

[39] D. V. Babu and N. R. Alamelu, "A novel morpho codec for medical video compression," *2013 IEEE Int. Conf. Comput. Intell. Comput. Res. IEEE ICCIC 2013*, 2013, doi: 10.1109/ICCIC.2013.6724246.

[40] M. Razaak, M. G. Martini, and K. Savino, "A Study on Quality Assessment for Medical

Ultrasound Video Compressed via HEVC," *IEEE J. Biomed. Heal. Informatics*, vol. 18, no. 5, pp. 1552–1559, 2014, doi: 10.1109/JBHI.2014.2326891.

[41] R. Mohanraj and B. Karthik, "Medical Video Compression Using Integer Wavelet Transform Systems in H . 264 / SVC Standard," vol. 1, pp. 2639–2645, 2015.

[42] A. Chaabouni, Y. Gaudeau, J. Lambert, J. M. Moureaux, and P. Gallet, "H.264 medical video compression for telemedicine: Aperformance analysis," *Irbm*, vol. 37, no. 1, pp. 40–48, 2016, doi: 10.1016/j.irbm.2015.09.007.

[43] Y. J. Chang, P. H. Tsai, and C. L. Lin, "Novel medical video compression methods over lossless HEVC coder," *ICASSP, IEEE Int. Conf. Acoust. Speech Signal Process. - Proc.*, pp. 1687–1691, 2017, doi: 10.1109/ICASSP.2017.7952444.

[44] L. N. Le, S. T. Nguyen, N. X. Nguyen, and T. T. Dang, "A principle of adaptively grouping frames on lossless medical video compression using ideal cross-point regions," *IFMBE Proc.*, vol. 63, pp. 19–23, 2018, doi: 10.1007/978-981-10-4361-1_4.

[45] D. V. Babu and N. R. Alamelu, "L Shaped Morpho Codec for Medical Video Sequences," *2018 IEEE Int. Conf. Comput. Intell. Comput. Res. ICCIC 2018*, pp. 1–3, 2018, doi: 10.1109/ICCIC.2018.8782422.

[46] M. Beladgham, Y. Habchi, M. Ben aissa, and A. Taleb-Ahmed, "Medical video compression using bandelet based on lifting scheme and SPIHT coding: In search of high visual quality," *Informatics Med. Unlocked*, vol. 17, 2019, doi: 10.1016/j.imu.2019.100244.

[47] A. S. Panayides, M. S. Pattichis, M. Pantziaris, A. G. Constantinides, and C. S. Pattichis, "The Battle of the Video Codecs in the Healthcare Domain - A Comparative Performance Evaluation Study Leveraging VVC and AV1," *IEEE Access*, vol. 8, pp. 11469–11481, 2020, doi: 10.1109/ACCESS.2020.2965325.