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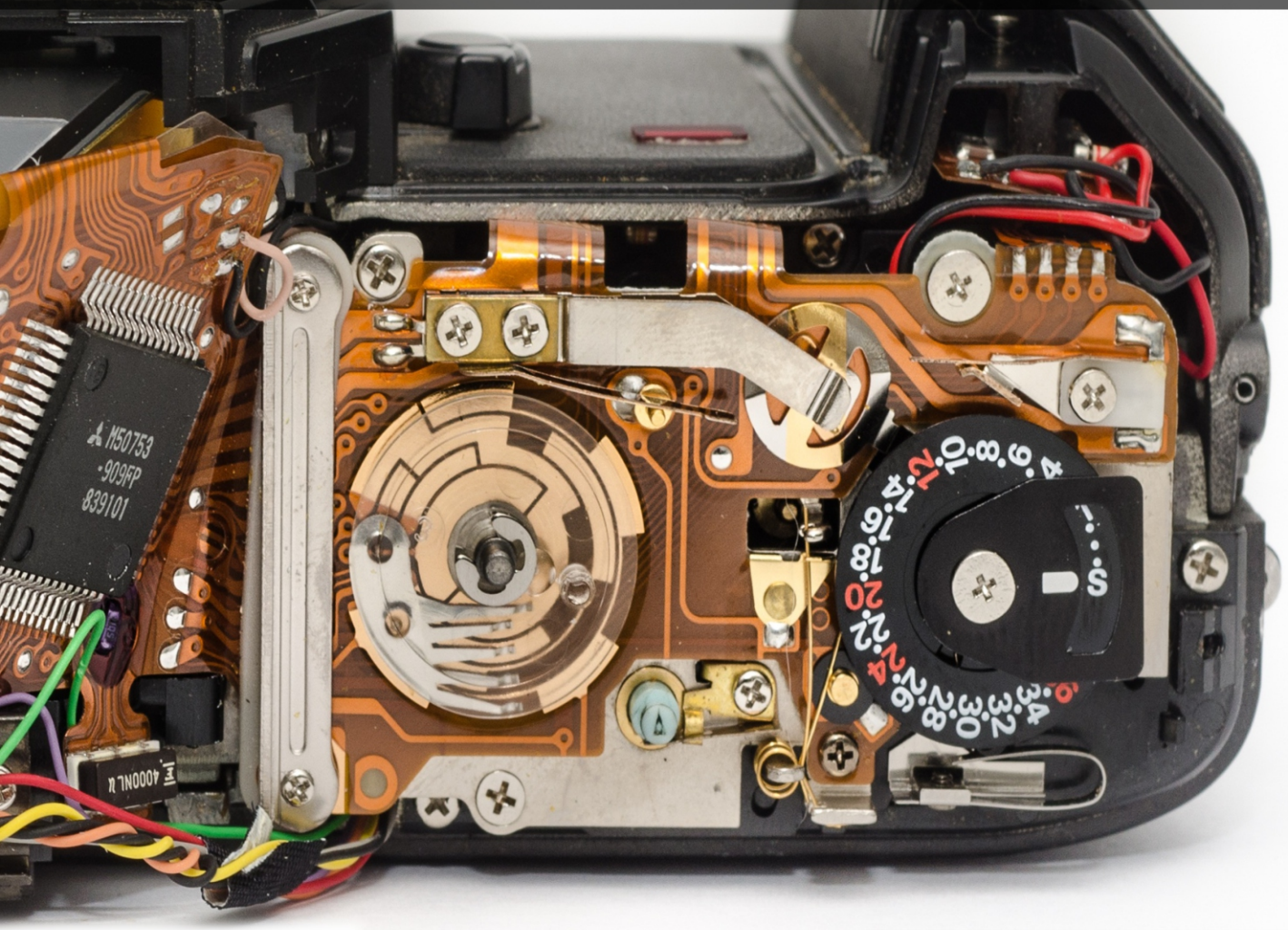

Highlights

Non Blind Watermarking

Towards Developing an Effective

Methodical Study of Content

Multimodal Biometrics Enhancement

Discovering Thoughts, Inventing Future

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Towards Developing an Effective Hand Gesture Recognition System for Human Computer Interaction: A Literature Survey

By Santosh Choudhary & Dr. Naveen Choudhary
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Abstract- Gesture recognition is a mathematical analysis of movement of body parts (hand / face) done with the help of computing device. It helps computers to understand human body language and build a more powerful link between humans and machines. Many research works are developed in the field of hand gesture recognition. Each works have achieved different recognition accuracies with different hand gesture datasets, however most of the firms are having insufficient insight to develop necessary achievements to meet their development in real time datasets. Under such circumstances, it is very essential to have a complete knowledge of recognition methods of hand gesture recognition, its strength and weakness and the development criteria as well. Lots of reports declare its work to be better but a complete relative analysis is lacking in these works.

Keywords: hand gesture recognition, neural network (NN), hidden markov model (HMM), Support Vector Machine (SVM), Principle Component Analysis (PCA).

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Towards Developing an Effective Hand Gesture Recognition System for Human Computer Interaction: A Literature Survey

Santosh Choudhary [α] & Dr. Naveen Choudhary [σ]

Abstract- Gesture recognition is a mathematical analysis of movement of body parts (hand / face) done with the help of computing device. It helps computers to understand human body language and build a more powerful link between humans and machines. Many research works are developed in the field of hand gesture recognition. Each works have achieved different recognition accuracies with different hand gesture datasets, however most of the firms are having insufficient insight to develop necessary achievements to meet their development in real time datasets. Under such circumstances, it is very essential to have a complete knowledge of recognition methods of hand gesture recognition, its strength and weakness and the development criteria as well. Lots of reports declare its work to be better but a complete relative analysis is lacking in these works.

In this paper, we provide a study of representative techniques for hand gesture recognition, recognition methods and also presented a brief introduction about hand gesture recognition. The main objective of this work is to highlight the position of various recognition techniques which can indirectly help in developing new techniques for solving the issues in the hand gesture recognition systems. Moreover we present a concise description about the hand gesture recognition systems recognition methods and the instructions for future research.

Keywords: hand gesture recognition, neural network (NN), hidden markov model (HMM), support vector machine (SVM), principle component analysis (PCA) .

I. Introduction

Human computer interaction (HCI) refers to the association between the human and the computer. The machine has no importance if it is not properly exploited. That is also called Man-Machine-Interaction (MMI).For the designing of HCI system we speculate on two important concepts: usability and functionality[9]. The system can be robust and affective on securing balance between usability and functionality. Gestures are to make an efficient and effective way on interaction and communication between the people adopting sign language[1] [10].Usually, HCI is consummate with devices such as mouse and keyboard, which are restricted in terms of operational distance and convenience. By contrast, hand gesture recognition provides an alternative to these awkward devices, and enables people to communicate with computer more easily and naturally [2].

Gestures recognition system increasingly becomes a significant part of human-computer interaction. Movement of humans creates the gestures. Face and/or hands are the sources of gestures. The movement of the body reflects the information/feeling through gestures. Gesture can be “saying hello” but typing something on keyboard is not considered gesture. It is because the movement of fingers typing on the keyboard is not noticeable.

Gestures are of two types: Static and Dynamic. The shape of poses of hands depicts Static Gesture whereas their movement is Dynamic Gesture [7]. Gestures have different versions based on culture/ region of different people which creates diversity and uncertainty [8].

Hand gesture is defined as the combination of all kinds of gestures and movements which produced by hand and arm[8]. Hand gesture is the most animated, mobile, communicative and the most often used, among a range of gestures. Gestures have been utilized as a form to communicate or interact with computers in an effortless and simple way. This type of human-machine interfaces will permit a user to manage and control an ample range of devices through hand gestures recognition. Using hands as a tool can support people interact with PC in a much intuitive way. When they communicate with other people their movements of hand plays an essential role and the data they convey is rich in several ways. They use their hands for denoting an object or person conveying data about shape, temporal and space features. They steadily use their hands to communicate with objects, change them, transform them and move them. In similar unconscious way they gesticulate while interacting to notions. Hand gesture recognition can be mainly divided into two types such as Data Glove-based and Vision based approaches [3]. Data Glove-based approach use a data glove to acquire a motion. In this approach it is possible to analyze 3D space hand motion with perceived data. As it is tedious and incurs high cost, it is not convenient for the user. The users have limitations in using the Vision based methods. Vision based methods have come up as a research area for improving Human

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Computer interaction without use of keyboard, mouse etc. [3].

Vision-based hand gesture recognition has pinched considerable attention from researchers in recent years. An automatic hand gesture recognition system will discover many applications in Human-Computer Interaction area. Hand gesture detection is a fundamental step in the practical application process of this system. It requires the ability to accurately segment the hand from the background. Due to the difficulty of this task, early systems usually require markers or colored gloves to make the detection easier. However, these methods often bring much in convenience for the Human-Computer Interaction process. Moreover, the current research is mainly focused on detecting the bare hand and recognizing hand gestures without any markers and gloves [5].

These days gesture recognition technique is used in a broad range like in Virtual reality, video games, sign language recognition etc. Gesture recognition is done by tools based on various methods like statistical modeling, signal and image processing, pattern recognition and computer vision etc. Statistical modeling been one of the most widely used methods in resolving problems such as HMMs, Kalman filtering, PCA and Finite State Machine (FSM) [6][12][13].

II. Review of Recent Researches on Hand Gesture Recognition System

Hand gesture recognition methods use different research approaches and these approaches are grouped together based on their techniques which they are using in the process of hand gesture recognition. By exploiting different recognition methods, the hand gesture recognition process is examined. Different types of recognition methods utilized by the researchers are such as HMM, NN and SVM, these methods plays vital role in hand recognition method. Most of the earlier researches were based on HMMs, NN and SVM.

a) Literature survey on HMM Based Recognition Methods in Hand Gesture Recognition System

Model based hand recognition system which consists of three phases; feature extraction, training and recognition. In feature extraction phase, spatial and temporal information of each frame is combined by the hybrid technique to extract the feature images. In training phase, spatial shape variation is characterized by principal component analysis (PCA) and temporal shape variations are described through Hidden Markov Models (HMMs). Generation of observation patterns from the input sequences is done with pre-trained PCA and HMMs in the recognition phase. After this Viterbi algorithm is applied for gesture identification [14].

HMM has been proposed for various types of hand gesture recognition. Hand localization, hand tracking and gesture spotting are the three different procedures in the pre-processing stage of this approach. In hand location detection procedure, hand region is detected on the basis of motion and color of skin. A hand trajectory is produced by joining the centroids of moving hand region. The centroid of the moving hand regions is detected through hand tracking algorithm. There after the gesture spotting algorithm separates the trajectory into real and meaningless sectors. A feature database is constructed using angle and velocity feature codes, combined and weighted location uses a k-means clustering algorithm for Hidden Markov Models code book.

Similarly different authors in their papers [16][17][18][19] and [20] have proposed different models or methods or techniques for a hand gesture recognition system.

But hand gesture recognition system is described in "Wearable Sensor-Based Hand Gesture and Daily Activity Recognition for Robot-Assisted Living", here gesture spotting is done by neural network and for contact-based recognition it used hierarchical HMM. The motion data collected from foot and waist of a human subject is processed by a multi-sensor fusion developed for daily activity recognition.

Use of two sensors, three axis accelerometer (ACC) and multichannel electromyography (EMG) sensors, is done for hand gesture recognition [22]. The intensity of EMG signals automatically detects the start and end points of significant gesture segments. The final result is obtained by utilizing a decision tree and multi-stream HMMs as decision level fusion.

b) Literature survey on NN Based Recognition Methods in Hand Gesture Recognition System

Based on motion trajectories, an algorithm classifies and extracts of two-dimensional motion in an image sequence. A homogenous region is generated in each frame by multi-scale segmentation. Two view correspondences are obtained by matching region between two consecutive frames. In order to define pixel match, a fine transformation is calculated from each pair of the corresponding regions.

Pixel-level motion trajectories are obtained by concatenating the pixel matches over consecutive images across the image sequence. Time delay neural network is used to learn about the motion patterns from the extracted trajectories. Forty hand gestures of American Sign Language are recognized in the proposed method.

Similarly different authors in their papers [24][25][26][27][28][29][30] and [31] have proposed different models or methods or techniques or ideas for a hand gesture recognition system.

A method of Hand gesture recognition in Indian Sign Language is proposed [32]. In this the Histograms of Oriented Gradients (HOG) features are used for

recognizing alphabets (A-Z) and numerals (0-9) with a purpose to implement the algorithm of extracting HOG features. The Histograms of Oriented Gradients (HOG) features are used for passing in neural network training for the gesture recognition purpose.

Using neural network a vision based sign gesture recognition system is proposed [33]. In the first step the images of static gestures of American Sign Language were converted into Lab Color space by the system. Parameter L denotes lightness & (a,b) are the dimensions of color-opponent. With color-opponent dimensions skin region segmentation is done using threshold technique. For feature extraction, hand (skin region) is cropped and converted into binary image. After this other dimensions (like height, area, centroid, centroid-distance from the origin) of the image are used as features. In order to train a feed forward back propagation network, we use feature vectors of each set.

c) Literature survey on SVM Based Recognition Methods in Hand Gesture Recognition System

Daehwankim et al have proposed a forward spotting scheme with sliding window and accumulative HMMs. Recognition and segmentation of gesture is executed simultaneously and it is applied to identify upper body gestures for controlling the lights and curtains in a smart home environment [34].

A user independent framework is proposed for demonstrating and identifying hand postures that are used in sign language [35].A hand posture feature, an Eigen space Size Function are proposed, which is robust to classify hand postures independent of the performer. On analysis of the properties of the proposed Eigen space size function, a significant improvement in performance is seen w.r.t original unmodified size function.

In [36] they have used twin support vector machine for gesture classification based on EMG, and shows that this technique is extremely suited to such applications.

Similarly different authors in their papers [37][38][39][40] have proposed different models or methods or ideas for a hand gesture recognition system.

A Gesture Recognition system for Alphabetical Hand Gestures was proposed to simplify the process of interaction of humans with computer [41]. Design of the system is done with the use of Support Vector Machine (SVM) classifier. SVM classifiers are widely used in classification and regression testing. A model is built by SVM training algorithm which predicts if a new example falls into one category or the other.

d) Literature survey on other Methods in Hand Gesture Recognition System

An approach based on fuzzy rule to spatio-temporal hand gesture recognition system is proposed in [42]. For selecting templates, it uses a method based on hyper rectangular composite neural networks (HRCNNs). If-THEN rules, represents the templates for each hand shape, If-THEN rules are obtained from values of synaptic weights of the corresponding trained hyper rectangular composite neural networks (HRCNNs) A special membership function is employed to fuzzify each crisp IF-THEN so that the pattern has similarity to the corresponding predecessor part. For the classification of any unknown gesture, each fuzzy rule tests each sample of the unknown gesture. The collected similarity of all the input samples is computed for each hand gesture in the vocabulary, and then the gesture can be classified as gesture yielding the highest accumulative similarity. A small sized dynamic hand gesture can be implemented based on the method used.

Similarly different authors in their papers [43][44][45][46][47][48][49][50][51][52][53] and [54] have proposed different models or methods or ideas for a hand gesture recognition system.

For gesture recognition, an algorithm framework was proposed which processed acceleration and surface electromyography (SEMG) signals [55].This algorithm includes a score-based sensor fusion scheme, a segmentation scheme and two new features. An improved dynamic time-warping algorithm and bays linear classifier are used in the framework. In addition to that a prototype system is developed to realize gesture-based real-time interaction. The prototype system includes an application program with the proposed algorithmic framework for a mobile phone and a wearable gesture sensing device (embedded with a three-axis accelerometer and four SEMG sensors).

Along with Kinect depth camera a super pixel hand gesture recognition technique based on a novel super pixel earth mover's distance metric was presented [56]. Marker less hand extraction is produced by effectively utilizing the depth and skeleton information from Kinect. The super pixels were represented by the hand shapes, corresponding depths and textures. Overall shapes and color of the gestures, to be recognized, is effectively retained. The dissimilarity between the hand gestures is proposed to be measured by super pixel Earth mover's distance (SP-EMD) and a novel distance metric.

III. Performance Review of Hand Gesture Recognition System

Hand gesture recognition systems have attained different recognition accuracy by using different recognition methods with different database. Here we have to analysis the hand gesture recognition methods recognition accuracy by differentiate the recognition methods. The different recognition methods recognition accuracies are tabulated from Table 1 to 4.

Table 1 : Performance of HMM based hand gesture recognition methods

Author's Name	Database	Recognition Accuracy (%)
Chung-Lin Huang and Sheng-Hung Jeng [14]	18 different gestures from 20 people	Simple gesture 92% Hybrid gesture 87%
Ho-Sub Yoon *et al.* [15]	4800 alphabetical gestures of 20 persons	Cartesian system 96.10% polar systems 96.04%
Feng-Sheng Chen *et al.* [16]	20 different gestures	>90%
Agnes Just *et al.* [20]	Interact Play database Two Hand Manip database	75% and 63% 99% and 97%
Chun Zhu *et al.* [21]	Five gesture data	82% and 91%
Xu Zhang *et al.*[22]	8640 CSL word samples 800 sentence samples	93.1% 72.5%

As mention in the above table-1 in performance of HMM based hand gesture recognition methods, we first analyze the HMM based hand gesture recognition methods with following data. Chung-Lin Huang and Sheng-Hung Jeng have taken simple gestures and hybrid gestures as input data. They have performed test on 10 simple gesture and 8 hybrid gestures and found correct recognition rate for simple gesture above 92% and the hybrid gesture is about 87%.

Similarly different authors analyze with different input data and got different outputs which are given in the above table.

Table 2 : Performance of NN based hand gesture recognition methods

Author's Name	Database	Recognition Accuracy (%)
Ming-Hsuan Yang *et al.* [23]	40 hand gestures	96.21%
Chia-Feng Juang*et al.* [24]	100 temporal gestures	92%
S.S. Ge*et al.* [25]	280 gesture samples	91.9%
Stergiopoulou*et al.* [26]	180 test hand images	90.45%
Heung-Il Suk *et al.* [27]	10 isolated gestures	99.59%
JawadNagi*et al.* [28]	2400 gesture images	96%
Wensheng Li *et al.*[29]	200 samples	94.7%
Trong-Nguyen Nguyen *et al.* [30]	445 samples	98%
Ao Tang *et al.* [31]	36 hand postures	98.12%
Parul Chaudhary *et al.* [33]	-	85%

As mention in above table-2 in performance of NN based hand gesture recognition methods we analyze second NN based hand gesture recognition methods with following data. Ming-Hsuan Yang et al. have applied the proposed method to recognize 40 hand gestures of American Sign Language. The resulting average recognition rates on the training and testing sets for gesture recognition were 99.02% and96.21%, respectively. Similarly different authors analyze with different input data and got different outputs which are given in the above table. Parul Chaudhary *et al.* trained and tested images with the help of image dataset of the proposed system. The dataset of images contains '.jpg format' of four static sign gestures of ASL. The performance of the proposed system was analyzed by the created image database that achieved an average recognition accuracy of 85%.

Table 3 : Performance of SVM based hand gesture recognition methods

Author's Name	Database	Recognition Accuracy (%)
Daehwan Kim *et al.* [34]	480 test gesture sequences	95.42%
Daniel Kelly *et al.* [35]	ISL Triesch	97.3% 93%
Ganesh R. Naik *et al.* [36]	49 sets of data	86%
Nasser H. Dardas *et al.* [38]	Sebastien Marcel database	96.23%
Daniel Kelly *et al.* [39]	962 signs	82.3%
Nasser H. Dardas *et al.* [40]	Four gestures with 1000 frames	97.6%
Aseema Sultana *et al.* [41]	5 alphabetical dynamic hand gestures	80%

As mention in above table-3 in performance of SVM based hand gesture recognition methods we analyze third SVM based hand gesture recognition methods with following data. Daehwan Kim *et al.* have used 480 test gesture sequences and results show that the proposed method has a good recognition rate of 95.42% for continuously changing gestures.

Daniel Kelly *et al.* have taken two different datasets: ISL and Triesch. 5520 hand postures images were used to train the SVMs, for the ISL data set. Data of half of the 16 subjects constituted the 5520 training images. On the remaining 5520 images, the recognition framework was tested. Two evaluation protocols (P1 & P2) were carried out for the Triesch data set.

Based on the same protocol as Triesch and von der Malsburg, the first evaluation was performed (2002). The data extracted from 3 of the 24 signer was used in the training of the SVMs on each of the 10 hand signs. Testing of the system is done on all the hand signs from remaining 21 subjects. In second evaluation, 8 of the 24 signers are used for training a validation and for testing the rest of the 16 used. The result of the experiments shows that the system is robust and recognition of hand gestures is independent of the person performing them. Similarly different authors analyze with different input data and got different outputs which are given in the above table.

Table 4 : Performance of other methods in hand gesture recognition

Author's Name	Database	Recognition Accuracy (%)
Mu-Chun Su [42]	90 spatio-temporal hand gestures	94.1% and 91.2%
Juan P. Wachs *et al.* [43]	Gripsee	93.75%
George Caridakis*et al.* [45]	30 gestures	93%
Deng-Yuan Huang *et al.* [46]	-	96.1%
Ruize Xu *et al.* [47]	628 gestures	95.6%
Luigi Lamberti *et al.* [48]	907 hand gestures	98.46%
Zhou Ren *et al.* [50]	-	93.2%
Yuan Yao *et al.* [51]	SQLite database	51.87%
Kui Liu *et al.*[53]	Microsoft MSR dataset	93%
Eshed Ohn-Bar *et al.* [54]	19 hand gestures	98.4%, 99.7% and 92.8%
Zhiyuan Lu *et al.* [55]	19 predefined gestures	95.0% and 89.6%
Chong Wang *et al.* [56]	Own dataset NTU hand digit dataset ASL finger spelling dataset	97.2% and 99.1% 99.6% 75.8%

As mention in above table-4 in performance of other methods in hand gesture recognition we analyze other methods in hand gesture recognition with following data. Mu-Chun Su used two data bases, for verifying its performance, comprised of 90 spatio-temporal hand gestures.. In first and second database he achieved 94.1% and 91.2% recognition results.

But Juan P. Wach s *et al.* have taken three types of gesture dataset (Gripsee, BGU and American Sign Language) and using the real-time implementation (Tele- Gest) compared the performance. In the comparison of user-dependent and user-independent systems 13 gestures dataset was made. Accuracies of 98.9% and 98.2% of the system were found for user-dependent and independent systems respectively on testing with their own trainer. The Gripsee system achieved 93.75% of recognition accuracy.

On an artificial dataset formed by 30 gestures, validation of the proposed architecture was performed by George Caridaki *set al*. 10-fold cross validation strategy was used in this experiment. An average recognition rate of 93 % was achieved.

Similarly different authors analyze with different input data and got different outputs which are given in the above table.

IV. Direction for The Future Research

In our review work, hand gesture recognition system is analyzed by using different recognition techniques. Here all the proposed methods are worked efficiently but these methods give high performance on the particular datasets. The datasets contains background images and face images datasets have the small recognition accuracy value than the other datasets. Hence there is a need to develop new techniques in the datasets with background and face images. So the proper analysis is to be needed. As a result this review paper will be supportive for the researchers to improve the hand gesture recognition system in real time datasets. We believe that in future various works will arise using our review work.

V. Conclusion

In this paper, an extensive survey has been performed about different recognition techniques used in the system of hand gesture recognition. While all the methods proposed are fairly accurate. Our goal of hand gesture recognition process needs to further perfect those approaches or develop some more efficient methods. Here the researches are categorized based on recognition techniques that are exploited in hand gesture recognition process and also an introduction about hand gesture recognition is presented. From this review, the researchers can able to know about several recognition techniques and their performance existing in hand gesture recognition system.

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Non Blind Watermarking Process using RSA Encryption Method

By M.M. Fazle Rabbi

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Abstract- With the growth of technology and continuous rapid improvement in this field, the digital content took an important role in this current era of time. Online transactions keep growing in many parts of the world. As a result it becomes the prime target for hackers and intruders. Consequently security of data has become a critical issue for experts. In this paper a robust algorithm is proposed in watermarking image to secure the digital data. The proposed algorithm is based on SVD-DWT with Harr Wavelet Transform (HWT) for embedding and extracting a digital watermark in an image. The experimental result shows that this technique is robust against few attacks like Gaussian, average and JPEG compression.

Keywords: watermarking, HWT, SVD-DWT, digital image processing, embedding, extracting, PSNR.

GJCST-F Classification : E.3, C.2.0

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I. Introduction

Digital content become more available than ever in the daily use of our life due to the increase and easy access of internet. E-commerce becomes more popular in the recent time as trading habit of people has changed. As a result cyber security becomes important factor to protect the digital content from unauthorized access and temperament. Digital watermarking has an important role in this context. In digital watermarking process secret information is embedded in the original content without or insignificant distortion of cover data to identify the authentication and protect the copyright of the author and tracing back the distribution.

There are two techniques available for watermarking process. One is spatial domain approach and other is frequency domain schemes [1]. Though the later one is more robust than the prior one against image processing attacks like compression or cropping [1][2]. The frequency domain approach mainly use discrete Fourier transform (DFT), discrete cosine transform (DCT), discrete wavelet transformation (DWT) and others. The discrete wavelet transformation (DWT) based on singular value decomposition (SVD). In this approach the image is embedded into the transformed coefficients.

On the other hand in spatial domain approach the image is processed in the form of matrix. These techniques are comparatively easier to implement. Though there is a tradeoff between robustness and easier implementation. A good watermark should be invisible into the cover image so that it does not attract intruder. The perceptibility of the image should be good after embedding. It also should be robust under different types of attack [4] and if it is altered then watermark should be recovered.

The Discrete Wavelet Transformation (DWT) combined with Singular Value Decomposition (SVD) is one of many effective methods that researchers use for signal processing for the purpose of watermarking technique. The Harr Wavelet Transform (HWT) is simple and widely used for signal processing.

In this paper a non-blind watermarking algorithm is used for embedding and extracting image in the frequency domain. The proposed method used RSA algorithm to encrypt the secret message before embedding it into the cover image. The cover and the secret images are decomposed using the Harr DWT and encrypted secret image into four sub band (CLL_3 , CLH_3 , CHL_3 & CHH_3) and (SLL_3 , SLH_3 , SHL_3 & SHH_3). After that Apply SVD to CHL_3 & SHL_3.

$$(C_u\ ,\ C_d\ ,\ C_v\ ) = \text{SVD}\ (CHL_3)$$
$$(S_u\ ,\ S_d\ ,\ S_v\ ) = \text{SVD}\ (SHL_3)$$

This paper has been organized as follows: section 2 explains the Haar Wavelet Transform (HWT), section 3 is the review of related works, section 4 is the proposed method used in this paper, section 5 is the analysis of the result and conclusion is drawn in section 6.

II. Haar Wavelet Transform (HWT)

Haar wavelet transformation (HWT) is used to decompose signal. When it decomposes a signal it does it into two components [5].

The Haar wavelet's mother wavelet function ψ (t) can be denoted as:

$$\psi(t) = \begin{cases} 1 & 0 \le t < \frac{1}{2}, \\ -1 & \frac{1}{2} \le t \\ 0 & otherwise, \end{cases} \quad (1)$$

Its scaling function ϕ(t) can be described as:

$$\phi(t) = \begin{cases} 1 & 0 \le t < 1, \\ 0 & \text{otherwise.} \end{cases}$$

After decomposing an image using HWT it produce four sub-bands LL, LH, HL and HH [6].

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III. Review Literature

Jing and Jen-Ho used a halftone watermarking method with kernels-alternated error diffusion and haar wavelets transform [7]. Mais and Hassan proposed phase-shifting 2-D no separable Haar wavelet coefficients [8]. Chen and Jiun proposed watermarking scheme for 3d models using haar discrete wavelet transform [5].

a) Algorithm for Embedding Formula

1. Read secret image and cover image
2. Encrypt the secret image using RSA algorithm with a key
3. Use three levels Haar DWT to decompose the cover image and encrypted secret image into four sub bands (CLL_3 , CLH_3 , CHL_3 & CHH_3) and (SLL_3 , SLH_3 , SHL_3 & SHH_3)
4. Apply SVD to CHL_3 and SHL_3
   a. (C_u , C_d , C_v) = SVD (CHL_3)
   b. (S_u , S_d , S_v) = SVD (SHL_3)
5. Add diagonal matrix (C_d) with the another diagonal matrix (S_d) using the following equation:
   c. $M_d = C_d + \alpha \times S_d$
   d. Where M_d is a modified diagonal matrix and α is a scaling factor which is used to control the strength of watermark.
6. Apply inverse SVD to the matrixes M_d , C_u , C_v to get modified band (M_b).
7. Obtain watermarked image by applying inverse DWT on one modified band (M_b) and other non-modified band.

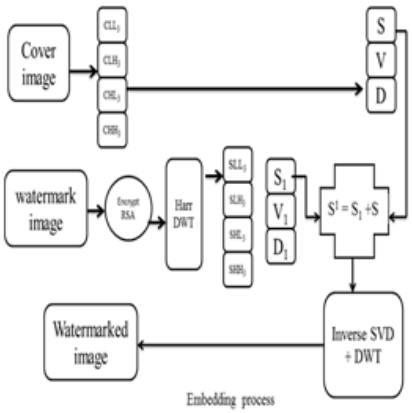

Figure 1 : Embedding process

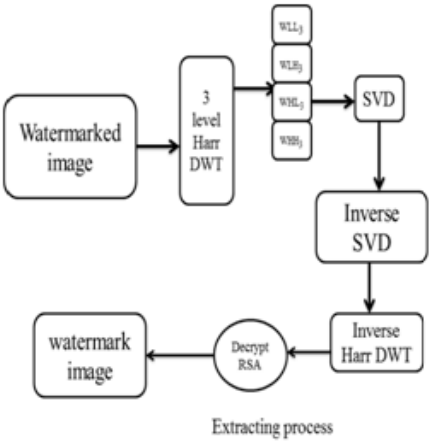

Figure 2 : Extracting process

b) Algorithm for Embedding Formula

1. Read Watermarked image
2. Apply three levels Haar DWT to decompose watermarked image into four sub bands (WLL_3, WLH_3, WHL_3 & WHH_3) .
3. Apply SVD to WHL_3

$$(W_u, W_d, W_v) = \text{SVD } (WHL_3)$$

4. Compute the extracted diagonal matrix (E_d) using the following equation:

$$E_d = (W_d - C_d)/\alpha$$

Now apply inverse SVD, inverse Haar DWT and decrypt RSA algorithm to get secret image which is called watermark image.

IV. Experiment Result

The proposed algorithm has been tested to check its robustness against some image attacks. The watermarked image went through few attacks to experiment the result. The obtained results are measured to observe its performance with the peak signal to noise ratio (PSNR) and normalized correlation (NC) criteria. The table1 illustrates the PSNR values for correlation between watermarked image and compromised image. Higher PSNR ratio indicates the better quality of the image. It also shows the NC values between original watermark and extracted watermark after being attacked. Higher the NC values better is the robustness of watermark. The higher ratio also indicates the better perceptibility of the image which is extracted after being attacked. The proposed algorithm performs better under the attack of Gaussian, average and JPEG compression.

Figure 3 : watermarked image

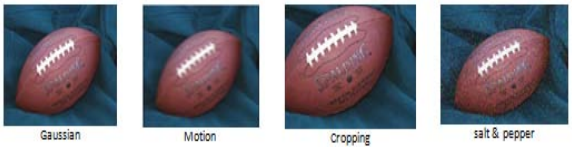

Figure 4 : Different types of attacks

Attack	PSNR	NC
Gaussian noise(.01)	48.9993 db	1.0
Gaussian noise(.02)	47.3897 db	1.0
Gaussian noise(.03)	46.9999 db	1.0
Salt and Pepper	49.1797 db	.9999
JPEG compression	51.4063 db	.9124
Rotation	48.6328 db	.8956
Cropping	37.6572 db	.9234
Motion	36.4215 db	.9289
Average	55.2135 db	1.0

Figure 4 : Performance of PSNR and NC

V. Conclusion

In the proposed algorithm of this paper we have used the DWT-SVD with Haar Wavelet Transform (HWT) technique for watermarking procedure. We have tested the algorithm by analyzing the result received from experiment. The obtained data clearly indicates the better perceptibility of the extracted image which went through different attacks. It also proves the robustness of the proposed algorithm used in this paper. In future experiment we will focus our concentrate for different methods to improve the robustness of the algorithm.

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Multimodal Biometrics Enhancement Recognition System based on Fusion of Fingerprint and PalmPrint: A Review

By Mouad. M. H. Ali & A. T. Gaikwad
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Abstract- This article is an overview of a current multimodal biometrics research based on fingerprint and palm-print. It explains the pervious study for each modal separately and its fusion technique with another biometric modal. The basic biometric system consists of four stages: firstly, the sensor which is used for enrolment & recognition the biometrics data. Secondly, the pre-processing stage which includes the enhancement and segmentation of Region-Of-Interest ROI. Thirdly, features extracted from the output of the pre-processing and each modal of biometrics having different type of features. Fourthly, the matching stage is to compare the acquired feature with the template in the database. Finally, the database which stores the features for the matching stags. Multimodal is being gathered of various types of biometrics objects from the same human. In this paper, the biometric system gives an explanation for each model. Also, the modalities of biometrics are discussed as well as focused on two different modalities : fingerprint and Palm-Print.

Keywords: multimodal, ROI, fingerprint and palm-print, fusion.

GJCST-F Classification : C.2.0

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Mouad. M. H. Ali [α] & A. T. Gaikwad [σ]

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Keywords: multimodal, ROI, fingerprint and palm-print, fusion.

I. Introduction

Along of various biometrics techniques , In the past few decades, human-beings have been addicted to various technologies such as captured photos, scanned signatures, bar code systems, verification Id & so on. Also, Biometrics is one of the applications in Image processing. Biometrics refers to technologies that measure and analyze human body characteristics for the user authentication. The biometric authentication system based on two modes: Enrolment and Recognition. In the enrolment mode, the biometric data is acquired from the sensor and stored in a database along with the person's identity for the recognition. In the recognition mode, the biometric data is re-acquired from the sensor and compared to the stored data to determine the user identity. Biometric recognition based on uniqueness and permanence. The uniqueness means that there is no similarity of feature between two different biometrics data. For example, there are no two humans having the same fingerprint feature even if they are twins. And when the features of biometrics do not change over the lifetime or aging, it is called permanence. Biometrics can have physiological or behavioural characteristics. The physiological characteristics are included in the physical part of body such as (fingerprint, palm print, iris, face, DNA, hand geometry, retina... etc). The behavioral characteristics are based on an action taken by a person such as (Voice recognition, keystroke-scan, and signature-scan).

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II. Biometric Modalities

a) Fingerprint

The fingertip surface consists of ridges and valleys. The ridge declare as black lines and the valleys declare as white lines Fig.1 .The minutiae points are the points where the ridge structure changes such as bifurcation and end point

Figure 1 : Graphical of ridge and valleys Ridge Ending, Bifurcation and short Ridge[14]

b) Palm Print

The human palm means the inner area between the fingers and wrist. The area of palm print compared to fingerprint is much larger, and then it can extract more features than a fingerprint. The palm print is similar to the fingerprint in ridges and valleys but the palm has also principle lines and wrinkles which can be acquired with a lower resolution scanner.

c) Face

Face recognition is the popular way for the humans to recognize each other. The face is the front part of a head from chin to the forehead. Face recognition can be used in surveillance application because the face is one of the few biometric traits that can be recognized by people at distance [1].

d) Iris

Iris means a ring-shaped behind the cornea of the eye. The iris is very difficult to use after death because it's one of the first parts of the body to decay after death. Also the right iris is different from the left iris.

e) Retina

Retina is the layer of blood vessels which is located on the back of the eye. It is one of most secure in Biometrics because it is not easy to change or replicate the retinal vasculature.

f) Hand geometry

Hand geometry recognition measures the size and shape of palm, and length and width of fingers. The merits are easy to use, technique is very simple. The demerit of hand geometry is that it can't be embedded to small devices like laptops, because the hand geometry sensor is large. Therefore, the hand geometry is suitable for verification only.

g) Voice

Voice Recognition is the task of recognizing people from their voices. It is a combination of behavior and physical biometrics. The physical features of voice are vocal tracts, mouth, nasal cavities, and lips which used to create the voices

h) Gait

Gait is the way of walking. Gait Biometrics can be used in surveillance application because it can be recognised at a distance.

i) Signature

Signature is a type of behavior biometrics and it can be changed by the person. The biometric system identifies the signature from the way of holding the pen and the time taken to sign. Also, it can be online or offline.

j) Keystroke

Keystroke is the way of typing on the keyboard. Most people have different ways to deal with the keyboard but this type of biometrics cannot be based for security accessing, thus it can be used after a strong biometrics for verification only 1:1.

k) DNA

DNA refers to deoxyribonucleic acid. This type of biometric is used in crime investigation. The identical twins have the same DNA pattern.

III. Fingerprint

Fingerprints are graphical patterns of ridges and valleys on the surface of fingertips , the ridge ending and ridge bifurcation is called minutiae as shown in fig.2. There are many methods based on minutiae-based fingerprint representation were proposed in [1],[2] . Every person has a unique fingerprint from any other person. The fingerprint identification is based on two basic assumptions:- Invariance and Singularity Invariance : means the fingerprint characteristics do not change along the life. Singularity: means the fingerprint is unique and no two persons have the same pattern of fingerprint.

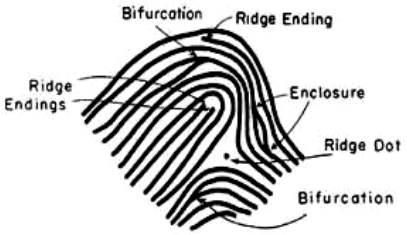

Figure 2 : Fingerprint image showing different ridge features

Table 1 : Shows the terms and definitions of fingerprint structure

No	Term	Definition
1	Termination	The location where a ridge comes to an end.
2	Bifurcation	The location where a ridge divides into two separate ridges.
3	Binarization	The process of converting the original gray scale image to a black-and white image.
4	Thinning	The process of reducing the width of each ridge to one pixel .
5	Termination Angle	The angle between the horizontal and the direction of the ridge.
6	Bifurcation Angle	The angle between the horizontal and the direction of the valley ending between the bifurcations.
7	Matching Score	it is used to calculate the matching score between the input and template data
8	False Non Matching Ratio	It is the probability that the system denies access to an approved user.

The main stages of fingerprint recognition system are shown in fig.3

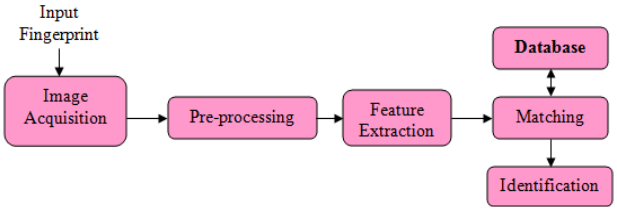

Figure 3 : Fundamental Steps of Fingerprint Recognition System

a) Image Capture or Image Acquisition stage

The Image Acquisition stage is the process to obtain images by different ways. There are two ways to capture fingerprint image; online and offline. In the online fingerprint identification the optical fingerprint reader is used to capture the image of fingerprint. The size of fingerprint image will be 260*300 pixels. The offline fingerprint identification is obtained by ink in the area of finger and then put a sheet of white paper on the fingerprint and finally scans the paper to get a digital image.

b) Image Pre-processing Stage

The pre-processing stage is the process of removing unwanted data in the fingerprint image such as noise, reflection.etc. The fingerprint image pre-processing is used to increase the clarity of ridge structure. There are many steps for doing this process such as Image Segmentation, Binarization, Elimination of noise ,smoothing and thinning. The propose of all these steps is to enhanced fingerprint image at the time of enrolment. In [3],in addition to Gaussian filter, Short Time Fourier Transform (STFT) analysis is adopted to enhance fingerprint image quality. Sometimes the binarized fingerprint image contains a number of false minutiae. In [4].a detailed pre -processing is mentioned to remove false minutiae. Jiao Ruili et. al., [5] proposed an automatic fingerprint acquisition and pre-processing system with a fixed point DSP, TMS320VC5509A and a fingerprint sensor, MBF200. The system is diminutive and flexible. The author presents a VC5509A based fingerprint pre-processing system, accomplished fingerprint image acquisition. The pre-processing system is accomplished with the properly selected algorithm on a DSP platform. Comparing the results of the algorithms, appropriate algorithms are selected for fingerprint identification pre-processing. They are Median Filtering, Directional Filtering Enhancement, Fixed Threshold Binarization, and Hilditch Thinning. Yun and Cho [6] proposed an adaptive pre-processing method, which extracts five features from the fingerprint images, analyses image quality with clustering method, and enhances the images according to their characteristics. The pre-processing is performed after distinguishing the fingerprint image quality according to its characteristics. The Table show the some recent research of pre-processing.

Table 2 : Summary of fingerprint pre-processing stage

Ref	Year	Pre-processing	Database
[67]	2004	Orintation field :Modal-based method, region segmention, orientation filed, ridge enhancement	THU
[68]	2006	Hierarchical Discrete wavelet Transformation(DWT)	FVC2002
[69]	2007	Gabor filters, mask estimation, Binarization, Thinnig	FVC2002
[70]	2008	Minutiae feature by using CNN	
[71]	2013	Normalization, Ridge segmention, Ridge orintation Core point detection.	FVC2002
[74]	2012	Enhancement using two stage determination of reference point and determination of ROI	FVC2002
[73]	2007	Gray scale image, binarization	------
[84]	2013	Gabor filter and FFT, Normalization, local orientation, local frequency, region mask, filter, Binarization	FVC2004

c) Feature extraction stage

The feature extraction process of fingerprint image applied on the output of pre-processing stage. The process of feature extraction depends on set of algorithms; A fingerprint feature extraction program is to locate, measure and encode ridge endings and bifurcations in the fingerprint. For extracting the features from the fingerprint image, a popular method is minutiae extraction. Minutiae extraction algorithm will find out the minute points from the fingerprint and then map their relative placement on the finger.

There are two types of minutiae points: Ridge ending and Ridge bifurcation[7]. In [8] an advanced fingerprint feature extraction method is introduced through which minutiae are extracted directly from original gray-level fingerprint images without binarization and thinning. Gabor filter bank can also be used to extract features from fingerprint [9]. Afsar et. al., [10] presented the minutiae based Automatic Fingerprint Identification Systems. The technique is based on the extraction of minutiae from the thinned, binarized and segmented version of a fingerprint image. The system uses fingerprint classification for indexing during fingerprint matching. Zebbiche and Khelifi [11] presented biometric images as one Region of Interest (ROI). The scheme consists of embedding the watermark into ROI in fingerprint images. Discrete

Wavelet Transform and Discrete Fourier Transform are used for the proposed algorithm. Yi Chen and Anil K Jain [12] proposed an algorithm based on fingerprint features viz., minutiae and ridges, Pattern and Pores. The correlation among Fingerprint features and their distributions are considered for the model. Tachaphetpiboont and Amornraksa [13] proposes a feature extraction method based on FFT for the fingerprint matching. The recognition rate obtained from the proposed method is also evaluated by the k- NN classifier. The amount of time required for the extraction and verification is very less in this approach.

Table 3 : Show the Summary of fingerprint feature extraction

Ref	Year	Feature extraction	Database
[60]	1992	Orientation field	NIST4
[61]	1996	Singularities	NIST4
[62]	1998	Ridge structure	NIST4
[63]	1999	Singularities and ridge	NIST4
[64]	2001	Fingercode	NIST4
[65]	2002	Ridge Distribution	NIST4
[66]	2003	Relational graph, fingercode	NIST4
[67]	2004	Minutiae extraction	THU
[68]	2006	Seven Invariant moment, fingercode, refrences point	FVC2002
[69]	2007	Ridge ending and ridge bifurcation	FVC2002
[70]	2008	Minutiae feature by using CNN	
A dina	2012	Scale Invariant Feature Transformtion (SIFT)	FVC2002
[71]	2013	ROI,Compute LDP Code (local Directional pattern)	FVC2002
[72]	2014	Fixed length represntion that provide extract aligment between features.	FVC2002/ FVC2004
[74]	2012	Local and globle Invariant moment Feature and PCA for feature selection	FVC2002

d) Matching stage

The matching stage is the process to compare the acquired feature with the template in the database ..In other words the process of matching stage is to calculate the degree of similarity between the input test image(for user when he wants to prove his/her identity)and a training image from database (the template which created at the time of enrolment).Matching can be done in three methods: hierarchical approach which employs simple but computationally effective features to retrieve a subset of templates in a given database. This approach increases matching speed at the cost of accuracy[14], classification: Classification approaches assign a class to each biometric in a database. There are many classification methods including KNN classifier [15].and Coding approaches will use one matching function to search entire databases. Arun Ross et. al., [16] proposed the hybrid fingerprint matcher which employs the combination of ridge strengths and a set of minutiae points. Johg Ku Kum et. al., [17] presented a study on Hybrid fingerprint matching methods. The minutiae and image based fingerprints verification methods are implemented together. The shapes in the fingerprint such as square, diamond, cross and dispersed cross are used for matching. Swapnali Mahadik et. al., [18] described an Alignment based Minutiae Matching algorithm. The minutiae extraction involves Filtering, Binarization, Orientation Estimation, Region of interest, Thinning and Minutiae Extraction. In the matching stage the images are subjected to translation Rotation and Scaling. Anil Jain et. al., [19] described the use of logistic regression method to integrate multiple fingerprint matching algorithms. The integration of Hough transform based matching, string distance based matching and 2D dynamic programming based matching using the logistic regression has minimized the False Rejection Rate for a specified level of False Acceptance Ratio. Aparecido Nilcau Marana and Jain [20] proposed Ridge Based Fingerprint matching using the Hough transform. The major straight lines that match the fingerprint ridges are used to estimate rotation and translation parameters.

Table 4 : Show the Summary of fingerprint matching

Ref	Year	Matching	Database
[76]	1996	Hough transform-based approaches	----------
[77]	1997	Ridge-based relative pre-alignment	----------
[67]	2004	Minutiae matching	THU
[78]	2005	Global matching of clusters of minutiae	----------
[68]	2006	Invariant moment finger Code and LVQ	FVC2002
[80]	2006	Global minutiae matching with image correlation	----------
[69]	2007	Minutiae matching, vector matching ,weight modification and local area matching process	FVC2002
[70]	2008	Minutiae matching, which find the similartiy between two images and by calculating the correlation between these images.	--------
[83]	2009	Global matching by evolutionary algorithms	--------
[82]	2010	Weighted global matching with adjustment of scores	--------
[81]	2012	Orientation image-based relative pre-alignment	--------
[71]	2013	LDP and SLFNN	FVC2002
[79]	2013	Hierarchical and/or multilevel minutiae matching	--------
[73]	2007	Minutiae matching, RMI and Fuzzy operator	--------
[74]	2012	ELM and R-ELM	FVC2002

IV. Palm Print

The palm used in fortune telling 3000 years ago, but in 1998 Wei and David [21] studied the palm print as personal identification and it became one type of physical biometrics. Wei and David found that the features of palm print are geometry, principle lines (life, heart and head), wrinkle, delta point and minutiae. No two humans' palms are identical. The space of palm is greater than the fingerprint space so the palm had more information than a fingerprint. The palmprint is to contain principal lines and wrinkles in addition to pattern of ridges and valleys similar to fingerprints. The principle lines and wrinkles can be captured by a lower resolution sensor fig.4 (b),whereas the ridges and valleys in palm are captured by high resolution . The ridges are shown as dark lines; and the valleys are the white lines between those black lines. The minutiae are the points where the ridges changed such as bifurcation and endpoint. The area of palm print is larger than the fingerprint area, then the number of minutes in a palm print around ten times the minutes in a fingerprint [22]. The palm can be captured from normal scanners.

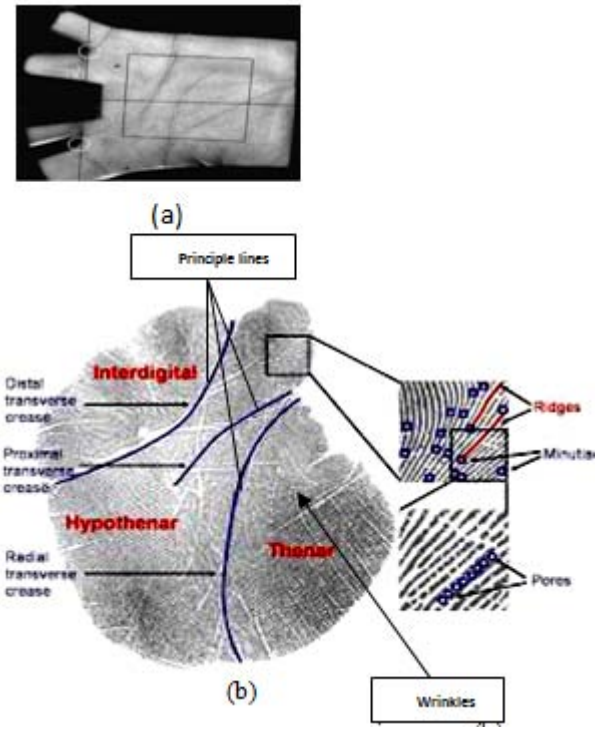

Figure 4 : (a) CCD-based palm print image, (b) ROI, ridges and valleys of palm

The palm print system recognition consists of four parts as shown in fig.5

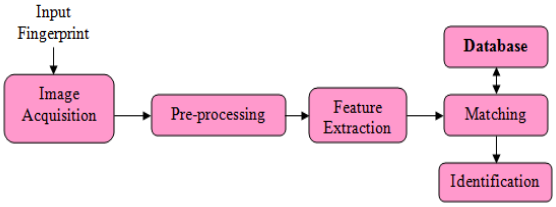

Figure 5 : Palm print recognition system

a) Image Acquisition

There are four types of devices that can capture the palm: CCD-based palmprint scanner, digital camera, digital scanner and video camera. The offline palmprint identification obtaines images by ink the area of palm and then put a sheet of white paper on the palm and then scans the paper to get a digital image [23]. Zhang et al [24] were the first research team to develop online palmprint identification (CCD-based palmprint scanner) and it captured high quality palmprint image. The CCD-based palmprint scanner is depended on the lens, camera and the light sources fig.6.

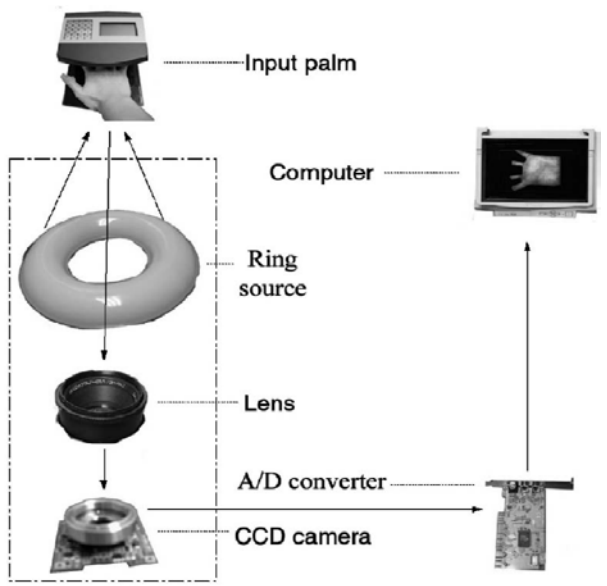

Figure 6 : Diagram of the palm print captured devices CCD [24]

b) Pre-Processing

The pro-processing stage in palm print applied to align the various palm images and to segment the region of interest ROI for feature extraction. The most common steps of pre-processing in palm print recognition as shown in the below diagram:-

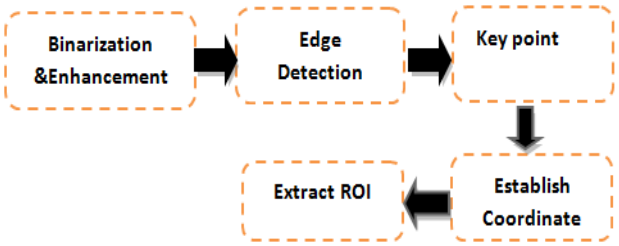

Figure 7 : Diagram of the most common steps of pre-processing

Zhang et al.[24] presented the Gaussian smoothing for the original image of palmprint, then transformed it into binary image. After that it used the boundary tracing algorithm for detect the edges, then computed the tangent between the two gaps of fingers to get the Y-axis and finally extracted a sub image of a fixed size based on coordinate system. However, in [25] it cropped the area of fingers to reduce the time of compute the tangent, and enhance the ROI to extend the gray scope into 256 to make the lines clear for feature extraction.

C. C. Han et al [26] applied to full palmprint images (scanner image) , it used the border tracing algorithm after convert the image into binary image, then located the five fingers tips and four fingers roots by used wavelet based segmentation, and from the ring fingers points are establish the coordinate of ROI.

K. Chuang et al. [27] applied the opening morphology operation for removing the noise of binary image of palm print, and then shrink the region of palm print image by segmented a rectangular region bounded by four lines: upper and lower bound should less than 200 white pixels, right and left bound should be less than 95 white pixels. It detected the boundary by using Sobel edge detection. Then, it took a double derivation of palm boundary to locate three points between the fingers. Next, it created a line by connecting the two points in the upper curve and lower curve, and this line used to align the difference palm print image. It created a point in the middle of the align line M. This point with the middle curve point used to establish the central point of coordinate of ROI.

In case of offline palm print image, no need for binarizing the palm print image because it is already black and white.

R. Wang et. al.[28] utilized Gaussian filter to remove the noise from the palm print image, and then used canny edge detection and convex hull to detected the end points of heart line and life line (datum points).

Table 5 : Summary of palm print pre-processing

Author name	Remove noise	Edge detection	Key points
D. Zhang et al. [24]	Gaussian smoothing then Binarizing	Boundary tracking algorithm	Gap fingers tangent
K. Chuang et al. [27]	Binarizing then opening operation	Sobel edge detection	Double derivation and get 3 points between fingers
C. C. Han et al [26]	Binarizing by using threshold histogram	Border tracing algorithm	Wavelet to locate the five fingers tips and four fingers root
R. Wang et. al.[28]	Gaussian filter	Canny edge detection	Convex hull to detect the end points of heart line and life line

c) Feature Extraction

The feature extraction applied on the output of pre-processing phase which is a fixed size of image. And extract the feature of palm like principle lines, wrinkles and minutiae, and each feature belongs to a different resolution.

Wei and Zhang [29] extracted the datum points and the line features from the palm print image. The datum points are defined as the points of palm print registration. Therefore, it detected the principle lines and their endpoints by using the directional projection algorithm. Moreover, the authors have improved template algorithm to extract the ridges and wrinkles as straight lines.

D. Zhang et al. [24] since the stack filter algorithm is able to extract the principle lines of palm print, but the principle lines are not sufficient to prove the uniqueness of palm print. Thus, the author's proposed the 2D Gabor to represent the palm print for extracting the texture features of palm print from low-resolution.

J. Gan and D. Zhou [25] decomposed the palm print image into sub-images by using the 2-dimensional multi-scale wavelet, then four images are obtained; one of those sub-images is the approximation image for low-frequency components, and the rest of sub-images are demonstrated for the high-frequency component. After that, segment each wavelet sub-image into n^2 blocks

C. C. Han et al [26] applied four directions of Sobel operators to extract the feature points of ROI of palm print, and then applied a complex morphology operator to extract the features of palm print image.

Yao et al. [30] proposed Gabor transformation to extract the texture of palm print features which divided the palm print image into 32 regions. And it was used eight direction $(0, \pi/8, \pi/4, 3\pi/8, \pi/2, 5\pi/8, 3\pi/4, 7\pi/8)$ and four scales (2,4,8,16) 8*4=32 regions to obtain the image texture characteristics. Then it was resized the domination of Gabor image into 1/16 of original image. After that, researchers used ICA (Independent Compo nent Analysis) for further extracted features.

d) Matching

The matching stage is to compare the acquired feature with the template in the database. In [29] proposed the Euclidean distances to match between the endpoints of two lines. And computed the three parameters (slope, intercept and angle) of each line segmented in the two palm print images and decided whether the two lines are equal or not. But in [31] it utilized the energy difference and Hausdroff distance to match between the two palms features. Gan and Zhou [25] the matching based on Euclidean distance between feature vectors and NND (Nearest Neighbour Distance) rule.

D. Zhang et al. [24] determined the similarity measurement of two palm print by using the Humming distance. And in [26] authors proposed two verification mechanisms, one is the correlation function to measure the similarity between the two feature vectors, and the second is Back propagation neural network (BPNN) with the scaled conjugate-gradient algorithm. Also, researchers in [30] identified the weight features by BBNN. X.Y Jing and D. Zhang [32] took the first five samples of each individual in database as training samples and the reminders as test samples, and then the number of training and testing will be 950 training and 2090 testing. The first twenty low frequency bands are selected. Thus, the principle components are 210 and it obtained 181 discrimination vectors. In this paper the result of the recognition accuracy is 98.13%.

Table 6 : Summary of palm print recognition

Ref no	Feature based	Feature extraction	Matching technique	Database
[29]	Straight lines	Directional projection algorithm	Euclidian distance	Offline, 200 samples
[31]	Texture & feature points	--------	Energy different & Hausdroff distance	Offline, 200 samples
[24]	Lines & textures	Stack filter & 2D Gabor	Humming distance	Online, 193*40 samples
[33]	Textures	LPQ	--------	PolyU 189*20
[26]	Lines feature	Sobel operator & morphology	Correlation function & BPNN	--------
[25]	Features vector	Multi-scale wavelet	Euclidean distance & NND rules	Online, 100*60 samples
[30]	Texture	Gabor transformation & ICA	BPNN	50*10 samples
[34]	Orientation features	Six Gabor filter on diff direction	Humming distance	--------
[32]	Discriminant DCT features	Improve Fisher Palm method	Neural network	Online 190*16 samples

Table 7 : Comparison between fingerprint and palmprint trait

No	Fingerprint	Palm print
1.	It contains pattern of ridges and Valleys	It contains pattern of ridges and Valleys also it contains additional features such as principal lines, wrinkles, dathm points.
2.	It is difficult to be captured even with the lower resolution scanner.	It is easy to be captured even with a lower resolution scanner.
3.	Both deal with the some problems like noisy data, Non-universality, intra- class variations, spoof attack.etc.	
4.	The area of finger is less.	The area of palm is much large in comparison to finger.
5.	It is less distinctive	It is more distinctive.

V. Multi-Modal

The multimodal biometrics combine more than one modalities of biometrics to improve the recognition accuracy [37]. The recognition system which acquires biometric information from many sources for the same person in order to determine the identity of a person known as multi-biometrics system. Any piece of evidence can be independently used to recognize a person is called a source of biometric information [38]. Biometric systems are becoming popular as measures to identify human being by measuring one's physiological or behavioral characteristics. The multimodal biometric systems provide advantage over the conventional Unimodal biometric systems in various ways [39].

The main goals of multi-modal biometrics are to reduce at least one of the following; FAR (False Accept Rate), FRR (False Reject Rate), FTE (Failure To Enrollment rate) and Susceptibility to artifacts or mimics. But it also increases sensor cost, enrollment time, transit time and system development [37,39].Multimodal biometric system acquires the input from one or more sensors measuring two or more different modalities of biometric characteristics.

VI. Fusion

[30] Proposed two steps for fusion the palm print and face feature at the feature level: firstly, since the huge difference between the face and palm then it normalized their features as certain range. Secondly, utilized User-specific weighting rule, where the weights of palm print are varies from 0.1 to 0.9, and the weights of face are varies from 0.9 to 0.1. Then selected the weight based on the highest recognition rate of all pairs weights of palm print and face varies weight.

In [33] proposed fusion of face and palm print at the four levels and each level had difference techniques: at the sensor level used wavelets based image fusion scheme, at the feature level used few normalization techniques, at the score level used a some rules of fusion such as sum, max and min rule to combine the matching score, finally at the score level used a logical AND & OR operators.

a) Levels of Fusion

i. *Sensor-level fusion*

The raw biometric data (e.g., a face image) acquired from an individual represents the richest source of information although it is expected to be contaminated by noise (e.g., non-uniform illumination, background clutter, etc.). Sensor level fusion refers to

the consolidation of (a) raw data obtained using multiple sensors, or (b) multiple snapshots of a biometric using a single sensor.

ii. *Feature-level fusion*

In feature-level fusion, the feature sets originating from multiple biometric algorithms are consolidated into a single feature set by the application of appropriate feature normalization, transformation and reduction schemes. The primary benefit of feature- level fusion is the detection of correlated feature values generated by different biometric algorithms and, in the process, identifying a salient set of features that can improve recognition accuracy. Eliciting this feature set typically requires the use of dimensionality reduction methods and, therefore, feature-level fusion assumes the availability of a large number of training data. Also, the feature sets being fused are typically expected to reside in commensurate vector space in order to permit the application of a suitable matching technique upon consolidating the feature sets.

iii. *Score-level fusion*

In score-level fusion the match scores output by multiple biometric matchers are combined to generate a new match score (a scalar) that can be subsequently used by the verification or identification modules for rendering an identity decision. Fusion at this level is the most commonly discussed approach in the biometric literature primarily due to the ease of accessing and processing match scores (compared to the raw biometric data or the feature set extracted from the data). Fusion methods at this level can be broadly classified into three categories: density-based schemes [56], transformation-based schemes [58] and classifier based schemes. The fig 8.show levels of fusions.

iv. *Decision-level fusion*

Many commercial off-the-shelf (COTS) biometric matchers provide access only to the final recognition decision. When such COTS matchers are used to build a multi biometric system, only decision level fusion is feasible. Methods proposed in the literature for decision level fusion include "AND" and "OR" rules [57], majority voting weighted majority voting, Bayesian decision fusion the Dumpster-Shafer theory of evidence and behavior knowledge space [59].

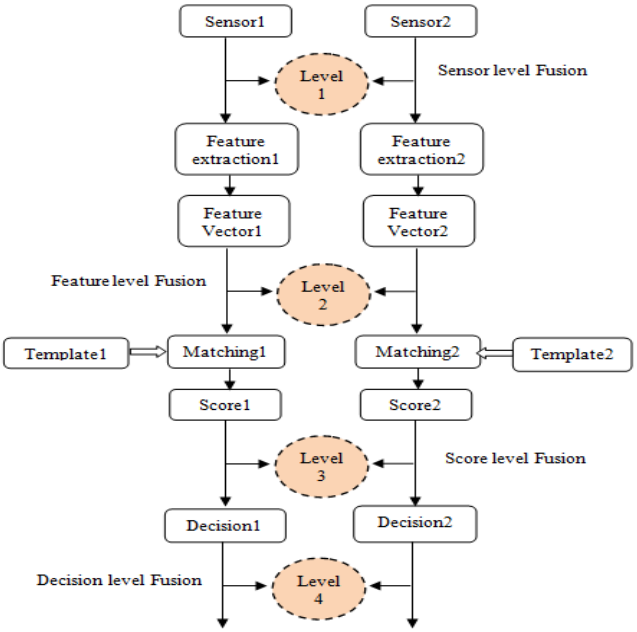

Figure 8 : Levels of fusions in biometric system

b) Fusion Methods

The fusion methods are divided into the following three categories: rule-based methods, classification based methods, and estimation-based methods. This categorization is based on the basic nature of these methods and it inherently means the classification of the problem space, such as, a problem of estimating parameters is solved by estimation-based methods. Similarly the problem of obtaining a decision based on certain observation can be solved by classification-based or rule based methods. However, if the observation is obtained from different modalities, the method would require fusion of the observation scores before estimation or making a classification decision. [59]. The figure 9 shows the Categorization of the Fusion Methods.

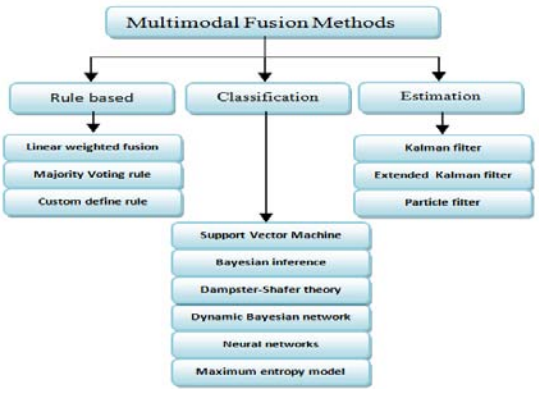

Figure 9 : Fusion Methods[59]

Table 8 : Fusion based on palm print, fingerprint and face

Ref	Biometrics modalities	Fusion level	Techniques	Notes
[30]	Face & palmprint	feature level	Weighting rules	BBNN for recognition the fusion
[33]	Face & palmprint	All levels	---------	--------
[35]	Face & palmprint	Feature level	----------	---------
[36]	Palmprint & fingerprint	Feature level	Fuzzy vault	--------

Table 9 : Some Recent Work on multimodal biometrics

Modality	Level of Fusion	Fusion Strategies	Authors
Palmprint and Face	Matching Level	Sum of Score	[40]
Fingerprint and Face	Score and Decision	Sum Rule and Likelihoods	[41]
Face, Fingerprint, and Hand Geometry	Matching Level	Sum Rule	[42]
Fingerprint and Hand-Geometry	Combination Approach	Sum, Max, Min Scores	[43]
Fingerprint, Palmprint, and Hand- Geometry	Feature Level	ANN	[44]
Face and Fingerprint	Matching Level	Sum, Min-Max, and Zscore	[44]
Face and palmprint	Feature	Feature concatenation	[45]
Fingerprint and signature	Match score	SVM in which quality measures are incorporated	[46]
Face and fingerprint	Match Score	Product rule	[47]
Face, fingerprint and voice	Match Score	Likelihood ratio	[48]
Face, fingerprint and hand geometry	Match Score	Sum rule; decision trees; linear discriminant function	[49]
Face and fingerprint	Match Score	Sum rule, Weighted sum rule	[50]
Fingerprint, hand geometry and voice	Match score	Weighted sum rule	[51]
Fingerprint and hand geometry	Match score	Reduced multivariate polynomial model	[52]
Fingerprint and voice	Match score	Functional link network	[53]

Many researches for person verification using multi biometrics with decision fusion traits are done.

Table10 : Summarized most important researches [55]

Researcher /Year	Multibiometric traits	Algorithm
Arun R., et al /2004	Information fusion in biometrics	The research used score level fusion multibiometrics system by combining three traits(face, fingerprint and hand geometry) are presented, using compare for the feature extraction in each single traits [5]
Rajiv.J, et al /2006	Multimodal Biometric using Face, Iris, palmprint and Signature Features	Multimodal biometric system of iris, palm print, face and signature based on wavelet packet analysis is adopted. The fused image is then extracted by using Inverse Discrete Wavelet Packet transform[8]
Kumar, A, et al. /2008	Fusion of Hand Based Biometrics using Particle Swarm optimization	The researchers applied palmprint and hand geometry over other biometric modalities. It implemented particle swarm based optimization technique for selecting optimal parameters through decision level fusion of two modalities: palmprint and hand geometry [42].

KarthikN.r, et al /2009	Fusion in Multibiometric Identification Systems	This research applied likelihood ratio-based score fusion and Bayesian approach for consolidating ranks and a hybrid scheme that utilizes both ranks and scores to perform fusion in identification systems[43].
Giot R., et al /2010	Fast Learning For Multibiometrics Systems Using Genetic Algorithms	This research use algorithm to learn the parameters of different multibiometrics fusion functions. It interested in biometric systems usable on any computer (they do not require specific material). In order to improve the speed of the learning, we defined a fitness function based on a fast ERR, FAR and GAR also, the search calculate the time that required to recognition the person [12].
Maya V. , et al /2013	Multimodal Biometrics at Feature Level Fusion using Texture Features	It presents a feature level fusion algorithm based on texture features. The system combines fingerprint, face and off-line signature. Texture features are extracted from Curvelet transform. The Curvelet feature dimension is selected based on d-prime number [45].

VII. Conclusions

This paper gave an overview of the fingerprint and palm print recognition . We highlighted in details the fingerprint and palm separately. We also referred to the image acquisition stage , image pre-processing stage, feature extraction stage and matching stage for recognition purpose in details. In addition to that we introduced some techniques for both modalities .Also ,we gave an elaboration about multimodal biometric system recognition and the fusion of biometric trait.

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A Methodical Study of Content based Medical Image Retrieval in Current Days

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Abstract- - Content-based image retrieval (CBIR) is standout amongst the most rich research fields in the area of computer vision & significant advancement has been made throughout the decade. CBIR is an image search methodology that changed the traditional text-based retrieval of images by utilizing various visual features, for example, color, texture, & shape, as criteria of search. In the area of medical, images, particularly digital images, are generated in constantly increasing quantities & utilized for diagnostics & therapy. Content based approaches into medical images to support in making clinical decision has been suggested that would simplify the management of clinical data & scenarios to incorporate the content-based approaches. As, the total quantity of data generated in diagnostic centers has increased, it leads to the utilization of CBIR in the daily routine of hospitals & clinics.

Keywords: content based image retrieval (CBIR), medical image retrieval, medical diagnostics, clinical reports and data.

GJCST-F Classification : H.3.3, J.3

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B. Satish [α] & Supreethi K. P [σ]

Abstract- Content-based image retrieval (CBIR) is standout amongst the most rich research fields in the area of computer vision & significant advancement has been made throughout the decade. CBIR is an image search methodology that changed the traditional text-based retrieval of images by utilizing various visual features, for example, color, texture, & shape, as criteria of search. In the area of medical, images, particularly digital images, are generated in constantly increasing quantities & utilized for diagnostics & therapy. Content based approaches into medical images to support in making clinical decision has been suggested that would simplify the management of clinical data & scenarios to incorporate the content-based approaches. As, the total quantity of data generated in diagnostic centers has increased, it leads to the utilization of CBIR in the daily routine of hospitals & clinics.

In this article, we recognized and talked about some of the issues exist in the area as numerous proposals for systems are made from the medical domain and research models are made in the department of computer science by utilizing medical datasets. Still, there are a small number of systems that appear to be utilized as a part of clinical practice. There is a needs to be expressed that the objective is not to change the text-based retrieval techniques as they exist right now but to enhance them with visual search tools. This article will provide a summary of available literature in the area of content based access to medical image data and on the method used in the area.

Keywords: content based image retrieval (CBIR), medical image retrieval, medical diagnostics, clinical reports and data.

I. Introduction to Image Retrieval

For the last 10 years, image retrieval has been a very active research field, however first review paper on access techniques in image databases was presented in the early 1980s. The subsequent review papers from different years describe the state-of-the-art of the corresponding years and comprise references to a large number of systems and explanation of the methodologies implemented. Enser presented a broad survey of image archives, numerous indexing techniques and basic searching tasks, utilizing typically text-based searches on annotated images. In 1997 a research paper presents an overview of the research domain about the past, present and future of image retrieval. An extensive overview of published systems is presented and an assessment of a subset of the systems is presented. Unfortunately, the assessment is very restricted and only for a little number of systems. Smeulders et al. presented abroad overview of methodologies to date. This paper depicts basic issues, for example, the semantic gap or the sensory gap and provides links to a large number of research papers describing the different techniques used in the field.

In this paper, section 2 covers overview of CBIR. Section 3 and section 4 describes briefly about necessity of CBIR system in medical field. Section 5 and 6 discuss about use of CBMIR in the relevant fields and finally future directions and conclusion of the paper.

II. An overview of Content-based Image Retrieval

CBIR is an image search technique intended to search images that are almost similar to a given query. This method enhance text-based retrieval by utilizing quantifiable &features of objective image as criteria of the search [1]. Basically, CBIR calculates the similarity between two images based on the similarity of the properties of their visual components, which can consist of the color, texture, shape, & spatial arrangement of regions of interest (ROIs). The non-dependence of CBIR on labels makes it perfect for large databases where it is not viable to manually assign keywords & other annotations. A selection of features utilized by CBIR imply that there is a possibility to display what images are similar & to describe why they are alike in an objective, non-qualitative way.

The main difficulties for CBIR comprise the application-specific definition of similarity (based on users' criterion), extraction of image features that are important to this definition of similarity, & sorting out these features into directories for fast retrieval from large databases [1, 2-4]. The selection of features is an important job during outlining a CBIR system as it is firmly correlated with the definition of similarity. Features fall into many classes. Common useful features can be extracted from nearly all images however are not essentially suitable for all applications, for example, color is not suitable for grayscale ultrasound images. Application-specific features are tuned to a specific issue & define characteristics unique to a specific

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problem domain; they are semantic features planned to encode a particular meaning [1]. Global features capture the overall characteristics of an image but unsuccessful to recognize essential visual characteristics if these characteristics take place in only a comparatively small part of an image. Local features defines the characteristics of a small set of pixels (possibly even one pixel), i.e., they signify the details. There has been a change towards using local features in current years, mostly driven by the certainty that more number of images are too complex to be defined in a general way; though, the combination of local & global features remains a research field of experimentation for practical computer vision applications [4].

A fundamental theory of most CBIR systems is that the selected image features used are adequate to define the image correctly. So, the selection of image features must be made to reduce two major constraints: the sensory gap & the semantic gap [1]. The sensory gap is the dissimilarity between the object in the world & the features selected from the image. It arises when an image is noisy, has low illumination, or incorporates objects that are partly blocked by other objects. The sensory gap is further compounded when 2Dimages of physical 3D objects are considered; some information is lost as the choice of view-point means an object might block part of itself. The semantic gap is the conflict between the purpose of the user & the images extracted by the algorithm. It happens as CBIR systems are not able to interpret images; they don't recognize the "meaning" in the images in the similar manner that a human does. Retrieval is executed based on the image features not image interpretations.

The similarity of image features can be measured in a number of ways. When the features are represented as a vector, distance metrics such as the Euclidean distance can be used. The idea of elastic deformation can be utilized to characterize similarity when subtle geometric dissimilarities between images are essential. Graph matching allows the comparison of images based on a combination of image features & the arrangement of objects in the images (or the relationships between them). At last, statistical classifiers can be trained to classify the query image into known classes. Classifier-based methodologies constitute an endeavor to overcome the semantic gap through training a similarity measure on recognized labeled data. A thorough discussion of different similarity measures can be found in [5].

The huge volume of modern image databases& high feature dimensionality of images has similarly added to challenges in effective real-time retrieval. In many situation, it is no more reasonable to compare a query with each element of the dataset. Effective indexing plans are important to store &divide the dataset so that the data can be accessed &pass through quickly, without demanding to visit or process unessential data. On the other hand, the search space can be trimmed by utilizing only a subset of the features or put on weights to features [4]. The large datasets additionally imply that accurate search paradigms, which look for images in the dataset that precisely fulfill all query norm, might no longer be feasible. This has led to the rise of approximated search methods, which rank the images in the dataset as per how well they fulfill every search criterion [1]. Possibly the most recognized estimated plan is k-nearest neighbor search, which retrieves the k most similar (highly ranked) images as calculated by distance from the query in the feature space.

There is a possibility that some of the images retrieved by approximate search models will be unsuccessful to meet the expectations of the users. Precision & recall are two quality measures defined to compute the precision of an approximate search model. Precision denotes to the proportion of retrieved images that are appropriate, i.e., the proportion of all retrieved images that the user was expecting. Recall is the proportion of all relevant images that were retrieved, i.e., the proportion of similar images in the dataset that were actually retrieved. The best case would be a retrieval system that accomplishes 100 % accuracy & 100% recall. Actually the thing is that the most current algorithms becomes unsuccessful to discover all similar images, &maximum of the retrieved images comprise different images (false positives).

Figure 1 displays a generic CBIR model that can be considered for a particular applications. The dashed arrows specify the offline procedure that makes the search index, while the solid arrows indicate the online query process. The dashed line separate the offline & online procedures. At the time of the offline procedure, features are extracted from every images from the dataset. These features are then indexed for offline & online procedures. Note that feature extraction participates in both the offline & online procedures searching. At the time of online procedure, the same feature extraction procedure is executed on the query image. The query image's features are then compared to the features of indexed images using a defined similarity measurement algorithm. The measurements can then be used to rank the images in order of similarity or can be used to classify the images as "similar" or "not similar." This ranking is then displayed to the user. In some cases, the user can give feedback as weights or similarity indication to more enhance the search results. The feedback & retrieval procedure is repetitive till the user is fulfilled with the retrieved outcomes. The papers [1] &d [2-4] in the reference list give thorough overviews of general CBIR systems& components.

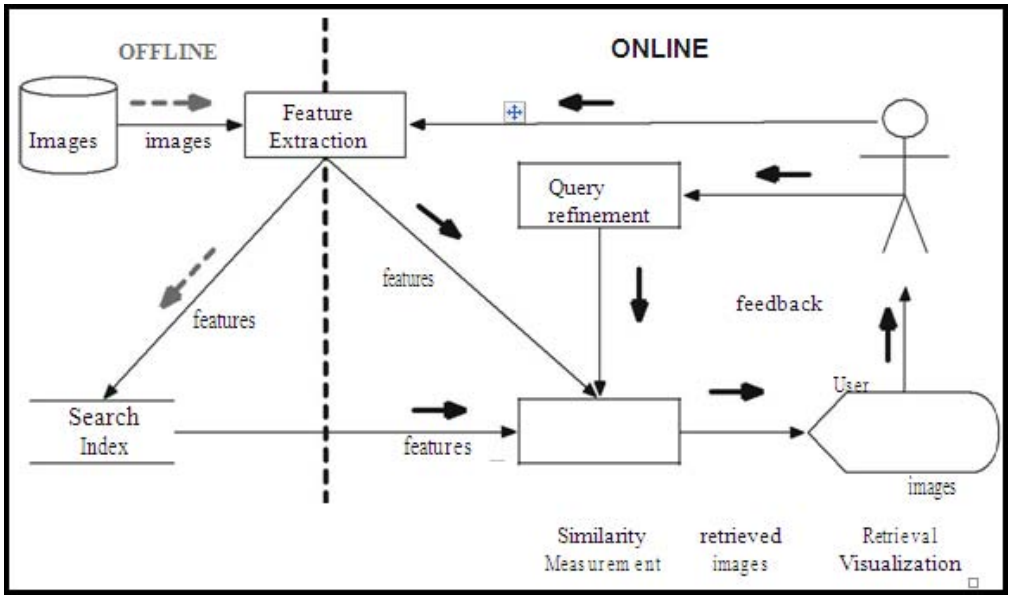

Figure 1 : A generic CBIR framework. The dashed arrows show the offline creation of the feature index from the image repository. The solid arrows show the online query process. The dashed line divides the offline and online processes. Note that feature extraction

Some examples of CBIR use are IBM's Query By Image Content (QBIC)system [6], which was used to search for famous artworks. Some others are Virage frame-work[7] & Photo book [8]. In recent times, Google Search by Image utilized the points, colors, lines, & textures in images uploaded by users to discover almost same type of images [9]. These new advancement simply that CBIR is a technology that is accessible to the masses.

Most recently, a shift in paradigm has changed the focus of CBIR research work in the direction of application-oriented, domain-specific technologies that would have more noteworthy effect on everyday life [4]. Because of developments in acquisition technologies, ongoing CBIR research work has moved towards images with an objective towards expanding image understanding. Present day medical imaging is one such field, where the retrieval of multidimensional & multimodal images from repositories of different data has possible applications in diagnosis, training, & research [10]. The content of medical images is complex: there is a high inconsistency in the detail of anatomical structures across patients; misalignment of structures can happen in volumetric and multimodality images; some imaging modalities experience the ill effect of low signal-to-noise ratios; & occlusion of structures is a common incidence. Moreover, there can be substantial variability among patients with the same health condition [11]. It is important that the qualities of specific medical images are considered when designing CBIR framework for them. The next segment presents a summary of the state of the art in medical CBIR.

III. The Need for Content-based Medical Image Retrieval

There are a few causes why there is a necessity for extra, alternative image retrieval techniques despite the gradually increasing rate of image production. It is critical to explain these requirements& to talk about potential technical & methodological enhancement and the resulting clinical benefits.

The objectives of medical information frameworks have frequently been defined to convey the required information at the right time, the right place to the right persons to enhance the quality &proficiency of care procedures [12]. Such an objective will most likely require more than a query by patient name, series ID or study ID for images. For the clinical decision-making procedure it can be helpful or even essential to find other images of the similar modality, the similar anatomic region of the similar disease. Even though part of this information is normally contained in the DICOM headers &numerous imaging devices are DICOM-compliant at this time, there are still a few issues. DICOM headers have shown to have a little bit high rate of errors, such as, for the field anatomical region, error rates of 16% have been described [13]. This can hamper the accurate retrieval of all wanted images.

Clinical decision support methodologies,for example, case-based reasoning [14] or evidence-based medicine [15,16] can generate a tougher need to retrieve images that can be important for supporting some of the diagnoses. It can even be imagined to have Image-Based Reasoning (IBR) as another discipline for diagnostic support. Decision support systems in

radiology [17] & computer-aided diagnostics for radiological practice as presented at the Radiological Society of North America (RSNA) [18] are growing & generate a necessity for powerful data & meta-data management & retrieval.

The general clinical advantage of imaging frameworks has already been presented in [19]. In [20], a technique is presented to recognize critical tasks for medical imaging based on their possible clinical advantages. It have to be expressed that the purely visual image queries as they are performed in the computer vision field will probably not be able to ever replace text-based techniques as there will always be queries for all images of some of the patient, yet there is a possibility to be a very good complement to text-based search based on their features. Still, the drawbacks & benefits of the technology have to be stressed to obtain acceptance and use of visual and text-based access methods up to their full potential. A situation for hybrid, textual & visual queries is presented in the CBIR2 system [21].

Other than diagnostics, teaching & research specifically are expected to improve through the use of visual access methods as visually interesting images can be chosen & can actually be found in the existing large repositories. The incorporation of visual features into medical studies is another fascinating point for many medical research fields. Visual features don't only let the retrieval of cases with patients taking similar diagnoses but also cases with visual similarity but distinctive diagnoses. In teaching, it can help teachers along with students to search educational image repositories & visually assess the out comes found. It may be a situation for directing in image atlases. Additionally, this can be utilized to cross-correlate visual & textual features of the images.

IV. Content-based Image Retrieval in Medicine

PACS & other hospital information systems store a huge amount of information, ranging from patient demographics & clinical measurements (age, weight, & blood pressure) to free text reports, test results, & images. The image types comprise of 2D modalities, for example, images of cell pathologies & plain X-rays, & volumetric images including CT, PET, & magnetic resonance (MR). Recent advances have introduced multimodality devices, e.g., PET-CT [22, 23]&PET-MR [24] scanners, which are capable of acquiring two co- aligned modalities during the same imaging session. Figure 2 presents a subset of the distinctive types of medical images.

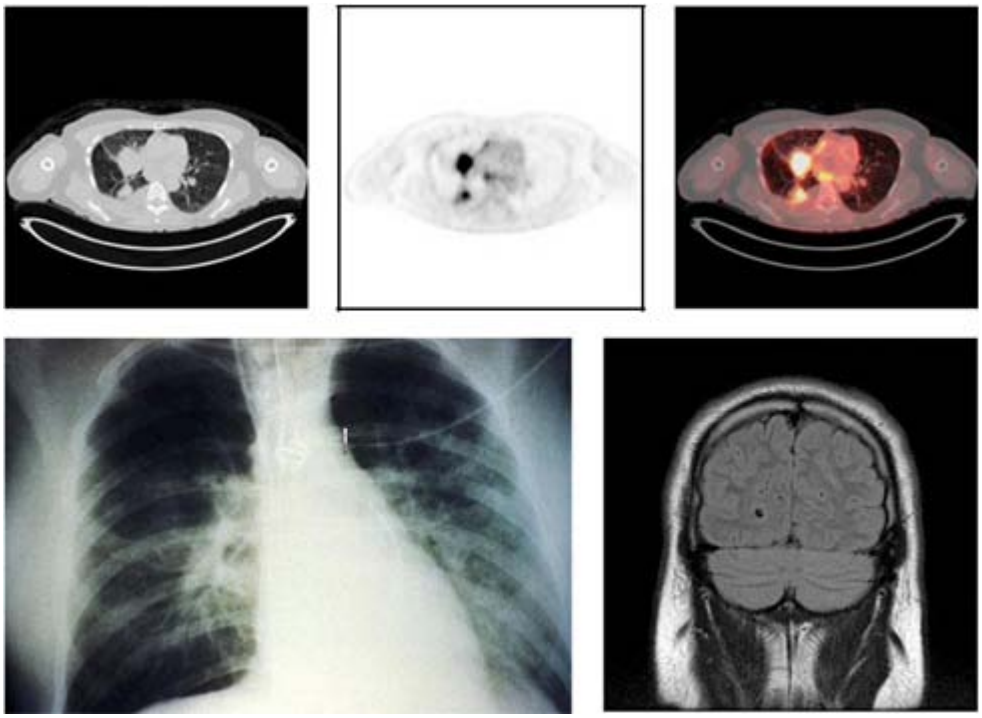

Figure 2 : A subset of the medical images available in many hospitals. Clockwise from the top left, they are axial CT slice, axial PET slice, axial fused PET-CT slice, coronal MR slice, and chest X-ray

Many research have already been done on the potential clinical advantages of CBIR in clinical applications. The ASSERT CBIR system utilized for High-Resolution CT (HRCT) lung images [25] exhibited an enhancement in the correctness of the diagnosis carried out by physicians [26]. Another research work for liver

CT showed that CBIR can deliver real-time decision support system [27]. Additionally, CBIR was presented to have advantages when utilized as part of a radiology teaching system [28].

In the next segment, we start our survey by presenting a summary of CBIR research for 2D medical images& inspect how these technologies have advanced & been applied to images with higher dimensions, e.g., volumetric CT scans, & images with a temporal dimension, e.g., dynamic PET. The incorporation of image with non-image data will then be discussed. Also, we will analyze how research works have dealt with the difficulties of retrieving images from datasets having images from various range of modalities. At last, we will present how multiple images from diverse modalities have improved medical CBIR abilities. Table 1 provides a brief summary of the studies that we will investigate in this review & the types of data utilized at the time of retrieval. Readers ought to refer to the appropriate article for further information, for example, figures demonstrating the retrieval results.

Table 1 : Studies divided by data types

Type of data	Studies
2D images	Radiographs: [35– 37]; spine X-rays: [38– 44]; cervicographs: [45, 46]; mammograms:[47– 49], [50, 51][a]; retinopathy: [49], [50, 51][a]
3D+ images	CT: [31, 32, 52], [33][a]; MRI: [53– 55]; dynamic PET: [56, 57][a]; PET-CT: [58– 69]
Non image Data	Text: [56, 57, 70– 76][b], [77, 78]; annotation or ontology: [33, 79, 80][b]; others: [50, 51][b]
Multiple Images	Image CLEF: [81–85]; pathology: [86]; general [87, 88]; PET-CT: [58– 69]

[a] Also used nonimage data

[b] Also used image data

a) 2D Image Retrieval

The most part of CBIR studies on 2D medical images has concentrated on radiographic images, for example, plain X-rays & mammograms. Our interest in this section is on techniques that mostly utilize conventional features, such as, shape & texture. These techniques will show how standard techniques in nonmedical CBIR [16] have been implemented in the medical field.

The Image Retrieval in Medical Applications (IRMA) project has been a continuous work in the CBIR of X-ray images for medical diagnosis systems. The IRMA methodology is separated into seven inter dependent phases [29]: (1) categorization based on global features, (2) registration by utilizing geometry & contrast, (3) local feature extraction, (4) category-dependent & query-dependent feature selection, (5) multiscale indexing, (6) identification of semantic knowledge, & (7) retrieval based on the earlier stages. The IRMA technique categories images into anatomical areas, modalities, & viewpoints & offers a generic system [30] that permits the derivation of flexible implementations that are enhanced for particular uses.

Other methods for radiograph retrieval have been tested to group features into semantically significant patterns. In one such kind of research work [31], multiscale statistical features were extracted from images by a 2D discrete wavelet transform. These features were then clustered into small patterns; images were represented as complex patterns comprising of sets of these smaller patterns. Experimentation outcomes find out that the technique had considerably higher precision & recall compared to two traditional methods: local & global gray-level histograms.

Various papers [32-38] have depicted experimentation into each component of CBIR for spine X-ray retrieval, comprising of feature extraction [39, 40, 37], indexing [38], similarity measurement [41, 44], & visualization & refinement [42]. The initial techniques of matching whole vertebrae shapes [33, 40] had a major shortcoming: in 2D X-rays, regions of the vertebrae that were not of pathologic interest could obscure dissimilarities between critical regions. Xu et al. [41] presented partial shape matching as an approach to manage with occlusion when comparing incomplete or distorted shapes. An application-centric feature, the nine-point landmark model utilized by radiologists & bone morphometrists in marking pathologies, was localized to enhance the computational performance of their algorithm for partial shape matching. In tests, their technique succeeded an accuracy>85 %. Although the users can apply weights to angles, lengths,& the cost to merge points on the model, it was tough to decide the effect these weights had on the retrieval outcomes, i.e., there was no feedback with respect to what every weight did to the shape.

This was solved in a later research work by Hsu et al. [42]; a web-based spine X-ray retrieval system

permit a user to alter the appearance of a shape & to assign weights to points on the shape to highlight their significance. The incorporation of relevance feedback further enhance the performance of the algorithm. Initially, 68% of the retrieved images were relevant (what the user expected); three iterations of feedback improved this by a further 22 %. Assigning weights to parts of the shape permitted the user to indicate why the images were similar. Moreover, the web-based shape retrieval algorithm was displayed to work with uterine cervix images; the system was able to differentiate between three tissue types with a precision of 64 % [45, 46].

The spine retrieval system was further enhanced with the introduction of several domain-specific features: the geometric & spatial relationships between adjacent vertebrae [43]. Merging these features with a voting consensus algorithm increased retrieval precision by about 8 %. To enhance the speed of the retrieval, Qian et al. [44] indexed the images by integrating the shapes in a Euclidean space. This index lead to a considerably faster retrieval time of 0.29 s compared to 319.42 s. Moreover, the integrated Euclidean distance measure was a decent calculation of the Procrustes distance used earlier; the initial 5 retrieved images were indistinguishable in both cases more than 100 queries.

Korn et al. [47] presented a tumor shape retrieval algorithm for mammography images. Specifically, the research work proposed application-centric features to model the "jaggedness" of the periphery of tumors; tumors were characterized by a pattern spectrum comprising of shape characteristics with high discriminatory power, for example, shape smoothness & area in different scales. This was carried out to differentiate benign & malignant masses, which are probably have higher fractal dimensions. Test on a simulated dataset found out that the proposed application-centric method succeeded 80 % accuracy at 100 % recall. Their utilization of pruning to diminish the search space brought about computational performance that was up to 27 times better than sequential scans of the full dataset.

Yang et al. [48] utilized a boosting framework to learn a distance metric that preserved both semantic & visual similarity at the time of medical image retrieval. At first, sets of binary features for data representation were found out from a labeled training set. To preserve visual similarity, sets of visual pairs (pairs of similar images) were utilized long with the binary features to train the distance function. The proposed method had higher retrieval precision than other retrieval techniques on mammograms & comparable accuracy to the best approach on the X-ray images from the medical dataset of the Cross Language Evaluation Forum's imaging track (Image CLEF). By learning dataset-centric features & distance functions, the retrieval system executed more reliably than other state-of-the-art methods across various datasets.

b) 3D+ Image Retrieval

In current years, numerous image retrieval algorithms have been considered to use in 3D medical image retrieval. A basic method is to change a 3D image retrieval algorithm into an alternate problem. One such type of case is to choose key slices from the volume to decrease a complex 3D retrieval to a 2D image retrieval problem. Other methodologies include representing 3D features in domains where the dimensionality of the image is not a factor, e.g., graph representations. This portion depicted how such methods have been used for images with more than two dimensions.

The most well-recognized3D image retrieval system is the ASSERT system [25], that retrieved volumetric HRCT images based on the key slices choose from the volumes. The system retrieved images with the same kind of lung pathology (such as, emphysema, cysts, metastases, etc.), preferably within the same lung lobe as the query. At the time of the query procedure, a physician would mark a pathology-bearing region in the HRCT lung slice; gray-level texture features and other statistics, were then extracted from these regions. Additionally, relational information about the lung lobes was achieved. In experimentation, the ASSERT system succeeded a retrieval accuracy of 76.3 % during matching the type of disease; this plunged into 47.3 % when the lobular location of the pathology was also taken into consideration. At the time of clinical evaluation [26], physicians used the ASSERT system to retrieve & display four diagnosed cases that were similar to an unknown case; this was demonstrated to enhance the precision of their diagnosis.

An enhancement in the ASSERT system included a two-phase unsupervised feature selection technique to "customize" the query [49]. In the first step, the features that best differentiated dissimilar classes of images were utilized to classify the query into the most applicable pathology class. During the second stage, the features that best differentiated between images within a class were utilized to detect the "subclass" of the query, i.e., to discover the most similar images within the class. The customized query method had an efficient retrieval accuracy of 73.2 % compared to 38.9 % using a single vector of all the features. The study demonstrated that finding images based on the class was suboptimal; there was a necessity to also discover the most similar images within a specific class.

Local structure information in ROIs was utilized for the retrieval of brain MR slices [50]. Two feature sets were compared for the representation of structural information. The first, local binary patterns (LBPs), treated every local ROI in the same way. On the other, Kanade-Lucas-Tomasi (KLT) feature points, provide

greater importance to the more salient regions. The out comes uncovered exciting insights about the trade-offs inherent in structure-based retrieval. LBPs were very dominant when spatial information was incorporated, & its precision was constantly higher than its rivals in experimentation including pathological cases or other anomalies. The tests also demonstrated that precision was degraded when KLT points were not matched.

Petrakis [51] proposed a graph-based technique to retrieve MR images. Every image was represented by an attributed graph; vertices presented ROIs, whereas edges represented relations between ROIs. Their outcomes demonstrated that a similarity measure on the basis of the idea of graph edit distance acquired the best retrieval accuracy, at the cost of computational effectiveness. Alajlan et al. [52] proposed a tree representation that attained enhanced computational performance by just indexing relations between ROIs that were incorporated (completely surrounded) within other ROIs.

Dynamic PET images comprise of a series of PET image frames obtained over time. Cai et al. [53] proposed a CBIR framework that use the temporal features in these images. They exploited the activity of pixels or voxels across different time frames by basing their retrieval on the similarity of tissue time–activity curves (TTACs) [54]. Cai et al. [55]also adopted three query input methods: textual attributes, definition of a query TTAC, & a combination of these features. Kim et al. [56] extended this retrieval to 4D (three spatial & one temporal) by processing 3D brain images to an anatomical atlas & defining the structures to search by utilizing the atlas' labels.

c) Retrieval Enhancement Using Non image Data

The greater part of image search in clinical field is performed by utilizing non image data. The abundance of non-image information stored in hospitals (clinical reports & patient demographics) implies that these data can improve the image retrieval procedure. In this portion, we concentrate on research work that present the use of non-image data to add semantic information to image features as a means of decreasing the semantic gap.

Text information is a basic add-on to image features [57], & medical CBIR research. Numerous examples of research consisting of non-image data have been described [53, 56]. Additionally, textual information has been utilized to complement many research work that were part of the Image CLEF medical challenge or used the same data [58-64].

A method to use text as the input query technique for image data together was proposed by Chu et al. [65]. The spatial properties of ROIs & the relationships among them were indexed in a conceptual model comprising of 2 layers. The 1st layer abstracted individual objects from images, whereas the 2nd layer modeled hierarchical, spatial, temporal, & evolutionary relations. The relationships represented the users' conceptual & semantic understanding of organs & diseases. Users made text queries by utilizing an SQL-like language; every query indicated ROI properties, like organ size, and relationships among ROIs. This retrieval method was expanded in [66] by incorporating a visual technique for query construction & by the addition of a hierarchy for grouping related image features.

Rahman et al. [63] introduced a method that utilized the correlation between text & visual components to implement the query. Their comparison of text, visual & combined methods shown that the text retrieval had a higher mean average precision than the purely visual method, while the combined method outpaced both text & visual features alone. This result could be observed in a comparison of different retrieval algorithms in [64] but could be described by the nature of the dataset that was utilized. The medical images in the Image CLEF dataset were very much annotated & this made text-based retrieval inherently simple compare to purely visual methods.

A comparison of text, images, & combined text & image features was carried out by Névéol et al. [67], by utilizing a dataset that was not as well annotated. The text features were extracted from the caption of the images in the document, as well as paragraphs referring to those images. The tests comprised of an indexing task that produced a single IRMA annotation for an image & a retrieval task that matched images to a query. The outcomes demonstrated that image analysis was better than text for both indexing & retrieval, however there were a few conditions where indexing executed better with text data. Additionally, the out comes shown that caption text gave more appropriate information than the paragraph text. Whereas combined image & text data appeared helpful for indexing, the retrieval precision was not considerably higher than that of using images alone.

A preliminary clinical study [27] assessed various features to retrieve the liver lesions in CT images. Especially, the study made a comparison among texture, boundary features, & semantic descriptors. Twenty-six distinctive descriptors, from a set of 161 terms from the RadLex terminology [68], were manually allotted by trained radiologists to the 30 lesions in the dataset; every lesion was given between 8 & 11 descriptors. The semantic descriptors were a feature that described why images were clinically similar. The similarity of a pair of lesions was described as the inverse of a weighted sum of dissimilarities of their corresponding feature vectors. The test results showed that the semantic descriptors beat the other features in precision & recall. Though, the highest accuracy was achieved during a combination of all the features was utilized or retrieval.

Quellec et al. [69] used unsupervised classification to index heterogeneous information (in the form of wavelets [49] & semantic text data) on decision trees. A committee was utilized to confirm that individual attributes (either text or image features) were not weighted too highly. A boosting algorithm was implemented to lessen the tendency of decision trees to be biased towards larger classes. The proposed algorithm succeeded an average precision at five retrieved items of about 79 % on a retinopathy dataset & of about 87 % on a mammography dataset. Without boosting, the results were lower, with 74 % for retinopathy&84 % for mammography. The method was robust to missing data, with an accuracy of about 60 % for the retinopathy data when <40 % of the attributes were available in the query images.

Likewise, in [71], wavelets were fused with contextual semantic data for case retrieval. A Bayesian network was utilized to evaluate the probability of unknown variables, i.e., missing features. Information from all features was then utilized to measure a correspondence between a query case & a reference case in the dataset, again utilizing conditional probabilities of a Bayesian network. An uncertainty component modeled the confidence of this correspondence. The highest precision was acquired during the use of all the features, however the Bayesian method alone outpaced Bayesian plus confidence information on a mammography dataset. On the retinopathy dataset, the highest accuracy was attained by the Bayesian plus confidence component.

d) Retrieval from Diverse Datasets

The various nature of medical imaging implies that CBIR abilities must have the capability to discriminate between modalities during searching for images. This drawback has been taken up by the medical image retrieval challenge at Image CLEF. Participants submit retrieval algorithms that are assessed on a large diverse medical image database [72]. General idea of submissions to the Image CLEF medical imaging task can be found in [73-75]. One key objective of the works incorporated is modality classification or annotation of regions, permitting successful retrieval on a subset of the various repository.

In 2006, Liu et al. [76] presented two techniques to solve this retrieval difficulties. The first method used global features such as the average gray levels in blocks, the mean & variance of wavelet coefficients in blocks, spatial geometric properties (area, contour, centroid, etc.) of binary ROIs, color histograms, & band correlograms. The second method divided the image into patches & used clusters of high dimensional patterns within these patches as features. Utilizing multiclass support vector machines (SVMs), they were able to accomplish a mean average accuracy of about 68 % when using visual features.

Tian et al. [77] utilized a feature set comprising of LBPs & the MPEG-7 edge histogram to analyze the impact of dimensionality reduction utilizing principle component analysis (PCA); the classification was executed by utilizing multiclass SVMs. The correctness of the dimensionally lessened feature set (80.5 % at 68 features) was not very different from the accuracy utilizing all features (83.5 % at 602 features). The maximum precision was succeeded by the feature set falling between these two extremes (83.8 % at 330 features).

Rahman et al. [78] presented a technique for the automatic categorization of images by modality & pre-filtering of the search space. They decreased the semantic gap by combining low-level global image features with high-level semantic categories utilizing supervised & unsupervised learning through multiclass SVMs & fuzzy c-means clustering. The retrieval efficiency was improved by utilizing PCA to decrease the feature dimension, whereas the learned category-zation & filtering decreased the search space. The tests on the Image CLEF medical dataset displayed that pre-filtering brought about higher precision & recall than executing queries on the whole dataset.

In a same kind of approach, the relationship between features in MPEG-7 format & anatomical ideas in the University of Washington Digital Anatomist reference ontology were utilized to annotate new, unlabeled images [79]. The most similar images, based on feature distance, were retrieved from the dataset based on the similarity of feature. The semantic annotation for the unlabeled image was derived from the annotations of the similar images. Experimentation on the Visible Human dataset [80] showed that their retrieval & annotation framework accomplished a precision of around 93.5%.

e) Retrieval of Multiple Images and Modalities

The storage of patient histories in PACS & the development of multimodality imaging devices have led challenges for the retrieval of several related images. The main challenge is utilizing complementary information from various images to execute the retrieval. The works described in this segment taken up this challenge by grouping images by the information they provide or by utilizing associations between features from various images.

A new research work [81] presented the utilization of several query images to augment the retrieval procedure. These images were of the similar modality: microscopic images of cells. Texture & color features were utilized in a two-tier retrieval method. In the first tier, SVMs were utilized to classify the most important disease type (same kind of approach used by [49]). The second tier was further divided into two

phases: the first level found the most similar images, whereas the second tier ranked individual slides by utilizing a nearest neighbor method for slide-level similarity. The slide-level similarity was weighted based on the distribution of the disease subtypes appearing on the slide & the frequency of that subtype across the entire dataset. The proposed technique achieved a classification accuracy of 93 & 86 % on two separate disease types.

Zhou et al. [82] proposed a case-based retrieval algorithm for images with fractures. The algorithm merged multi-image queries comprising of data from various imaging modalities to search a repository of different images. The cases in the repository incorporated X-ray, CT, MR, angiography, & scintigraphy images. The cases were represented by a bag of visual keywords & a local scale-invariant feature transform [83] descriptor. Retrieval was accomplished by measuring the similarity of each image in the query case with every image in the dataset to locate the set of most similar images (for a particular image in the query case). The list of all similar images was then converted to a list of unique cases in the dataset. Three feature selection strategies were assessed & it was showed that feature selection based on case offered the best performance & stability.

The studies explained before in this segment operated on multiple images or multiple modalities but were not intended to retrieve multimodality images that were achieved on a combined scanner. Devices, for example, the PET-CT & PET-MR scanners produce co-aligned images from two different modalities. The co-alignment of the various modalities provides opportunities for searches on the basis of the complementary features in the various modalities & spatial relationships between regions in either modality.

While clinical usage of co-aligned PET-CT has grown rapidly [84, 85], few studies have researched PET-CT CBIR [86-97]. Kim et al. [86] proposed a PET-CT retrieval system that allowed a user to search for images with tumors (extracted from PET) that were enclosed within a particular lung (extracted from CT) utilizing overlapping pixels. The research work presented the ability to search for tumors using their location or size. Song et al. [87] proposed a PET-CT retrieval technique utilizing Gabor texture features from CT lung fields & the SUV normalized PET image. Experimentations demonstrated that the technique which had higher accuracy than methods that used conventional histograms & Haralick texture features. A technique for matching tumors & abnormal lymph nodes by pair wise mapping across images was proposed in [90]. A weight learning method using regression for feature selection was proposed in [92]. Though the algorithms were limited to thoracic images, they showed promise for adaptation to entire body images.

Kumar et al. [93] presented a approach based on graph to PET-CT image retrieval by indexing PET-CT features on attributed relational graphs [51]; graph vertices represented organs extracted from CT & tumors extracted from PET. The methodology based on graph exploited the co-alignment of the two modalities to extract spatial relationship features [94] between tumors & organs; these were represented as graph edges. This permitted their graph representation to model tumor localization information, relative to a patient's anatomy. Retrieval was done by utilizing graph matching to make a comparison between the query graphs to graphs of images in the dataset. The method was extended to volumetric ROIs rather than key slices, thus allowing retrieval based on 3D spatial features [94]. Additionally, they presented that constraining tumors to the nearest anatomical structures by pruning the graph enhanced the retrieval procedure on simulated images [95]. In addition, they exploited their graph-based retrieval algorithm to describe the reason behind the retrieved images were similar to the query by designing user interfaces that allow the interpretation of the retrieved 2D PET-CT key slices [96]&3D PET-CT volumes [97].

V. The use in Various Medical Departments

The similar diversity that exists with regard to proposed applications exists similarly relating to the medical field where the utilization of content-based access techniques has been implemented or proposed. Apparently, most of the applications are based on the images generated in radiology departments, however there are additionally a few other departments where CBIRSs have been implemented. A group of images from numerous departments has been described in [51, 99]. A characterization of dermatologic images is described in [63,98,99]. Cytological specimens have previously been explained (in 1986, [100]) & also later on [101] although the search for 3D cellular structures followed later on [85].

Pathology images have been proposed over and over again for content-based access [43,102] as the color & texture characteristic can comparatively easy to be identify. The jobs of a pathologist when searching for reference cases similarly backings the use of an image retrieval system without only reference books. The utilization of tuberculosis smears is depicted in [103]. Ause of histopathologic images is presented in [104]&histological images are studied in [105,106,107]. In cardiology, CBIR has been utilized to find stenosis images. MRIs of the heart have been studied in [108].

In the radiology section, mammographies are a standout amongst the most frequent application parts with regard to classification & content-based search. The negative psychological impacts to remove tissue for false positive patients have been explained of one of the

main objective to be diminished. Diverse ultrasound images are utilized in [41].

Another active field is the categorization of High Resolution Computed Tomography (HRCT) scans of the lung as carried out by the Assert project [113,114]. A research on the diagnostic quality with & without utilizing the system exhibited a substantial enhancement of the diagnostic quality with utilizing a retrieval technique for finding related cases [115]. Also, a project using HRCT lung images is presented in [116, 117]. An explanation of use in this field is the hard decision-making job & the strong need of the diagnoses from texture properties. Explanations of HRCT lung images, their visual properties & their pathologies are presented in [118,119]. The utilization of thorax radiographies is presented in [18]. This will be a consider ably tougher job as quite a few layers are superposed & a lot of factors except the pathology can impact on the visual content strongly.

Numerous different articles use medical images to show their algorithms but a clinical assessment of their utilization has rarely been carried out. In [50, 51, 120], magnetic resonance images (MRIs) of the brain are utilized to show the image search algorithms but the research papers don't discuss regarding any medical integration. [121,122] also utilize MRIs of the head to test their algorithms. CT brain scans to categorize lesions are utilized in [123]. The search for medical tumors by their shape characteristic (after segmentation) have been presented in [21]. Functional photon emission tomography (PET) images for retrieval are utilized in [124]. Spine X-rays are utilized in [21,126].

Table 2 displays an outline of a number of image types & the systems that are utilized to retrieve these images.

Table 2 : Images used-Name of the systems

Images Used	Names of the systems
HRCTs of the lung	ASSERT
Functional PET	FICBDS
Spine X-rays	CBIR2, MIRS
Pathologic images	IDEM, I-Browse,PathFinder, PathMaster
CTs of the head	MIMS
Mammographies	APKS
Images from biology	BioImage, BIRN
Dermatology	MELDOQ, MEDS
Breast cancer biopsies	BASS
Varied images	I^2C, IRMA, KMed, COBRA,MedGIFT, ImageEngine

VI. The use in Fields Close to Medicine

There are several fields close to the medical domain where the utilization of content-based access techniques to visual data have been presented also or are already implemented. In the USA, a biomedical research network is going to be set up & the sharing of visual information & their management incorporate the utilization of similarity queries. Multidimensional biological images from different devices are used in the Bio Image project.

VII. Techniques Used in Medical Image Retrieval

This segment explains the different methods that are presently-used or that have been proposed for the utilization in medical image retrieval applications. Many of the methods are almost same to those used for general content-based retrieval but also methods that have not yet been utilized in medical applications are recognized. A specific objective centered on the data sets that are utilized to assess the image retrieval systems & on the measurements utilized for assessment. But, the performance assessment of systems is presently strongly ignored. Additionally, machine learning in medical uses gets ever more importance & it is necessary to research numerous possibilities. Specialized work-shops exist for this area [164].

a) Features used

This portion explains the (visual) characteristic that are utilized in the different applications. In this segment text is added to examine whether this ought to be named content-based retrieval or rather not. As the formulation of similarity queries instead of text might be somewhat problematic, another subsection is added to depict the different prospects to formulate queries without text.

i. *Query formulation*

The query formulation with using entirely visual characteristics can be a huge issue. Maximum systems in CBIR use the query by example(s) (QBE) paradigm which require an proper starting image for querying. This problem of a sometimes missing starting image is well-known as the page zero problem.

If text is attached to the images, which is generally the case in medical applications, then the text can be utilized as a beginning stage & once visually relevant images have been found, further queries can be completely visual to discover visually similar cases not

able to be found by text or to sort the found cases by their visual resemblance. In the medical decision-making procedure, there are frequently images generated & accessible for the current case. At the beginning stage does not necessary to be further defined but the images of the case can be utilized directly. With regard to the segmentation of the images the user can additionally limit the query to some region of interest (ROI) in the image, which can lead to much more particular queries than if utilizing an image in its whole.

The use of human sketches has already been presented in basic image retrieval &it has additionally been presented for the utilization in medical applications. In view of the difficulty in exact drawing & the necessity for some artistic skills & time, this technique will only be appropriate for a very small subset of queries, for example, tumor shapes or spine X-rays, where sketches are possible directly in the image. For general image retrieval, sketches are excessively time-consuming & the retrieved results regularly not exact enough.

ii. *Text*

Numerous frameworks presented to utilize text from the patient record or studies to search by content. Others characterize a context-free grammar, a standardized vocabulary for image description [106] organ image definition language for the querying of images in image repositories utilizes text from radiology reports to change it into ideas in the UMLS meta thesaurus to then retrieve the images. The utilization of text for queries is undeniable efficient but the question is whether this can actually be called content-based queries as the text does not essentially define the image content. It rather puts the images into the context they have been taken in, so it ought to be called context-based queries as defined in [95]. The combination of textual with visual features or content & context of the images does have the most possibility to lead to good outcomes [21]. One can likewise be utilized to control the quality of the other or to get an improved recall of the retrieval results.

Other than the free text that is often used for retrieval, medical patient records like wise comprise extremely valuable structured information, for example, age, sex & profession of the patient. This information is just as significant as free text to put the images into a context.

iii. *Visual features*

Unfortunately, most articles that propose content-based queries don't clarify thoroughly which visual features have been utilized or are intended to be used. Some of the times, just a very vague depiction, for example, general texture & color or grey level features are given as in [51].

Mostly all the systems that do give details use color & grey level features, typically in the form of a histogram [107, 108]. Local & global grey level features are utilized, in [99]utilized statistical distributions of grey levels for the classification of images & presents a brightness histogram. Since a number of images in the medical domain don't have colors or are taken under controlled conditions, the color properties are not in any way in the focus point of research & the same holds for invariants to lighting conditions. This can alter during using photographs, for example, in dermatology. Pathologic images will require to be normalized in some way as various staining techniques can generate diverse colors. In radiology, the normalization of grey levels between various modalities or even for the same modality can bring about problems when there is no definite reference point as is for the density of the CT.

As color & grey level features are of less significance in medical images with compare to in stock photography, the texture & shape features achieve in importance. Actually the majority of the standard methods for texture characterization are utilized from edge detection utilizing Canny operators [103] to Sobel descriptors [113]. [21,101,113] additionally utilized Fourier descriptors to classify shapes, [21] use invariant moments & [21] also scale-space filtering. Features derived from co-occurrence matrices are also regularly utilized [81, 118], along with responses of Gabor filter, wavelets & Markov texture properties. In mammography, denseness is utilized to find small nodules. It is intriguing to have a comparison of a few texture descriptors. A significant number of them model the same information & will probably deliver very similar results.

With regard to segmentation, the shape of the segments can be utilized as a powerful feature. Yet again, the exact nature of the shape features is not explained [112] which makes it impossible to define what exactly had been used. In [108] no segmentation has been carried out for the gaining of shape features but computer-assisted outlining. The segmentation of pathologic images is explained in [102]. In [122] even shape descriptors for 3D structures utilizing modal modeling are explained. Most common shape descriptors are Fourier descriptors [37,117,103] that simply permit to get invariant descriptions. The pattern spectrum is presented in [110] & morphological features are utilized in [110].

Utilizing segments in the images also permits utilizing spatial relationships as visual descriptors of the images. This is frequently proposed [111] but hardly any detail is given on how to obtain the objects/segments in the images, which does not allow to judge whether an implementation is possible. Another research paper shown interest on the issues of automatic segmentation.

The utilization of Eigen images for the retrieval of medical images in analogy to Eigen faces for face

recognition is presented in [62]. These features can be utilized for categorization when many images for every class exist. Still, the features are absolutely statistical & it is difficult to actually describe the comparability of two images on the basis of these features which can more effectively be carried out for a histogram intersection, for instance.

Like generic CBIR, semantic features are presented for visual similarity queries with medical images [107]. But then also, it comes down to simple textual labels attached to the images & a mapping between the text & the low-level features. A project to attach semantic labels automatically to images or regions is explained in [105]&in Project Image.

VIII. Summary and Future Directions

Various methodologies in the literature have been approved for various image modalities & clinical applications (breast cancer, spinal conditions, etc.). The multiplicity of 2D CBIR research has led to numerous 2D methodologies being implemented to images with higher dimensions, e.g., the representation of volumetric images using key slices.

The Image CLEF medical retrieval task has motivated research into retrieval from different datasets. The CBIR technologies made as part of the task are well positioned to to handle the difficulties in clinical environments where a variety of image modalities are obtained. Specifically, the Image CLEF task has prompted the improvement of methods for characterizing image modalities on the basis of features. In previous years, maximum of the images in the Image CLEF medical dataset were inherently 2D or 2D constructions of multidimensional data. The dataset is extending to incorporate volumetric, dynamic & multimodality images to motivate further research into the retrieval of such data.

The use of non-image features to complement image features has been broadly studied because all patients have some related textual data, for instance clinical reports & measurements. It has been shown that merging visual features together with text data enhance the precision of the search, however further research is important to make the contribution of this combination statistically significant [67].

In this survey, we have presented the evolution of CBIR towards the retrieval of multidimensional & multimodality images. While incredible advancement has been made, there are still a few difficulties to be solved. In the next portion, we explained particular areas for forthcoming research that ought to be pursued to enhance CBIR abilities for multidimensional & multimodality medical image retrieval from repositories comprising a different collection of data.

a) Visualization and User Interfaces

There has been inadequate research into visualization technique for CBIR framework, with maximum research work concentrating on enhancing retrieval accuracy & speed. Though, image retrieval tasks are generally done for a specific purpose. In medicine, these purposes can incorporate image-based reasoning, image-based training, or research. As such, a viable technique for demonstrating the images to the user is a critical part of CBIR systems.

Present research works that already discuss about these issues are frequently 2D or key slice CBIR systems, e.g. [127] for non-medical images. The introduction of multidimensional & multimodality data presents new visualization difficulties. CBIR systems require to have the ability to display multiple volumes or time series (one for every retrieved image), along with fusion information in the case of multimodality images. The systems need to improve hardware utilization, particularly when volume rendering is being utilized. Moreover, Tory & Moller [128] proposed many human factors that also need to be considered to facilitate the interpretation of visualized data by users. The visualization ought to exploit the retrieval procedure to show why the retrieved images are significant.

The development in the area of effective user interfaces is gaining interest, particularly if the CBIR systems are to be trialed in clinical settings. The guidelines of user inter face to search applications have to be pursued to guarantee that users can easily incorporate the CBIR system into their clinical workflow. Context-aware multimodal search interfaces, e.g. [129], ought to be followed to provide users the flexibility to solve the sensory & semantic gaps.

b) Feature Selection

The dimensionality has been a problematic area all the time for medical CBIR algorithms & stays significant as algorithms are developed for cutting edge medical images. Feature extraction & selection algorithms should develop a core component of retrieval techniques to guarantee that indexing & retrieval can be executed in an effective way. Methods that extract multidimensional local features from each pixel are no more viable for volume & types of images routinely gained in modern hospitals.

Moreover, the growing clinical usage of multi-modality images provides the chance to derive complementary information from various modalities, the combination of which will give extra multidimensional features that might not be obtainable from a single image type. Up coming research work should make full utilization of these features by characterizing similarity in terms of features from both modalities. Likewise, useful indexing features can potentially be extracted from the relationships between ROIs in diverse modalities. Feature selection algorithms should inspect the balance between features from individual modalities, along with relationship features between modalities.

c) Multidimensional Image Processing

Multidimensional images are currently developed as a routine part of clinical work processes. However, in spite of the predominance of volumetric images (CT, PET, MR, etc.) & time-varying images (4D CT, dynamic PET, & MR), some medical CBIR algorithms accept key slices to represent the complete set of multidimensional image data. While this has demonstrated viable in a few situations, it is exceptionally reliant on the selection of appropriate key slices; manual selection is subjective. In applications where key slices are still feasible, subjective determination can be kept away from utilizing a selection algorithm trained by unsupervised learning, as in [130]. In another cases, the utilization of key slices may not be possible as it may loss spatial information, for instance clinically relevant information (a fracture, multiple tumors, etc.) that is spread over numerous sites & slices. Several key slices, as in [91, 130], become less feasible in cases where the disease possibly spreads all through the body, e.g., cancer. As such, it is essential that upcoming medical CBIR research work do not depend on key slices & are enhanced to work directly on the rich multidimensional image data gained in modern hospitals.

The direct utilization of multidimensional images will need the incorporation of image processing methods (compression, segmentation, registration, etc.) that are intended for such images. The trend towards utilizing local features in general CBIR [4] shows that the improvement of correct segmentation algorithms will become important for the advancement of ROI-based CBIR solutions. The effectiveness of some present algorithms will additionally require to be enhanced for real-time operation. For instance, a new adaptive local multi-atlas segmentation algorithm [130] needs about 30 min to segment the heart from chest CT scans with a mean accuracy of about 87 %; this kind of processing times are not viable for rapid data access.

Registration will be essential to retrieve multimodality images. Specifically, registration will be required to extract the relational features, segmentation tumors given anatomical priors, & fused visualization. Luckily, hybrid multimodality PET-CT & PET-MR scanners inherently provide co-alignment information that can be utilized for these reason.

d) Standardized Datasets for Evaluation

Most of the medical CBIR research work is assessed on the basis of private datasets that are collected for particular studies or purposes, for instance, retrieval of lung cancer images. These datasets are presented in the research work where they are utilized. This kind of datasets have the benefit of allowing CBIR that is enhanced for specific clinical applications or objectives. Additionally, it has the possibility to enhance the results by decreasing the number of variables that the algorithm must consider, e.g., by having fixed image acquisition protocols, devices, resolutions, etc. In this way, researchers can resolve a particular issue before generalizing their algorithms for a wider array of circumstances.

Though, the utilization of private datasets makes it hard to compare diverse CBIR algorithms across various research work. To ease this issue, there has been a push for the creation & utilization of huge & varied publicly accessible datasets with standardized gold standards or ground truth. We list a few such datasets in this segment.

The Image CLEF medical image dataset [72] have more than 66,000 images between 2005 & 2007. The collection was derived from many sources & contained radiology, pathology, endoscopic, & nuclear medicine images. In 2013, the Image CLEF medical image task had over 300,000 images comprising MR CT, PET, ultrasound, & combined modalities in one image.

The PEIR Digital Library [12] is a free pathology image database for medical education. Text descriptions have also been added to the images in this database as its main purpose was for the creation of teaching materials. These text descriptions can present the ground truth from which retrieval algorithms can be assessed.

The National Health & Nutrition Examination Surveys (NHANES)were a family of surveys carried out more than 30 years to monitor several health trends in the USA. The dataset comprise of spine X-ray images (as used in [35]), along with hand & knee X-rays. Though, just a portion of this dataset is freely accessible.

The Cancer Imaging Archive (TCIA) is a set of quite a few image collections, each of which was built for a specific reason, for instance the Lung Imaging Database Consortium (LIDC) [107] of chest CT & X-rays. The images in the TCIA collection comprised of several different image modalities, many subjects & several forms of supporting data.

To allow retrieval on huge collections, the VISCERAL project is a new initiative where main objective is to give 10 TB of medical image data for research & validation. Specifically, the project expects to hold challenges that exploit the knowledge stored in repositories for the improvement of diagnostic instruments. The VISCERAL dataset will be included two annotation standards: a gold corpus annotated by domain experts & a silver corpus annotated by deriving a consensus among research systems developed by challenge participants.

e) Clinical Adoption

There is a lack of clinical examples of CBIR us fullness in site of many years of CBIR research. This is partly because of the focus of most medical CBIR research: solving technical challenges (enhancing feature selection, similarity measurement) contrasted

with fulfilling a clinical goal. Likewise, the greater part of CBIR research is assessed only in nonclinical environments; association between physicians & computer scientists is generally limited to sharing data. Clinical assessment of CBIR will permit the examination of the advantages & downsides of current algorithms & will enable more prominent clinical importance in upcoming CBIR research.

The utilization of medical literature to guide CBIR design is another area that need research. Disease staging & classification schemes in cancer [109, 110] deliver contextual information that can be utilized to improve medical CBIR systems on the basis of the guidelines utilized by physicians. Moreover, the integration of medical terminology in ontologies like RadLex & the Unified Medical Language System [19] by learning correspondences between image features & text labels ought to be investigated for the case of multidimensional images.

Closer communication is required with clinical staff to guarantee that medical CBIR research has results that are relevant to health care. Clinical staff have to be involved in the design of CBIR systems; medical specialists should be consulted particularly if a domain-specific paradigm [4] is being adapted. An example of this kind of research is presented by Depeursinge et al. [2], who implemented three clinical work process to help students, radiologists, & physicians in the diagnosis of interstitial lung disease utilizing a hybrid detection-CBIR diagnosis system. The implementation of CBIR research as essential components of the clinical work process, compare to stand-alone applications, will enable its adoption in routine clinical practice [21].

In content based image retrieval, there are several problems that one can define to explain the variations between the growth of CBIR systems in the literature and the lack of their use in applications. The sensory and semantic gaps present in the image are the major problems to be eliminated as it may lead to lose of the information content in any image. Especially in medical images, which are complex to be retrieved form the database as it may contain more noises because of the uncertainty of defined features. To get rid of these problems and to develop a new idea in CBIR medical analysis, it is essential to analyze systems presented in the literature on their possibility to minimize the gaps.

The survey shows that many algorithms proposed earlier aims at reducing the seriousness caused by the feature gaps and to increase the accuracy and exactness of the retrieval process from the databases. Dealing with the two modalities such as 2D and 3D perspective view becomes active research in all of the developing algorithms. Generally, the multi-dimensional images are likely to be affected by the misclassification factor, which further reduces the clarities In addition, the reports generated by analysis of algorithm depicts that all finds difficulty of measuring the similarities between the input image and images in the database, which further leads to occurrence of false positive data result. The level of precision and exactness is lost when more number of false positive data are generated by the algorithm. To satisfy this criteria, our system focuses on the iterative development of the similarity measurement to reduce the false positive maximum.

The other problem that affects the retrieval accuracy is noisy factors, which tend to appear in medical images as the center pixel is affected or hided by the surrounding pixels present in the features. The selection of suitable enhancement and filtering techniques to solve the invariance in pixels can be adopted in our method to eliminate the problems caused by noises. Thus, the factors affecting the retrieval of the multidimensional view of the medical image as discussed above are identified from the existing systems and the design of our proposed algorithm is promoted.

X. Conclusions

The large number of research publications in the field of content-based medical image retrieval especially in recent years shows that it is very active and that it is starting to get more attention. This will hopefully advance the field as new tools and technologies will be developed and performance will increase. Content-based visual information retrieval definitely has a large potential in the medical domain. The amount of visual data produced in medical departments shows the importance of developing new and alternative access methods to complement text. Content-based methods can be used on a large variety of images and in a wide area of applications. Still, much work needs to be done to produce running applications and not only research prototypes. When looking at most current systems, it becomes clear that few to none of them are actually in routine use.

In this review, we examined how state-of-the-art medical CBIR studies have been applied in the retrieval of 2D images, 3D images with multiple dimensions, and multimodality images from repositories containing a diverse collection of medical data. We also examined the manner in which non-image data were used to complement visual features during the retrieval process. The development of open toolboxes is another important factor for successful applications. Not only do interfaces for the communication with other applications need to be developed, also within the application it is important to stay modular, and so parts and pieces can be exchanged easily. This will help to reduce the number of applications developed and will make it possible to spend more time on the important tasks of integration and development of new methods and system optimizations.

It is clear that new tools and methods are needed to manage the increasing amount of visual information that is produced in medical institutions. Content-based access methods have an enormous potential when used in the correct way. It is now the time to create medical applications and use this potential for clinical decision-making, research and teaching.

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Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

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Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

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Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

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10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

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16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

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18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

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21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

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33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

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Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

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Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

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The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

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- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
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- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

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- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

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- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

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- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

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The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

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- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
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- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

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- In spite of position, each table must be titled, numbered one after the other and complete with heading
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- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
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- Submit to generally acknowledged facts and main beliefs in present tense.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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