Jumping particle swarm optimization algorithm framework for content-based image retrieval system

Atheer Bassel[1], Mohammed Jameel[1], Mohammed Ayad Saad[2,3,4]
[1]Computer Center, University of Anbar, Al-Anbar, Iraq
[2]Department of Medical Instrumentations Technique Engineering, Al-Kitab University, Kirkuk, Iraq
[3]Department of Electrical, Electronics and Systems Engineering, Universiti Kebangsaan Malaysia, Bangi, Malaysia
[4]Department of Medical Instrumentations Technique Engineering, Jannat Iraq College, Ramadi, Iraq

Article Info

Article history:

Received Oct 17, 2022
Revised Dec 16, 2022
Accepted Feb 3, 2023

Keywords:

Content-based image retrieval
Jumping particle swarm optimization
Medical image retrieval
Metaheuristic algorithms
Wavelet transformation

ABSTRACT

Content-based image retrieval (CBIR) has been studied well in the last decades in numerous research fields such as medicine, journalism, and private life. Applications of CBIR have been widely employed in medical images due to their direct impact on human life. With continues growing of digital libraries, there is a need for an efficient method to retrieve images from large datasets. In this paper, a new method was developed for CBIR based on the jumping particle swarm optimization (JPSO) algorithm. The proposed algorithm represents a developed instant of particle swarm optimization (PSO). However, JPSO the approach does not consider the velocity components to guide particle movements in the problem space. Instead of relying on inertia and velocity, intermittently random jumps (moves) occur from one solution to another within the discrete search space. To test the performance of the proposed algorithm, three types of medical image databases were used in the experiment which are the endoscopy 100, dental 100, and 50 skull image databases. The results show that the proposed algorithm could achieve high accuracy in image extraction and retrieve the accurate image category compared with other research works.

This is an open access article under the CC BY-SA license.

Corresponding Author:

Atheer Bassel
Computer Center, University of Anbar
Al-Anbar, Iraq
Email: atheerbassel@uoanbar.edu.iq

1. INTRODUCTION

There are many applications for image processing algorithms including medical diagnosis, art collections, crime prevention, and geographical information [1]. Image retrieval is among the most important applications for handling large image databases. Images can be retrieved based on image, text, and content, which are referred to as text-based and content-based image retrieval (CBIR) respectively. In CBIR, each image is represented by a feature vector and this vector is used for image indexing and computing similarity with the query image. Based on the image similarity measures, the most relevant images are retrieved.

Many researchers proposed medical image retrieval using various methodologies. But a lot of techniques are growing to increase the CBIR performance and to classify an image. In the medical image, the retrieval field proposed the various stages of extracting and indexing the different visual features of the images [2]. In the area of medical image processing, medical images are utilized for analysis reasons. The calculation and models of image processing are applied to the investigation and choice expectation towards the medical field. The medical imaging framework developed the most noteworthy type of computerized image, for example, ultrasound, x-beam tomography, MRI, atomic imaging, and endoscopic image. This built image from this innovation proposed and showed the medical history of the patients [3].

In the period of example acknowledgement, medical image processing assumes a significant job. Medical image processing is the way toward delivering a noticeable image from the inward structure of the body towards logical and restorative examination. Based on this noticeable inward perspective on human body the medical master is given the treatment to the patients.

The natural eye doesn't notice and comprehends the part structure of the inward object of the body. In the current time, the quick advancement of the web becomes a piece of human life. Utilizing the web and world wide web structure the entrance of information and data starting with one spot and then onto the next spot is a conceivable effective way. The computational world gives a group of mechanized gadgets to the medical society, for example, magnifying instruments, computerized cameras, focal points, sensors, and automated therapeutic items. The image databases are gotten the biggest and progressively across the board over the network [4], [5].

In the medical field, the comparative kinds of patients and their treatment concerning the medical issue happen step by step. The comparative type of medical issues happened in the thousand patients. For comparable kinds of patients need homogeneous and anticipated equivalent types of medicines. In the emergency clinic, radiology and cardiology are both offices that created thousands of medical images in a day. It is difficult that a medical master helps the previous history to remember the comparable cases which are valuable for the current dynamic patient's treatment. Dealing with the executives of this kind of huge medical image is a difficult errand and too difficult.

The medical imaging region permits the specialist to comprehend the determination and give viable, safe treatment to the patients. For the plan, the substance put together an image processing framework concerning the endoscopy, dental and skull image database following the targets planned.

– To characterize the procedure for the visual element extraction dependent on shading and shape utilizing the descriptor and wavelet-based strategies.
– To make a dataset from the highlights-based medical images utilizing the middle factual measure and used this dataset for further examination.
– To assess the presence of the framework dependent on Canberra separation and Euclidean separation similitude measurements based on estimated and exhibition assessment.

2. RELATED WORKS

There is a developing requirement for the advancement of a successful and effective image recovery framework in the space of medical imaging. This CBIR framework for medical space is accessible widely and it is gotten to by the medical master concerning the data and medical history of the patients. The effective access to the medical comparative data image is unquestionably valuable for the medical master for the analyses, treatment, and fix of the medical condition customary business image listing framework was accessible yet it has a degree level of confinement in light of the explanation was done based on human perception and manual checking of each image [6], [7].

There is a need for the advancement of substance-based image retrial framework for medical image databases which are used as a reality and productive access. This framework is created utilizing computational and web-based innovation. The on-the-web and disconnected mode is needed for this framework. The radiology and cardiology divisions of all clinics need these kinds of frameworks for the medical master to find, treat, and fix medical conditions based on the last sure condition from a similar set of the problem [8].

There is having to structure and improvement of the framework which viably recovers, and put away images rapidly and precisely. The comparative image-based inquiry application was utilized by the medical master as a query by image content (QBIC) strategy. This framework handles the query embedded by the master to connect the looked-through images from the database. A lot more application is utilized for the advancement of the content-based image retrieval (CBMIR) framework. A different analyst has contributed to the exploration examines in regards to the improvement of the query-based hunt execution with the advancement of decreased cost [9], [10]. The difficult errand in the CBIR framework is the capacity of the gigantic measure of images in the dataset. The immediate pixel-based image stockpiling decreases the exhibition of the framework. In the CBIR framework, the images are files and named based on explicit informatics highlights and their properties concerning the shading, shape, and layout [11], [12].

This CBIR framework is centred on image recovery from the database which is put away in the record-based capacity way. The different ordering calculation was produced for the existing CBIR framework advancement which diminish the extra room and accelerate the looking-through procedure. The different calculations used for the CBIR framework improvement incorporate the multidimensional element extraction and correlation of the images from the database based on the separation measure. For the looking and recovery, the query-based images comprise of shading, shape, surface, and format of the image highlights has been expanded at the degree level. The primary consideration has been attracted to that substance-based image recovery framework accomplished extraordinary intrigue and extension for the scientist in the last not many years [13], [14]. Issues with customary strategies for image order are prompting the ascent of enthusiasm for methods for recovering images based on naturally determined highlights, for example, shading, surface, shape, and innovation currently for the most part alluded to as CBIR. In any case, the innovation despite everything needs development and isn't yet being utilized on a noteworthy scale.

Consideration is subsequently attracted to CBIR which has accomplished extraordinary development over the most recent couple of years. From the above area information on medical imaging and its application to the public, we are chosen the CBIR for the medical image database for our exploration study. The exploration incorporates the component extraction calculation for the low-level and significant-level highlights extraction. The structure of the substance-based image recovery framework for the medical database dependent on the endoscopy, dental, and skull image dataset has been executed here [15], [16].

3. THE PROPOSED SOLUTION TO THE PROBLEM

For the accomplishment of the plan goal of this exploration, the arrangement is proposed towards the planning of the CBIR for endoscopy, dental, and skull image database. The CBIR is the development use of computer vision and image processing for taking care of and examination of enormous scope image database stockpiling and recovery process. The improvement of this framework is managing two principal difficulties, for example, goal and schematic hole. The aim hole happens the because of confronting troubles to communicate the normal visual substance of the query-based pursuit result of the image [17]. The troubles looked for the communicating rather muddled semantic ideas with the straightforward visual feature.

The general plan of the proposed system for the image-based recovery calculation is created utilizing two stages. The disconnected and online stages are produced for the application area and look through the need concerning the CBIR framework. The graphical portrayal of the proposed structure is clarified in Figure 1.

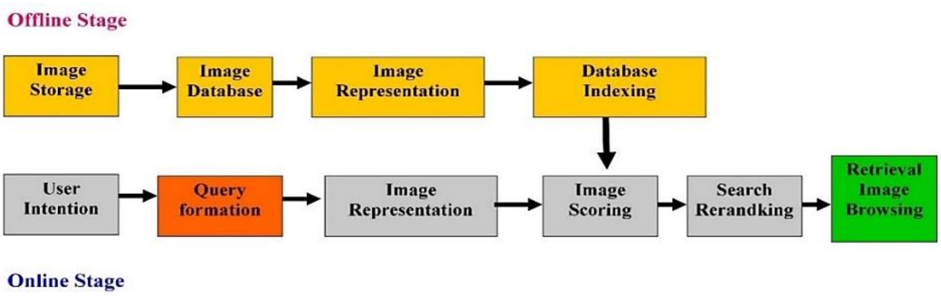

Figure 1. Proposed flow diagram for the CBIR in medical image development

The image presentation implies the image property features is relying upon the stage utilized for usage and calculation used in this execution. The capacities of these means are to fulfil the condition for comparable and non-comparative images based on clear and similarity investigation utilized by the calculation. The image stockpiling in the huge scope image database commonalty utilized the structure of list-based capacity towards the recovering activity. The hunt positioning activity was done based on the similarity measure record which is useful for the recover the nearest comparative image from the littlest separation. The image recovery based on the schematic component is acknowledged the inconsistency structure schematic gap the pursuit and recovery of the comparable substance image have been on from the separation measure factual calculation [18].

3.1. Techniques used for the experiment

In the proposed solution, several techniques are used for the experiment, including pre-processing, feature extraction, and similarity measures. These techniques are applied to address the challenges of goal and schematic gap in CBIR for endoscopy, dental, and skull image databases. Pre-processing: the pre-processing step involves applying various operations to the collected images to enhance their quality and remove any noise or artifacts. In this study, an image processing toolkit is used, which includes filtering techniques for adjusting the color and enhancing the objects in the images. Specific filtering algorithms, such as spatial filters or frequency domain filters, may be employed to achieve these goals. Feature extraction is a crucial step in CBIR, as it aims to capture the distinctive characteristics of images that can be used for comparison and retrieval.

Different algorithms or methods are used to extract relevant features from the pre-processed images. These features can include color histograms, texture descriptors, shape-based features, or any other visual properties that can effectively represent the content of the images. The choice of feature extraction technique depends on the specific requirements and characteristics of the image database being analyzed. Similarity measures: once the features are extracted, similarity measures are used to quantify the resemblance between query images and the images in the database.

Various statistical algorithms or distance metrics can be employed to compute the similarity scores. Examples of commonly used measures include Euclidean distance, cosine similarity, correlation coefficients, or more advanced methods like neural networks or deep learning models for similarity estimation. The similarity measure determines the ranking of the retrieved images, with closer matches having higher similarity scores. It is important to note that the specific algorithms and techniques used for pre-processing, feature extraction, and similarity measures may vary depending on the implementation and research context. The choice of these techniques should be based on the specific requirements of the image database, the desired accuracy, and efficiency of the CBIR system [16].

3.2. Feature extraction techniques

Feature extraction techniques are used to capture relevant and discriminative information from images that can be used for comparison and retrieval in the CBIR system. Here are some commonly used features extraction techniques: i) color-based features: these techniques focus on extracting color information from images; color histograms, color moments, or color correlograms are commonly used to represent the distribution of colors within an image. Color-based features are effective for distinguishing objects based on their color characteristics; ii) texture-based features: texture features capture the spatial arrangement of pixels in an image. They are useful for representing the patterns, surface properties, and fine details of objects. Common texture descriptors include local binary patterns (LBP), gray-level co-occurrence matrices (GLCM), and Gabor filters. Texture-based features are particularly suitable for images where texture plays a significant role, such as in medical or material science applications; iii) shape-based features: these techniques focus on extracting geometric or shape-related information from images. Shape descriptors such as FD, moments, or contour-based features can capture the outline or structural properties of objects. Shape-based features are often used when the shape or structure of objects is critical for retrieval, such as in object recognition or biometric systems; iv) local feature descriptors: local feature extraction techniques aim to capture distinctive regions or keypoints in an image. These methods identify salient points, such as corners or blobs, and extract local descriptors around those points. Popular local feature descriptors include scale-invariant feature transform (SIFT), speeded-up robust features (SURF), or oriented FAST and rotated BRIEF (ORB). Local feature descriptors are robust to changes in scale, rotation, and viewpoint, making them suitable for image matching and retrieval tasks.

Deep learning-based features: deep learning techniques, particularly convolutional neural networks (CNNs), have shown remarkable success in feature extraction for various computer vision tasks. CNNs can automatically learn hierarchical representations of images, capturing both low-level, and high-level features. Pre-trained CNN models, such as VGGNet, ResNet, or InceptionNet, are often used to extract deep features from images, which can then be used for CBIR. The choice of feature extraction technique depends on the characteristics of the image database, the specific requirements of the CBIR system, and the nature of the objects or content being retrieved. It is common to employ a combination of different feature extraction techniques to capture various aspects of the images and enhance the retrieval performance [19].

3.2.1. Fourier descriptor

The fourier change is the strategy which creates the element vectors dependent on mean factual measure for the genuine and fanciful piece of the intricate number in recurrence space. This highlight is accomplished the shape-based prevailing aspects which speak to the limits of the article for further execution. Consider a M point advanced limit, beginning from a self-assertive point (x0 and y0) to (xM-1 and yM-1) is generated [20]. These directions can be spoken to in an unpredictable structure. The discrete fourier transform (DFT) of q(m) gives:

$$b(k) = \frac{1}{M}\sum_{m=0}^{M-1} q(m)e^{-j2\pi km/M}$$
$$\mathbf{k} = 0,1,2,\ldots\mathbf{M-1}$$

The complex coefficients b(k) is extracted from the values of the D which carry the boundary features of the image.

3.2.2. Wavelet transformation

For this experiment, we featured the Haar wavelet from the wavelet family. Haar wavelet is the quickest wavelet for figuring and the least demanding execution approach. The query-based image watches out for an enormous steady shading area which is spoken to utilizing this wavelet component. This element extraction method accomplished the shading-based component in terms of Haar wavelet transformation [21]. Haar wavelet's mother wavelet function (t) can be described as:

$$\Psi(t) = \begin{cases} 1 & 0 \leq t < \frac{1}{2} \\ -1 & \frac{1}{2} \leq t < 1 \\ 0 & \end{cases}$$

The actual measurement of physical occurrence shall require a large number of computing resources. Therefore, often a limited number of values (samples)
For t values between 0 (inclusive) and 12 (exclusive), Ψ(t) is equal to 1.
For t=5 or t=10, since 0 ≤ t < 12, Ψ(t)=1.
For t values between 12 (inclusive) and infinity, Ψ(t) is equal to -1.
For t=12 or t=15, since t ≥ 12, Ψ(t)=-1.
For any other t values outside of the specified intervals, Ψ(t) is equal to 0.
For t=-5 or t=20, since t is outside the specified intervals, Ψ(t)=0.
Were collected, if the value is taken at regular intervals over some time, t can be represented discretely by signal vector s, where: s={s1, s2, s3, ... sn}. N is an even positive integer representing the number of limited cases where the signals are recorded.

3.3. Techniques for similarity measure

For the recovery, the comparative component-based image from the colossal measure of image database separation measure measurements is utilized. This separation measure measurement expands the arranged the separation of the current query image is determined the separation concerning all images from the database. The vector of separation measurements is created. Littlest one separation speaks to the image is nearer to the query-based image. For this test we have utilized the Euclidean separation and Canberra towards the comparably measurements estimation and image recovery from the database. The scientific portrayal of the Euclidean separation and Canberra separation is portrayal following way.

$$ED = \sqrt{\sum_{i=1}^{N} (fq(i) - fdb(i))^2}$$

In the above numerical articulation, the fq(i) used for ith query-based image highlight and fdb(i) speak to the comparing highlight vector from the database. N I complete number of image accessible in the database [22].

$$\text{Canberra distance (CD)} = \frac{\sum_i |u_i - v_i|}{\sum_i |u_i| + |v_i|}$$

From the mathematical expression of Canberra distance, the variable u and v are utilized as both n-dimensional vectors. Where n is the number of total image available in the database in the Canberra distance, the variables “u” and “v” represent n-dimensional vectors, where “n” is the number of total images available in the database. Each image is represented as a vector in an n-dimensional feature space, where each dimension corresponds to a specific feature or attribute of the image. Let's say we have a database of n images and each image is described by a set of features or attributes. For simplicity, let's consider a database of 3 images and each image is represented by a 2-dimensional vector:
Image 1: u=(u1, u2)
Image 2: v=(v1, v2)
Image 3: w=(w1, w2)

The Canberra distance measures the normalized absolute difference between corresponding features of the vectors, taking into account the magnitudes of the features. It is often used in CBIR systems as a similarity measure to rank images based on their feature similarity. In a database with n images, you would calculate the Canberra distance between a query image and each image in the database, then rank the images based on their distance values to retrieve the most similar images [23], [24].

3.4. The jumping particle swarm optimization algorithm

Particle swarm optimization (PSO) is a population-based metaheuristic algorithm inspired by the flocking and swarming behavior of bird flocks and fish schools [25]. In PSO, each individual in the population is called a particle. Each particle represents a candidate solution for the optimization problem under study. Each particle has a position and velocity. The position of the particle is determined by the solution that the particle represents. In PSO, each particle has two kinds of experience [26]. The first kind is the experience that results from its local memory of its past history such as the best-so-far position it has had, called as the local best. The second kind of experience is the collective experience that is resulted from the global memory of the past history of the whole swarm called as the global best position that is achieved by the whole swarm. Thus, there are two important pieces of information in PSO that guides the movements of all particles in the population; the first piece is the local best of each partial and the second one is the global best of the whole swarm [27]. Through particle changes its location by its own past experience of searching as well as other experience of searching for particles. The jumping particle swarm optimization (JPSO) proposed, a discrete PSO method inspired by the behavior of frogs in the wild. Unlike PSO, JPSO does not consider the velocity components to guide particle movements in the problem space. Instead of relying on inertia and velocity, intermittently random jumps (moves) occur from one solution to another within the discrete search space [28], [29]. The pseudocode of the simple PSO algorithm.

Algorithm 1: pseudocode of the basic JPSO algorithm [12]
Start
P=initial population.
Evaluate *(P)*.
While *termination condition not satisfied* **Do**
  for *i*=1 to population size.
    Update the velocities of particles $v_i(t)$.
    Move to the new position $x_i(t)=x_i(t-1)+v_i(t)$;
    if $f(xi) < f(pbesti)$ then $pbest_i = x_i$.
    if $f(xi) < f(gbest)$ then $gbest_i = x_i$.
    Update (x_i, v_i).
  end for
end while
End.

The particles in the swarm can perform four types of jumps (moves) depending on which particles acts as the attractor. Given that only one type of move is generated at each iteration, then $\sum_{i=1}^{4} c_i = 1$. A randomly chosen number r with a uniform distribution in [0, 1] along with weights c_x determines the new position of the particles as follows [29], [30]:

a. If $r \in c_1$, then no particle acts as the attractor and the particle randomly moves with respect to its current position x_{ij}. This phenomenon is called iinertial move, which helps explore the surrounding area of the particle.
b. If $r \in c_2$, then the particle moves toward the best achieved position b_i. An exchange algorithm is applied, in which a random segment is copied from the attractor to the follower and duplicated nodes in the newly exchanged segment are removed. This phenomenon is called cognitive move, which guides an attractive path within the swarm.
c. If$r \in c_3$, then the particle follows the best position g_j found by the swarm. The current solution x_{ij} takes a section from g_i using the exchang algorithm. The local move guides the particle in exploring related structures in gi to improve its current position x_{ij}.
d. If$r \in c_4$, then the particles follow the best position g_{ij}, found by the neighbouring particles during the search process. An exchange algorithm is applied between the follower xij and the attractor g_{ij}. This global move encourages the reuse of parts of the overall best sub-swarm solution g_{ij} found in the design of diverse structures.

The overall process allows the JPSO algorithm to incorporate new elements into the process, making it a favorable option for solving complex optimization problems.

4. SIMULATION EXPERIMENTAL RESULTS

For the step-by-step implementation of the CBIR system we are used a MATLAB toolbox and its software package for the development. The detail specification of the experimental analysis is elaborated as follows. The implementation of the proposed system was done using MATLAB 2015 version on the

Intel Core i7, 2 GHz windows with 4 GB of RAM, specification-based machine. This experiment was tested over three types of medical image database. The system tested for the endoscopy 100, dental 100, and 50 skull image databases using the MATLAB implementation environment.

4.1. Performance measurement

The performance of the implemented system is measured based on precision and recall statistical measure for the achievement of the accuracy-based performance. Here in the paper the precision is defined as the number of significant digits to which a value may be measured reliably. Where the precision calculates by the equation, that will be show the true positive (TP) which means the true positives, whereas the false positive is FP.

$$precision = \frac{TP}{TP + FP}$$

The recall, it is fraction of the relevant data that is successfully retrieved. The mathematical equation is:

$$Recall = \frac{TP}{TP + Fn}$$

Where the FN is the false negatives. In addition, the main fitness function of the proposed CBIR model is to maximize the precision and recall using the optimal weighted as given by the mathematical equation is:

$$fitnessfunction = Max(precision, recall)$$

4.2. Results discussion

The experiment for this research is tested over the endoscopy, dental, and skull image dataset. The FD, Haar wavelet techniques were used for the shape and color-based feature extraction. The classification for the distance measure is elaborated using the Euclidian distance and Canberra distance measure. The endoscopy-based image experiment was tested over this research. The graphical representation of the query by image provided by endoscopy experiment testing is shown in Figure 2.

The performance of the endoscopy images is calculated on the basis of accuracy, precision, and recall. The experimental results of the endoscopy images are described in Table 1. The query-based image search for the dental image database is represented in Figure 3. The performance evaluation experimental-based results outcome for the dental images is described in Table 2. The user input query for the image retrieval-based image for the dental skull image database is represented in Figure 4. The performance evaluation experimental-based results outcome for the skull images is described in Table 3.

The comparative performance of all their medical database with respect to the feature extraction techniques is extracted. The Euclidian distance-based measurement for endoscopy, dental, and skull database with respect to FD and Haar wavelet transformation is elaborated in Table 4. The graphical representation of the Euclidian distance-based performance is shown in Figure 5.

Figure 2. The query search image for the endoscopy image experiment

Table 1. Performance of the system for endoscopy images

Feature extraction	Distance measure	Accuracy	Precision	Recall
Fourier descriptor	Euclidian distance	92.25	0.935	0.955
Fourier descriptor	Canberra distance	91.18	0.921	0.889
Haar wavelet	Euclidian distance	93.28	0.943	0.905
Haar wavelet	Canberra distance	93.02	0.923	0.899

Figure 3. The query search image for the dental image experiment

Table 2. Performance of the system for dental images

Feature extraction	Distance measure	Accuracy	Precision	Recall
Fourier descriptor	Euclidian distance	90.39	0.903	0.922
Fourier descriptor	Canberra distance	89.32	0.897	0.898
Haar wavelet	Euclidian distance	91.42	0.923	0.911
Haar wavelet	Canberra distance	91.16	0.896	0.902

Figure 4. The retrieval query image for the skull image experiment

Table 3. Performance of the system for skull images

Feature extraction	Distance measure	Accuracy	Precision	Recall
Fourier descriptor	Euclidian distance	90.39	0.903	0.922
Fourier descriptor	Canberra distance	89.32	0.897	0.898
Haar wavelet	Euclidian distance	91.42	0.923	0.911
Haar wavelet	Canberra distance	91.16	0.896	0.902

Table 4. Euclidian distance-based performance of the system for all database

Database	Feature extraction	Accuracy
Endoscopy	Fourier descriptor	92.25
	Haar wavelet	93.28
Dental	Fourier descriptor	90.39
	Haar wavelet	91.42
Skull	Fourier descriptor	92.28
	Haar wavelet	93.31

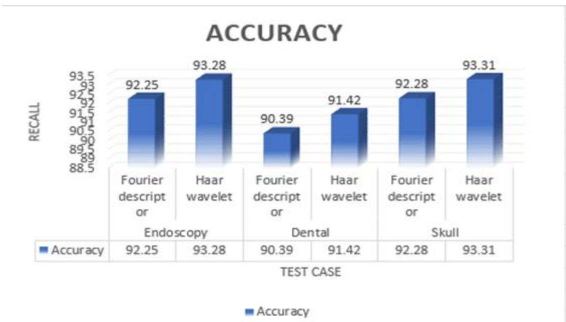

Figure 5. Comparative performance based on Euclidian distance measure

The Canberra distance-based measurement for endoscopy, dental, and skull database with respect to FD and Haar wavelet transformation is elaborated in Table 5. The graphical representation of the Canberra distance-based performance is shown in Figure 6. The comparative measurement based on Euclidian distance and Canberra distance-based performance is elaborated in Table 6.

Table 5. Canberra distance-based performance of the system for all database

Database	Feature extraction	Accuracy
Endoscopy	Fourier descriptor	91.18
	Haar wavelet	93.02
Dental	Fourier descriptor	89.32
	Haar wavelet	91.16
Skull	Fourier descriptor	91.21
	Haar wavelet	93.05

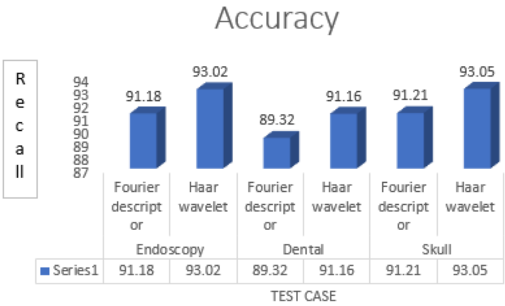

Figure 6. Comparative performance based on Canberra distance measure

Table 6. Comparative performance based on Euclidian and Canberra distance measure

Database	Feature extraction	Euclidian distance accuracy	Canberra distance accuracy
Endoscopy	Fourier descriptor	92.25	91.18
	Haar wavelet	93.28	93.02
Dental	Fourier descriptor	90.39	89.32
	Haar wavelet	91.42	91.16
Skull	Fourier descriptor	92.28	91.21
	Haar wavelet	93.31	93.05

From Table 6, it is seen that the Euclidean separation-based estimation for the presentation accomplished the most noteworthy exactness when contrasted with Canberra separation precision. The Haar wavelet highlight extraction demonstrates better exactness in contrast with the FD. The Haar wavelet with the Euclidean separation likeness measure demonstrates better execution.

There are provided parameter settings and definitions of the values for the parameters used in this work. Table 7 represent the values of parameters utilized in this study. All the parameters used in this experiment followed the same setting of the JPSO algorithm.

Table 7. Parameter settings

Parameter name	Description	Value
Swm size	Swarm size	5
NG	The number of generations	100
NP	The number of particles	20
DP	The dimension of the particle	55
MV	The maximum velocity	0.2
W	The weight	1.0
CC	The acceleration coefficients	1.5
r_1, r_2	r_1, r_2 are random variables	[0, 1]
α	Search strategy acceptance factor	3000

In addition, the value after the number of iterations will be seen in this work. Finding the best goal function, too (fitness). Figure 7 indicates the outcome for the best fitness and the mean fitness during iteration number and for the Haar wavelet system without any adjustment. Also, show the result was stuck after the number of iterations, in this case, use any optimization algorithm to solve this problem. JPSO algorithm, which has the ability to solve the stuck algorithm in local optimum.

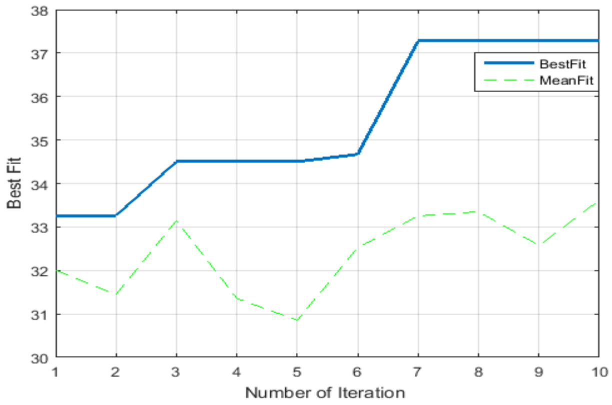

Figure 7. Haar only for 10 iterations

In addition, this work implements the JPSO to improve the ability of JPSO to solve the complex CBIR system problem. This result was obtained at 50 iterations and the result was better than the Haar wavelet only. Finally, the fitness value increases, which means the accuracy value and the NC increase which can show in Figure 8.

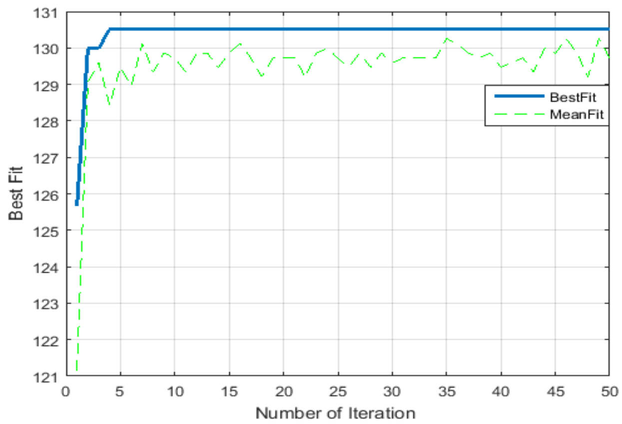

Figure 8. Haar for 50 iterations

5. CONCLUSION

This experiment analysis utilized the most noteworthy data from the image towards the advancement of productive and quick substance-based image recovery arrangement of endoscopy, dental, and skull image databases. This examination proposed image recovery dependent on FD and wavelet-based element extraction. The comparability estimation and recovery dynamic is managing Euclidean separation and Canberra separation. The trial was tried on three distinctive medical images database for endoscopy, dental, and skull images. The database utilized for this investigation was downloaded from the web as an open examination dataset. The framework is executed so as to quantify the precision and heartiness of the framework. The exhibition estimation of the framework is determined based on exactness, accuracy, and review-based factual measure. From the test examination, it is seen that the Euclidian separation-based estimation for the presentation accomplished the most noteworthy exactness when contrasted with Canberra separation precision. The Haar wavelet highlight extraction demonstrates better precision in contrast with the FD. The Haar wavelet with the Euclidean separation similitude measure demonstrates the better execution.

REFERENCES

[1] E.-G. Talbi, *Metaheuristics: From Design to Implementation*. Canada: Wiley- A John Wiley and Sons, INC., Publication, 2009.

[2] S. Fadaei and A. Rashno, "Content-based image retrieval speedup based on optimized combination of Wavelet and Zernike features using particle swarm optimization algorithm," *International Journal of Engineering*, vol. 33, no. 5, pp. 1000–1009, 2020, doi: 10.5829/IJE.2020.33.05B.34.

[3] P. Kaur and and R. K. Singh, "An Efficient Approach for Content-Based Image Retrieval Using Cuckoo Search Optimization," *International Journal of Modeling and Optimization*, vol. 9, no. 2, pp. 77–81, Apr. 2019, doi: 10.7763/ijmo.2019.v9.688.

[4] B. Hasan, S. Alani, and M. A. Saad, "Secured node detection technique based on artificial neural network for wireless sensor network," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 11, no. 1, pp. 536–544, Feb. 2021, doi: 10.11591/ijece.v11i1.pp536-544.

[5] K. M. Hosny, A. M. Khalid, and E. R. Mohamed, "Efficient compression of volumetric medical images using Legendre moments and differential evolution," *Soft Computing*, vol. 24, no. 1, pp. 409–427, Mar. 2019, doi: 10.1007/s00500-019-03922-7.

[6] D. B. Renita and C. S. Christopher, "Novel real time content based medical image retrieval scheme with GWO-SVM," *Multimedia Tools and Applications*, vol. 79, no. 23–24, pp. 17227–17243, Mar. 2020, doi: 10.1007/s11042-019-07777-w.

[7] H. F. Hashim, M. M. Kareem, W. K. Al-Azzawi, and A. H. Ali, "Improving the performance of photovoltaic module during partial shading using ANN," *International Journal of Power Electronics and Drive Systems (IJPEDS)*, vol. 12, no. 4, pp. 2435–2442, Dec. 2021, doi: 10.11591/ijpeds.v12.i4.pp2435-2442.

[8] M. A. Saad, R. Jaafar, and K. Chellappan, "Variable-Length Multiobjective Social Class Optimization for Trust-Aware Data Gathering in Wireless Sensor Networks," *Sensors*, vol. 23, no. 12, pp. 1–29, Jun. 2023, doi: 10.3390/s23125526.

[9] M. J. Mnati, R. F. Chisab, A. M. Al-Rawi, A. H. Ali, and A. V. den Bossche, "An open-source non-contact thermometer using low-cost electronic components," *HardwareX*, vol. 9, pp. 1–9, Apr. 2021, doi: 10.1016/j.ohx.2021.e00183.

[10] A. Anand and A. K. Singh, "An improved DWT-SVD domain watermarking for medical information security," *Computer Communications*, vol. 152, pp. 72–80, Feb. 2020, doi: 10.1016/j.comcom.2020.01.038.

[11] M. Roy, K. Mali, S. Chatterjee, S. Chakraborty, R. Debnath, and S. Sen, "A Study on the Applications of the Biomedical Image Encryption Methods for Secured Computer Aided Diagnostics," in *2019 Amity International Conference on Artificial Intelligence (AICAI)*, pp. 881–886, Feb. 2019, doi: 10.1109/aicai.2019.8701382.

[12] B. A. Y. Alqaralleh, T. Vaiyapuri, V. S. Parvathy, D. Gupta, A. Khanna, and K. Shankar, "Blockchain-assisted secure image transmission and diagnosis model on Internet of Medical Things Environment," *Personal and Ubiquitous Computing*, pp. 1–11, Feb. 2021, doi: 10.1007/s00779-021-01543-2.

[13] A. H. Mutlaq, M. A. Saad, F. H. Tata, and G. T. Hasan, "Analysis the efficiency of multi-input-multi-output (MIMO) transmit receive systems," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 29, no. 1, pp. 190-196, Jan. 2022, doi: 10.11591/ijeecs.v29.i1.pp190-196.

[14] A. Kumar, K. Chellappan, A. Nasution, and R. V. Kanawade, "Diffuse reflectance spectroscopy based blood oxygenation monitoring: a prospective study for early diagnosis of diabetic foot," in *Optical Diagnostics and Sensing XXI: Toward Point-of-Care Diagnostics*, pp. 1-5, Mar. 2021, doi: 10.1117/12.2583022.

[15] M. A. Saad, M. H. Ali, S. Alani, A. H. Ali, and Y. A. Hussein, "Performance Evaluation Improvement of Energy Consumption in Ad-Hoc Wireless Network," *International Journal of Advanced Science and Technology*, vol. 29, no. 3, pp. 4128-4137, Feb. 2020.

[16] S. H. Rhaif, A. H. Ali, R. K. Abdulnabi, and A. A. Abdulrazzaq, "Fiber optics based schemes modeling and simulation of QoS for Wi-Fi scenarios using OPNET modeler," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 10, no. 3, pp. 2569-2578, Jun. 2020, doi: 10.11591/ijece.v10i3.pp2569-2578.

[17] A. S. Mahmood, M. Teke, R. K. Ibrahim, A. H. Ali, A. A. Abdulrazzaq, and M. M. Kareem, "Tracking the MPP of a PV system using an advanced fuzzy logic control technique," in *2022 Second International Conference on Advances in Electrical, Computing, Communication and Sustainable Technologies (ICAECT)*, pp. 1-7, Apr. 2022, doi: 10.1109/icaect54875.2022.9808009.

[18] M. Moshref, R. Al-Sayyed, and S. Al-Sharaeh, "Improving the quality of service in wireless sensor networks using an enhanced routing genetic protocol for four objectives," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 26, no. 2, pp. 1182-1196, May 2022, doi: 10.11591/ijeecs.v26.i2.pp1182-1196.

[19] H. Silva, K. Chellappan, and N. Karunaweera, "Image Processing for mHealth-Based Approach to Detect the Local Tissue Inflammation in Cutaneous Leishmaniasis: A Proof of Concept Study," *Computational and Mathematical Methods in Medicine*, vol. 2021, pp. 1–9, Nov. 2021, doi: 10.1155/2021/4208254.

[20] A. T. Al-Heety, M. T. Islam, A. H. Rashid, H. N. Abd Ali, A. M. Fadil, and F. Arabian, "Performance evaluation of wireless data traffic in mm wave massive MIMO communication," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 20, no. 3, pp. 1342–1350, 2020, doi: 10.11591/ijeecs.v20.i3.pp1342-1350.

[21] B. S. Hassen, S. A.-S. Lafta, H. M. Noman, and A. H. Ali, "Analyzing the Performances of WSNs Routing Protocols in Grid-Based Clustering," *International Journal on Advanced Science, Engineering and Information Technology*, vol. 9, no. 4, pp. 1211-1216, Aug. 2019, doi: 10.18517/ijaseit.9.4.8900.

[22] M. Z. Suboh, R. Jaafar, N. A. Nayan, N. H. Harun, and M. S. F. Mohamad, "Analysis on Four Derivative Waveforms of Photoplethysmogram (PPG) for Fiducial Point Detection," *Frontiers in Public Health*, pp. 1-12, Jun. 2022, doi: 10.3389/fpubh.2022.920946.

[23] J. Kennedy and R. Eberhart, "Particle swarm optimization," in *Proceedings of ICNN'95 - International Conference on Neural Networks*, vol. 4, pp. 1942–1948, Nov. 1995, doi: 10.1109/ICNN.1995.488968.

[24] A. Bassel, A. B. Abdulkareem, Z. A. A. Alyasseri, N. S. Sani, and H. J. Mohammed, "Automatic Malignant and Benign Skin Cancer Classification Using a Hybrid Deep Learning Approach," *Diagnostics*, vol. 12, no. 10, pp. 1-15, Oct. 2022, doi: 10.3390/diagnostics12102472.

[25] M. A. Saad, H. J. Alhamdane, A. H. Ali, S. Alani, M. M. Hashim, and B. Hasan, "Total energy consumption analysis in wireless mobile ad hoc network with varying mobile nodes," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 20, no. 3, pp. 1397-1405, Dec. 2020, doi: 10.11591/ijeecs.v20.i3.pp1397-1405.

[26] M. K. Abed, M. M. Kareem, R. K. Ibrahim, M. M. Hashim, S. Kurnaz, and A. H. Ali, "Secure Medical Image Steganography Method Based on Pixels Variance Value and Eight Neighbors," in *2021 International Conference on Advanced Computer Applications (ACA)*, pp. 199-205, Jul. 2021, doi: 10.1109/aca52198.2021.9626807.

[27] S. A. S. Lafta, M. M. Abdulkareem, R. K. Ibrahim, M. M. Kareem, and A. H. Ali, "Quality of service performances of video and voice transmission in universal mobile telecommunications system network based on OPNET," *Bulletin of Electrical Engineering and Informatics*, vol. 10, no. 6, pp. 3202–3210, Dec. 2021, doi: 10.11591/eei.v10i6.3139.

[28] B. H. Hameed, A. Y. Taher, R. K. Ibrahim, A. H. Ali, and Y. A. Hussein, "Based on mesh sensor network: design and implementation of security monitoring system with Bluetooth technology," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 26, no. 3, pp. 1781-1790, Jun. 2022, doi: 10.11591/ijeecs.v26.i3.pp1781-1790.

[29] A. Bassel, M. J. Nordin, A. A. Jihad, and K. A. Ahmed, "Jumping Particle Swarm Optimization Algorithm for Robust Image Watermarking," in *2019 IEEE Jordan International Joint Conference on Electrical Engineering and Information Technology (JEEIT)*, pp. 389-394, Apr. 2019, doi: 10.1109/jeeit.2019.8717382.

[30] S. M. Azooz, J. H. Majeed, R. K. Ibrahim, and A. H. Ali, "Implementation of energy-efficent routing protocol within real time clustering wireless sensor networks," *Bulletin of Electrical Engineering and Informatics*, vol. 11, no. 4, pp. 2062–2070, Aug. 2022, doi: 10.11591/eei.v11i4.3916.

BIOGRAPHIES OF AUTHORS

Atheer Bassel received the B.Sc. degree in Computer Science from University of Anbar, Iraq, in 2004, the M.Sc. degree in Computer Science, in 2011 and the Ph.D degree in Computer Science from Universiti Kabangsaan Malaysia (UKM) in 2018. He is currently an assistant professor in the Department of Computer Science, Faculty of Computer Science and Information Technology, University of Anbar, Iraq. His main research area are metaheuristics, optimization algorithms, ımage processing, and their applications. He can be contacted at email: atheerbassel@uoanbar.edu.iq.

Mohammed Jameel received the B.Sc. degree in Software Engineering from the University of Technology, College of Software Engineering and the M.Sc. degree in Software Engineering from the University of Ulyanovsk, Russian. He is currently one of the teaching staff at the University of Anbar, Iraq, at Computer Center. His research area includes information technology and security. He can be contacted at email: mjj81sw@uoanbar.edu.iq.

Mohammed Ayad Saad received his B.S degree in Computer and Communication (2011-2015) in Iraq. He earned his master's degree in Engineer Telecommunication and Computer from University Kebangsaan Malaysia (UKM). He is currently pursuing his Ph.D at University Kebangsaan Malaysia. He is the Director of the University of Al-Kitab at Technical Engineering College of the Medical Instruments Technical Engineering and also coordinator. His research area includes information technology, wireless communication, VANET, WSN, power electronic circuit systems, wireless networking, IoT smart healthcare, mobile sink, data gathering e cognitive radio networks, sensor networks, and network security. He can be contacted at email: mohmmad9alani@gmail or p106139@siswa.ukm.edu.my.