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Original Article

Interactive CBIR System for Various Similarity Metrics Based on Colour Content of Image

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Abstract - *The 'Content Based Image Retrieval' (CBIR) is a well-known image retrieval system. It has become more popular in recent decades due to its large image datasets. This paper provides a detailed interactive CBIR system for comparing various similarity metrics. Similarity metrics are usually distance metrics that can measure the closeness of the image features. Image retrieval is implemented as user interactive, where users can select various similarity measures for comparison. This interactive or graphical system allows six distance metrics on retinal image retrieval. The reported results confirm that the implemented system performs well.*

Keywords - *CBIR, Similarity metrics, Image retrieval, GUI, MATLAB.*

1. Introduction

The info highway has made communication and storage of large images easier. This opens the research door for image processing and retrieval. The classical image retrieval techniques are based on textual description, which is inefficient for such a vast dataset. The existing high computing facilities gave birth to Content Based Image Retrieval (CBIR). Based on the photos' content, the CBIR system retrieves the pertinent images from the bulky pictures. The CBIR techniques are prevalent since the 1990s [1-4]. The CBIR examines the pictures found on the "content" of images, viz. colour, shape, and structure [5-7]. The CBIR system is widely used, and much work is seen in the literature [1-7].

Further, the work presented in [8-10] shows how the images are retrieved visually. The strategies presented are either partial to specific applications or capabilities. Thus, there is a requirement for a Graphical User Interface (GUI) that can facilitate image retrieval for comprehensive comparison. The core phases of any CBIR system are image retrieval methods [11, 12] and similarity measuring metrics [13]. However, the similarity measuring metrics are superficial to implement but show a significant role in the CBIR system [13].

This paper implements a CBIR system for compressive comparison among the six well-known similarity metrics. Further, this paper implements a simple and easy GUI tool for similarity metrics comparison. The GUI will be beneficial for visual execution and viewing the results. Additionally, it will be handy enough to retrieve the images. The GUI presented in the paper has fixed the image retrieval methods to colour-based histograms and gives selection options among various similarity measures. The retinal images image dataset used for comparison is taken from [31]. The outcomes are shown as numerical values and graphical forms for the implemented system for a comprehensive comparison. The paper is organised in the following pattern: Section 2 gives the CBIR system and literature review, and Section 3 shows the implementation of CBIR and its GUI counterpart. Section 4 presents the results and is concluded in Section 5.

2. CBIR System and Literature Review

The basic working of the CBIR system and related literature reviews are included in the following sections.

2.1. CBIR System

The CBIR system takes the query image and extracts the features. Similarly, it extracts the features of all the images from the database and constructs the feature database. Then, it searches for photos from this database, similar to query images.

The CBIR system explained in Figure 1, has two major sections: feature extraction and matching the features. The feature extraction methods extract the image features based on their content. Various methods include colour-based, edge histogram-based, K-means etc. The second phase, responsible for matching and indexing the features for retrieval, is essential and critical.

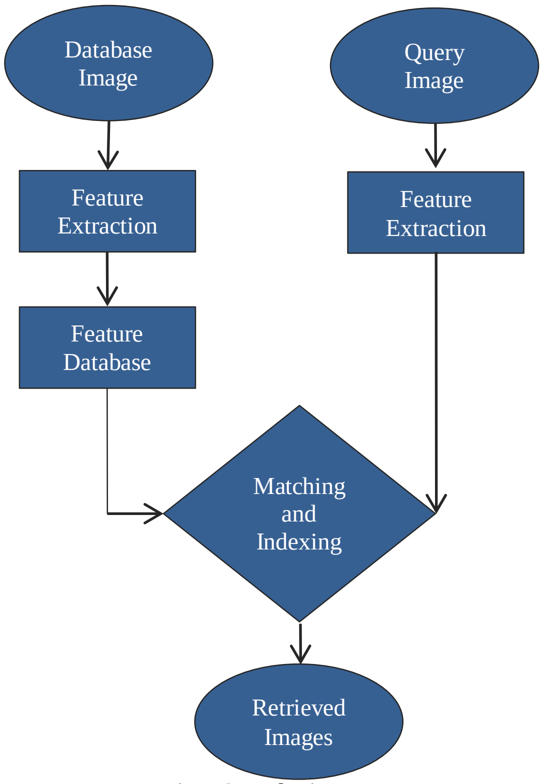

Fig. 1 CBIR basic system

2.2. Literature Review

Detailed information on CBIR and its types can be found in [14]. In [14], authors have presented various retrieval methods, such as colour, histogram, statistical, and 'texture-based' methods. The authors' work in [14] has further shown the "hybrid" feature abstraction to improve the image retrieval speed of the CBIR. The research in [15] has classified the CBIR system into three categories. They are based on image colour, shape logic, and abstract features [15]. The detailed work on the CBIR system can be found in [16]. The work in [17] explains the complex, comprehensive analysis of distance metrics over image retrieval in the CBIR system. Similarly, the literature on retrieval methods and similarity measures can be found in [11-13].

The work presented in [18] explains the CBIR system with enhancement based on averaging colour technique. Further, the authors in [18] compared mean-based and central tendency image retrieval methods. The complete and detailed survey can be found in [19]. The detailed CBIR based on the image histogram is explained in [20].

The image histogram represents the detailed distribution of the colour in an image. The image 'histogram' may be formed from any combination of colours, but the predominant is RGB or HSV [21, 22]. The histogram shows the distribution of colour data of an image [23-26]. A detailed survey and advancements in 'Content Based Image Retrieval' can be found in [27]. The work presented in [27] shows the working of CBIR and the work done on CBIR with advancements till 2016. The work presented in [28] shows how various image retrieval processes can efficiently retrieve labelled and unlabelled images.

Further, the authors in [28] submit a detailed literature review on retrieval of unlabelled images and give directions for improving the CBIR system. The work presented in [29] surveys analyses and compares CBIR methodologies. This work [29] further develops low-level feature extraction methods and similarity measures. The authors in [30] explain CBIR systems with known image features with different weight assignment methods. They have given the direction for automated CBIR for new challenges. The GUI is implemented in [32] but is limited only to Euclidean distance. The work in [33] also shows the GUI implementation specific to the medical domain.

3. Proposed Interactive CBIR System

This paper proposes an interactive CBIR system. The proposed strategy implements the interaction using a Graphical User Interface (GUI). The system is suggested since it is learned from the literature that there is a requirement for a GUI system for a comprehensive comparison. The tool presented is simple; the user can retrieve the images visually. This eliminates the requirement of having complex code for execution.

Further, the similarity measuring metrics are an essential phase in any CBIR system for image retrieval. Considering the above issues, the authors have developed an interactive GUI to compare various similarity measures comprehensively. The well-known methods of feature extraction, the histogram-based approach and its enhancement can be found in [18, 21, 22]. There are works available for GUI-based CBIR, like in [8-10]. Further, the works on similarity measure comparison are also found in [11, 12]. However, there is a need for a GUI-based interactive system so that users can select several similarity metrics and see the results visually.

The feature extraction strategy used in the proposed system is based on RGB image histogram. The user is given interactive means for selecting one similarity metric among well-known metrics for matching and indexing. All the comparisons are validated over a well-known retinal dataset [31]. This is implemented to ensure that the comparisons are fair.

Figure 2 shows the detailed proposed system; it has options for selecting a query image and all dataset images. Since the image retrieval method is fixed to an RGB histogram, the proposed system does not give explicit options for our selection. The detailed figure with options explored is shown in Figure 3. This figure shows the option of selecting query images, images from the dataset and selection of similarity metrics. After selecting all the options, the applications will be executed, and the results will be given.

After all the selections through options, the complete code is executed by pressing the GUI's start retrieve button. The proposed can display the selected query image with its category as the label. Further, the sixteen closest retrieved are shown in the exact figure. The retrieved images are also labelled with their category, which helps to visualise the retrieval efficiency by only looking at the central figure. For a fair comparison, the authors have implemented the same application that can be executed through the command prompt. The results generated by the proposed interactive CBIR can be fairly compared with classical applications with similar options.

Fig. 2 Interactive CBIR system

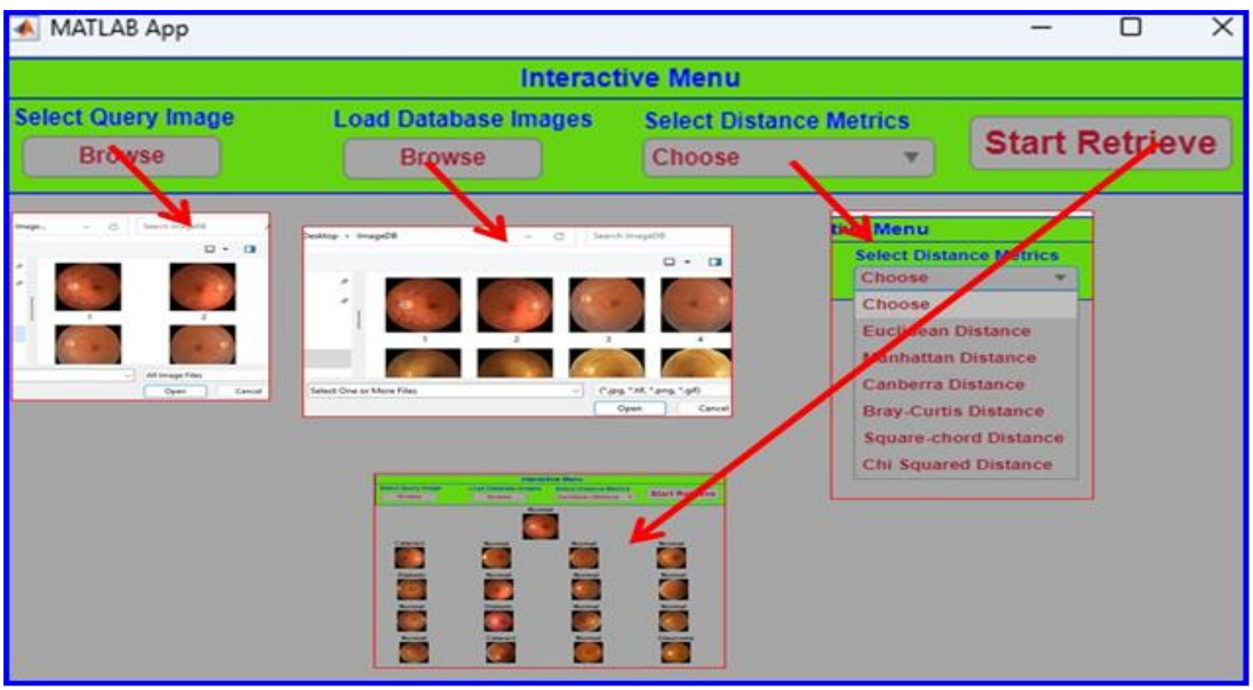

Fig. 3 Interactive CBIR system with options

4. Results and Discussion

The proposed interactive CBIR system is implemented in Matlab 2021 on Windows 11 OS over an I3 processor with a 2.5GHz frequency. The large set of "retinal images" is taken from [31], which have four distinct images for four retinal diseases. Normal, Glaucoma, Diabetic Retinopathy and Cataract.

The widespread similarity measuring distance metrics viz. Euclidean, Manhattan, Canberra, Bray-Curtis, Square Chord and Chi-Squared. The detailed definitions of these metrics are given in the following equations.

Euclidean distance

$$D_E(x,y)=\sqrt{\sum_{i=1}^{d}(x_i-y_i)^2}$$

Manhattan distance

$$D_{MAN}(x,y)=\sqrt{\sum_{i=1}^{d}\|x_i-y_i\|}$$

Canberra distance

$$D_{CAN}(x,y)=\sqrt{\sum_{i=1}^{d}\frac{|x_i-y_i|}{|x_i|-|y_i|}}$$

Bray-Curtis distance

$$D_{BRY}(x,y)=\sqrt{\sum_{i=1}^{d}\frac{|x_i-y_i|}{x_i-y_i}}$$

Square Chord distance

$$D_{SQC}(x,y)=\sqrt{\sum_{i=1}^{d}(\sqrt{x_i}-\sqrt{y_i})^2}$$

Chi-Squared

$$D_{CHI}(x,y)=\sqrt{\sum_{i=1}^{d}\frac{(\sqrt{x_i}-\sqrt{y_i})^2}{x_i-y_i}}$$

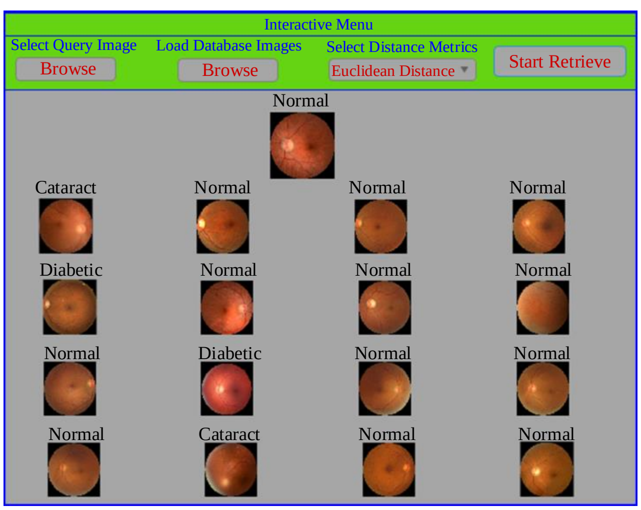

Fig. 4 Normal retina and Euclidean distance with CBIR System

Authors have recorded results of four different retinal from both the systems said above. To save space and clarify, only four figures for four diseases with one similarity measure are shown from Figures 4 to 7. These result figures are generated from the Interactive GUI CBIR system. However, the numerical results of all the options are shown in Table 1.

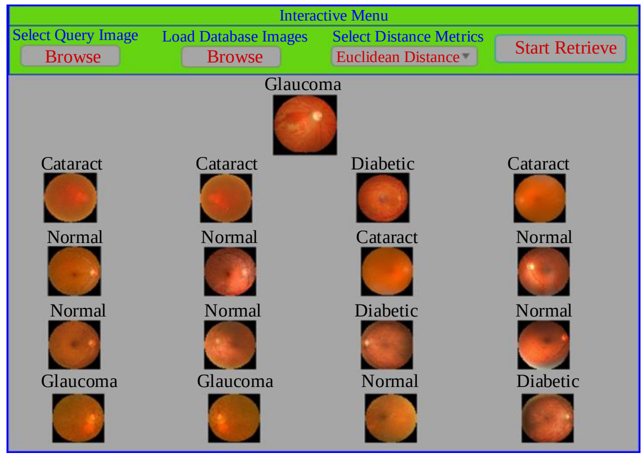

Fig. 5 Glaucoma retina and Euclidean distance with CBIR System

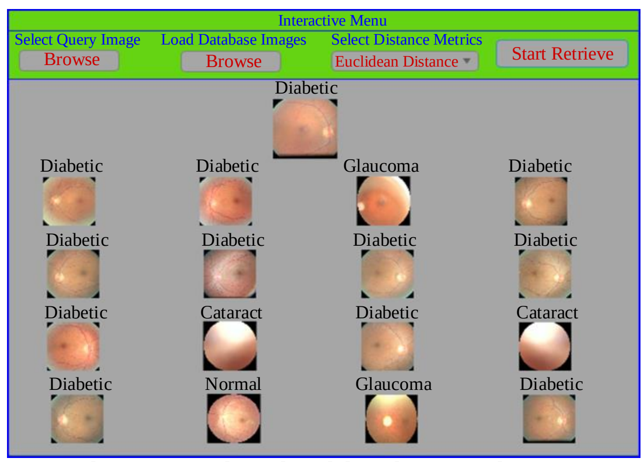

Fig. 6 Diabetic retinopathy and Euclidean distance with CBIR System

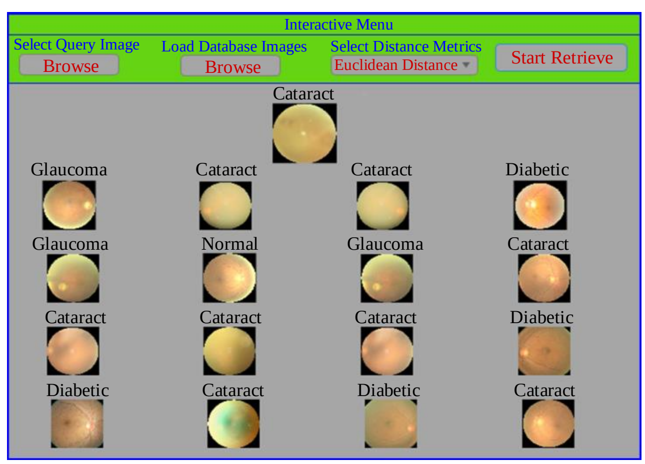

Fig. 7 Cataract retina and Euclidean distance with CBIR System

Table 1. Relevant retrieved images with GUI

	Normal	Glaucoma	Diabetic	Cataract
Euclidean	11	2	11	8
Manhattan	11	2	13	8
Canberra	10	5	14	9
BrayCurtis	10	5	14	9
Squarechord	11	7	11	9
Chi-Squared	12	5	12	10

Table 2. Relevant retrieved images with classical application

	Normal	Glaucoma	Diabetic	Cataract
Euclidean	12	3	11	8
Manhattan	11	2	13	8
Canberra	10	5	14	9
BrayCurtis	10	5	14	9
Squarechord	11	7	11	9
Chi-Squared	12	5	12	10

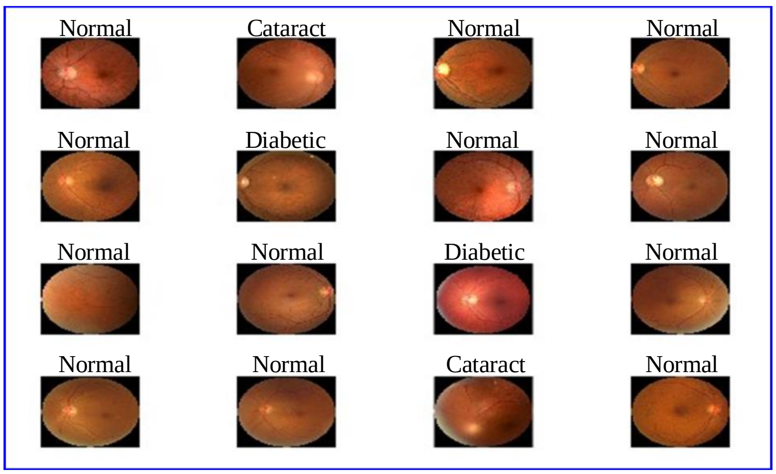

Fig. 8 Normal retina and Euclidean distance

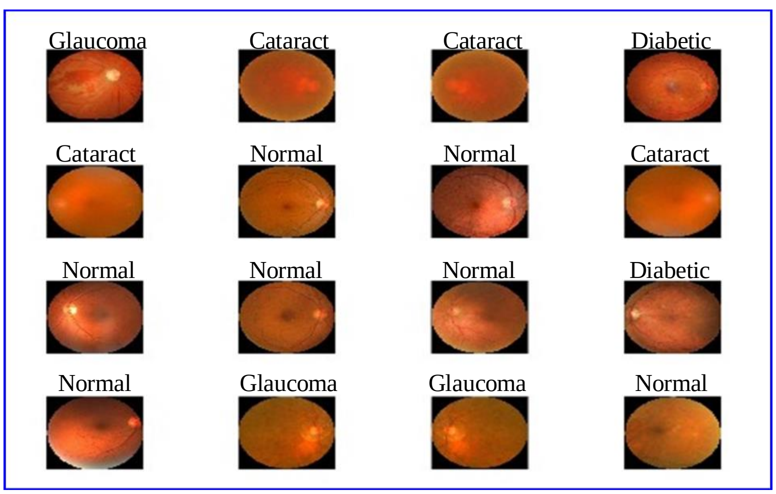

Fig. 9 Glaucoma retina and Euclidean distance

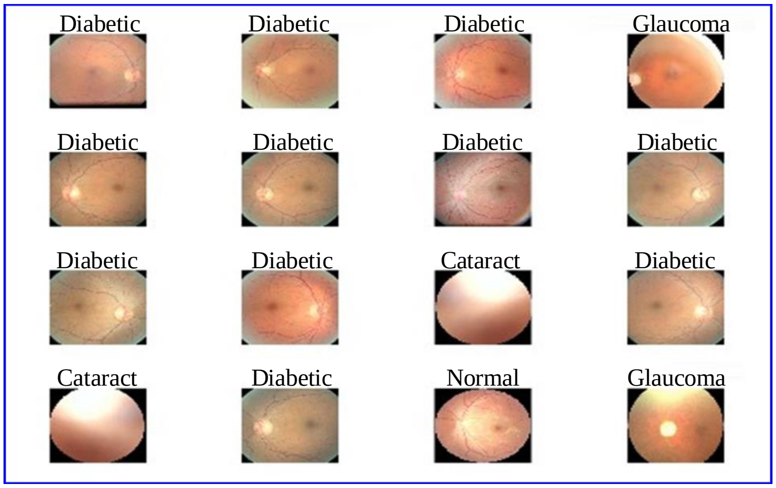

Fig. 10 Diabetic retinopathy and Euclidean distance

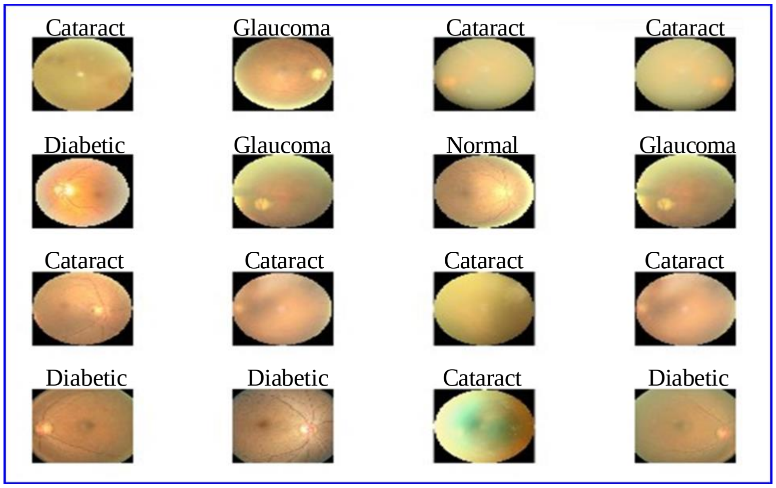

Fig. 11 Cataract retina and Euclidean distance

The figures from Figure 8 to Figure 11 show results achieved by classical applications developed for comparison. Similarly, Table 2 shows the corresponding numerical results.

From these figures and tables, it can be witnessed that the interactive GUI methods for image retrieval perform comparably. Further, it is observed that almost all the mentioned similarity matrices do well for retinal disease detection. However, except for Glaucoma, all the other diseases can be efficiently recognised and retrieved by all the mentioned similarity metrics.

5. Conclusion

This paper proposes an interactive GUI-based CBIR system. The proposed GUI is validated for a comprehensive comparison of various similarities measuring metrics. These assessments are carried out to detect multiple retinal diseases. The results produced in images retrieved and corresponding numerical values confirm that the proposed GUI performs equally well compared to classical applications. Further, it can be concluded that such GUI-based applications will benefit any user, whether domain-specific or general researcher.

References

[1] V.N. Gudivada, and V.V. Raghavan, "Content-Based Image Retrieval Systems," *Computer*, vol. 28, no. 9, pp. 18-22, 1995. [CrossRef] [Google Scholar] [Publisher Link]

[2] Manesh Kokare, B.N. Chatterji, and Prabir k. Biswas, "A Survey on Current Content Based Image Retrieval Methods," *IETE Journal of Research*, vol. 48, no. 3-4, pp. 261-271, 2002. [CrossRef] [Google Scholar] [Publisher Link]

[3] David Dagan Feng, Wan-Chi Siu, and Hong-Jiang Zhang, *Multimedia Information Retrieval and Management: Technological Fundamentals and Applications*, 1st ed., Springer Berlin, 2003. [CrossRef] [Google Scholar] [Publisher Link]

[4] Avinash Tiwari, and Veena Bansal, “PATSEEK: Content Based Image Retrieval System for Patent Database,” *The Fourth International Conference on Electronic Business (ICEB2004)*, pp. 1167-1171, 2004. [Google Scholar] [Publisher Link]

[5] Jing-Ming Guo, and Heri Prasetyo, “Content-Based Image Retrieval Using Features Extracted from Halftoning-Based Block Truncation Coding,” *IEEE Transactions on Image Processing*, vol. 24, no. 3, pp. 1010-1024, 2015. [CrossRef] [Google Scholar] [Publisher Link]

[6] Jun Yue et al, “Content-Based Image Retrieval Using Color and Texture Fused Features,” *Mathematical and Computer Modelling*, vol. 54, no. 3-4, pp. 1121-1127, 2011. [CrossRef] [Google Scholar] [Publisher Link]

[7] Ahmed J. Afifi, and Wesam M. Ashour, “Content-Based Image Retrieval Using Invariant Color and Texture Features,” *2012 International Conference on Digital Image Computing Techniques and Applications (DICTA)*, Fremantle, Australia, pp. 1-6, 2012. [CrossRef] [Google Scholar] [Publisher Link]

[8] Guoping Qiu, Jeremy Morris, and Xunli Fan, “Visual Guided Navigation for Image Retrieval,” *Pattern Recognition*, vol. 40, no. 6, pp. 1711-1721, 2007. [CrossRef] [Google Scholar] [Publisher Link]

[9] EL Maliki Nawfal, Silkan Hassan, and El Maghri Mounir, “Combining Human Visual Features for Efficient Retrieval in Faces Databases by Using a Convivial Interface,” *MIIR’18: The 2nd International Workshop on Multimedia, Indexing and Information Retrieval*, pp. 1-13, 2018.

[10] Orazio Gambino et al., “A Framework for Data-Driven Adaptive GUI Generation Based on DICOM,” *Journal of Biomedical Informatics*, vol. 88, pp. 37-52, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[11] Hany F. Atlam, Gamal Attiya, and Nawal El-Fishawy, “Integration of Color and Texture Features in CBIR System,” *International Journal of Computer Applications*, vol. 164, no. 3, pp. 23-29, 2017. [CrossRef] [Google Scholar] [Publisher Link]

[12] J.Z. Wang, Jia Li, and G. Wiederhold, “SIMPLIcity: Semantics-Sensitive Integrated Matching for Picture Libraries,” *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 23, no. 9, pp. 947-963, 2001. [CrossRef] [Google Scholar] [Publisher Link]

[13] M. Kokare, B.N. Chatterji, and P.K. Biswas, “Comparison of Similarity Metrics for Texture Image Retrieval,” *TENCON 2003. Conference on Convergent Technologies for Asia-Pacific Region*, Bangalore, India, vol. 2, pp. 571-575, 2003. [CrossRef] [Google Scholar] [Publisher Link]

[14] Yogita Mistry, and D.T. Ingole, “Survey on Content Based Image Retrieval Systems,” *International Journal of Innovative Research in Computer and Communication Engineering*, vol. 1, no. 8, pp. 1827-1836, 2013. [Google Scholar] [Publisher Link]

[15] Ritika Hirwane, “Fundamental of Content Based Image Retrieval,” *International Journal of Computer Science and Information Technologies*, vol. 3, no. 1, pp. 3260-3263, 2012. [Google Scholar] [Publisher Link]

[16] K. Bharathi, and Miryala Chandra Mohan, “Content Based Image Retrieval: An Overview of Architecture, Challenges and Issues,” *International Journal of Engineering Research in Computer Science and Engineering*, vol. 4, no. 12, pp. 31-36, 2017. [Google Scholar] [Publisher Link]

[17] Bhagwandas Patel, kuldeep Yadav, and Debashis Ghosh, “State-of-Art: Similarity Assessment for Content Based Image Retrieval System,” *2020 IEEE International Symposium on Sustainable Energy, Signal Processing and Cyber Security (iSSSC)*, Gunupur, Odisha, India, pp. 1-6, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[18] C. Vasanthanayaki, and R.Malini, “An Enhanced Content Based Image Retrieval System Using Color Features,” *International Journal of Engineering and Computer Science*, vol. 2, no. 12, pp. 3465-3471, 2013. [Google Scholar] [Publisher Link]

[19] Ying Liu et al., “A Survey of Content-Based Image Retrieval with High-Level Semantics,” *Pattern Recognition*, vol. 40, no. 1, pp. 262-282, 2007. [CrossRef] [Google Scholar] [Publisher Link]

[20] Arun Jb, and Reshu Choudhary, “Image Retrieval Using Histogram Based Contents of an Image,” *International Journal of Engineering Research & Technology (IJERT)*, vol. 2, no. 10, pp. 3219-3223, 2013. [Publisher Link]

[21] Jing Huang et al., “Image Indexing Using Color Correlograms,” *Proceedings of IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, San Juan, Puerto Rico, pp. 762-768, 1997. [CrossRef] [Google Scholar] [Publisher Link]

[22] G. Pass, and R. Zabih, “Refinement Histogram for Content-Based Image Retrieval,” *Proceedings Third IEEE Workshop on Applications of Computer Vision*, Sarasota, USA, pp. 96-102, 1996. [CrossRef] [Google Scholar] [Publisher Link]

[23] Jozsef Vass et al., “Interactive Image Retrieval over the Internet,” *Proceedings Seventeenth IEEE Symposium on Reliable Distributed Systems*, West Lafayette, USA, pp. 461-466, 1998. [CrossRef] [Google Scholar] [Publisher Link]

[24] J.C. Baillie, “Certainty Color Maps Compared to Histograms,” *Proceedings. International Conference on Image Processing*, Rochester, NY, USA, vol. 3, pp. 765-768, 2002. [CrossRef] [Google Scholar] [Publisher Link]

[25] Ryszard S. Choras, “Image Feature Extraction Techniques and Their Applications for CBIR and Biometrics Systems,” *International Journal of Biology and Biomedical Engineering*, vol. 1, no. 1, pp. 6-16, 2007. [Google Scholar] [Publisher Link]

[26] Baochang Zhang et al., “Histogram of Gabor Phase Patterns (HGPP): A Novel Object Representation Approach for Face Recognition,” *IEEE Transactions on Image Processing*, vol. 16, no. 1, pp. 57-68, 2007. [CrossRef] [Google Scholar] [Publisher Link]

[27] Wengang Zhou, Houqiang Li, and Qi Tian, “Recent Advance in Content-Based Image Retrieval: A Literature Survey,” *arXiv*, pp. 1-22, 2017. [CrossRef] [Google Scholar] [Publisher Link]

[28] T. Dharani, and I. Laurence Aroquiaraj, "A Survey on Content Based Image Retrieval," *2013 International Conference on Pattern Recognition, Informatics and Mobile Engineering*, Salem, India, pp. 485-490, 2013. [CrossRef] [Google Scholar] [Publisher Link]

[29] Ibtihaal M. Hameed, Sadiq H. Abdulhussain, and Basheera M. Mahmmod, "Content-Based Image Retrieval: A Review of Recent Trends," *Cogent Engineering*, vol. 8, no. 1, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[30] Narendra Kumar Rout, Mithilesh Atulkar, and Mitul Kumar Ahirwal, "A Review on Content-Based Image Retrieval System: Present Trends and Future Challenges," *International Journal of Computational Vision and Robotics*, vol. 11, no. 5, pp. 461-485, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[31] Guna Venkat Doddi, Eye Disease Retinal Images, Kaggle, 2023. [Online]. Available: https://www.kaggle.com/datasets/gunavenkatdoddi/eye-diseases-classification

[32] Md. Baharul Islam, Krishanu Kundu, and Arif Ahmed, "Texture Feature Based Image Retrieval Algorithms," *International Journal of Engineering and Technical Research*, vol. 2, no. 4, pp. 169-173, 2014. [Google Scholar] [Publisher Link]

[33] Thomas M. Deserno et al., "Extended Query Refinement for Medical Image Retrieval," *Journal of Digital Imaging*, vol. 21, pp. 280-289, 2008. [CrossRef] [Google Scholar] [Publisher Link]