NOISE REMOVAL TO ENAHNCE IMAGE QUALITY DURING BRAIN TUMOUR DETECTION

Madhu[1], Dr. Saurabh Charaya [2]

[1]PH.D Scholar, Email: madhugoyal0294@gmail.com,
Om Sterling Global University Hisar, India

[2]Associate Professor, Dept. of CSE, Email: deansvs@osgu.ac.in,
Om Sterling Global University Hisar, India

Abstract:

In order to keep up with the ever-increasing demand for content-based image retrieval (CBIR), which is employed in the diagnosis of brain tumours, numerous different methods of soft computing are used during image processing. Techniques such as edge identification and compression are possible to shorten the amount of time required for processing CBIR activities. However, the quality loss that results from the compression process is a problem. After image compression has been performed, the quality of the picture is the primary focus of the research being done at the moment. In the subject of image analysis, one of the most important topics of research is the effect that the processing has on the overall picture quality. In addition to this, research into lossless compression techniques that keep the image quality intact is essential. The present study is looking at the many methods that are used in the most recent research piece, as well as its functioning mechanism, advantages, and disadvantages. Image processing is being investigated as a means of extracting data from photographs for use in a broad range of settings and purposes. The CBIR is playing a vital role in the areas of commercial and educational sectors as well as the healthcare sector. Previous research focused on increasing the speed of the picture processing, but they paid little attention to the quality of the images. The need of preserving picture quality throughout the CBIR procedures does not go away. In order to make the CBIR system more effective, an integration of edge detection and compression technology has been completed as part of an effort to develop a hybrid approach to soft computing. A lossless picture compression technique has been developed using Canny-based edge detection. Huffman is the process for lossless compression that is used in order to keep the quality of the picture after it has been compressed. In the suggested research, compression and edge detection mechanisms have been integrated with DWT. As a result, a hybrid technique has been used to overcome the problem of standard CBIR systems' lacklustre performance. In addition, noise reduction procedures have been used in order to improve the quality of the brain picture.

Keywords: Brain tumor detection, Image Processing, Image Extraction, CBIR, Compression, edge detection, DWT, Noise removal.

DOI Number: 10.14704/nq.2022.20.9.NQ44791 **Neuro Quantology 2022; 20(9):6763-6770**

[1] Introduction

Magnetic resonance imaging is often the first test that is performed while trying to diagnose a brain tumour (MRI). After an MRI has confirmed the presence of a tumour in the brain, the findings of a tissue sample obtained by either a biopsy or surgery are often analyzed in order to identify the specific kind of brain tumour that is present. The methods of image processing are now being used in research work for the identification of brain tumours. Image processing is a technology that is being researched as a way to extract data from photos and integrate it so that it may be used in a variety of settings. Image processing software might prove to be quite useful in a wide variety of situations. Imaging in medicine is only one example; there are many applications in industry. In addition to their applications on Earth and other planets, we also consider the ways in which they may be used in the military, in space, and for remote sensing. Because of the application of computer vision methods to the issue of visual content retrieval, it is difficult to discover digital photographs in huge datasets. Previous research has focused on improving image processing while maintaining picture quality as a primary objective. Additionally, there has been an increase in the dependability of one's own judgments. During all stages of the CBIR process, the researchers have decided to maintain the image's high quality [1, 2]. The importance of images cannot be overstated in many different sectors, including health, space exploration, and others. If this data is carefully evaluated, it may provide the user with a great deal of information that is helpful to them. Image processing techniques assist in evaluating and manipulating snapshot visual information, which is necessary for the production of vectors for the function. Further investigation is being carried out in the realm of image processing in order to guarantee that the visible picture content will be converted to its specialized vectors using as few feature vectors as is humanly possible in a manner that is speedier, more appealing, better, and more efficient.

1.1 IMAGE PROCESSING

The term "Image Processing" refers to a methodology that involves performing a number of operations on an image in order to achieve the goal of recovering a better picture or isolating a few key components. Image Processing is a methodology in which input is offered and outcomes are emphasised or shown. This is a technology that is making its way into an increasing number of subsets of the industrial industry. CBIR [1] is gaining more and more attention, and various deep learning algorithms [2] are being used to put it into practise as it does so. Characterization from a semantic perspective has been the focus of research in a few different studies [3]. The present research is concentrating on three different image processing methods.

Image compression requires a reduction in the overall size of the image. A number of people have referred to it as an image compression method. The quantity of space that may be stored must be reduced in order to accomplish this goal. When the image size is reduced, processing speeds are significantly improved. It is feasible to utilise the lossless compression approach. [13]

Edge detection is a technology that is used to locate edges in a photograph, and its name comes from the term itself. Edge detection is one technique that may be used during the process of choosing features from a picture. This can assist reduce the amount of data that is not essential. The process of selecting features may be sped up with the aid of edge detection, which works by deleting unimportant sections of an image. In order to hasten the procedure and save time, the approach of edge detection was used before the feature selection step. It is also true that photos can be compressed in order to make them smaller, but this process may take a significant amount of time. [14]

Identifying a pattern begins with identifying elements that are pertinent to that pattern. It is a method for selecting the appropriate characteristics from among a vast pool. Because of the influence it has on accuracy, feature selection has taken on an increasingly vital role in recent years. [15]

In the work that has been suggested, the Huffman algorithm has been used for image compression, the canny edge detector has been used for edge detection, and the DWT algorithm has been used for feature selection.

1.2 CONTENT-BASED IMAGE RETRIEVAL

Because of CBIR, photos stored in a vast database may be located by searching for their picture content. CBIR looks through a large collection of photographs to find the ones that are most similar to the picture that was requested. The subject of CBIR research is becoming more popular right now. People will be able to browse video and picture archives from all around the globe and evaluate them when internet accessibility improves and becomes more widespread. Private content-based image retrieval, also known as PCBIR, is a method that does not reveal the information that is gleaned from an image query in a database. This method has become an important area of research due to the abundance of digital video and picture content. [1, 2]

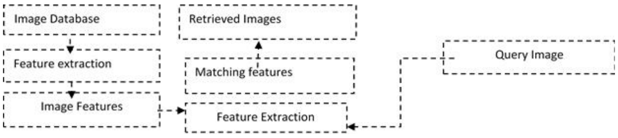


Fig 1 CBIR Block Diagram

1.3 NEED OF CBIR

Looking for a certain photograph in a large archive may be a daunting undertaking. Perhaps manually labelling files might fix the problem. However, there are limited uses because to its high cost, high complexity, and low efficiency. Labeling is performed based on how well the picture is represented semantically. Many different approaches for retrieving low-level functions for representing pictures depending on their content have been developed as a consequence. A typical content-based retrieval system comprises of offline function extraction and on-line image retrieval. During the off-line phase, the system gathers pixel value-based visual attributes from each image in the database and saves them in a database inside the system referred to as a function database. CBIR has sometimes used K-NN and Bayes Net [4] to boost performance.

1.4 IMAGE PROCEEDING

As part of a process is called "Image Proceeding," raw photos that are captured by cameras or sensors are sent to satellites. For spacecraft and aeroplanes specifically, better visualization tools have been created. Over the years, several image processing methods have been created. Several of these methods have been used to improve the aesthetic appeal of spaceships. It's possible that these kind of images are also taken by spacecraft and military aircraft with a mission to monitor the skies. This kind of visual analysis tool has become more popular as more powerful personal computers have been widely available to the general public. In addition, graphics software and high-capacity memory devices each have their own distinct set of obstacles and possibilities.

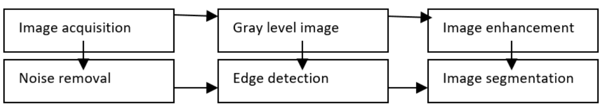


Fig 2 Process flow of Image proceeding

1.6 USE OF IMAGE IN PREDICTION

Images captured by the system's sensors serve to preserve the image. Both the Portable Network File Format and the Joint Picture Expert Graphic Format are used to store these raster images. Image processing methods may vary widely. These pictures would next undergo edge detection to remove any extraneous details, & CNN process would be used to train network for prediction based on the learned dataset.

1.7 VARIOUS ALGORITHMS FOR IMAGE PROCEEDING TECHNOLOGY

When it comes to modifying visual content, image processing technologies are commonly applied to resize, compare, and change the pictures. A CNN model might be used often to identify masking patterns in a photo library.. However, there are a number of issues that arise when trying to categories data using CNN.

1.8 SENSOR FOR IMAGE PROCEEDING TECHNOLOGY

All digital cameras have a lens and a sensor. A lens projects an image onto the sensor plane. The image sensor is made up of a number of light-sensitive pixels, each of which generates a digital value representing the number of photons it has captured during the exposure. CMOS and CCD are the two most important and common technologies for the image sensor market. CMOS sensors have high speed, low sensitivity, and high, fixed-pattern noise. A CCD sensor is a “charged coupled device.” Just like a CMOS sensor, it converts light into electrons. Unlike a CMOS sensor, it is an analog device. It is a silicon chip that contains an array of photosensitive sites. The camera's image sensor is responsible for converting the light and color spectrum into electrical signals for the camera to convert into zeros and ones.

1.9 IMAGE PROCESSING MECHANISM

Studies focus on various aspects of the processing processes. Before implementing CNN during CBIR operations, researchers are considering picture reduction and edge detection. [13, 14, 15, 18, 21].

a) **Image compression [24, 25]:** The image's size must be reduced. Compressing a picture has always been thought of as a way to reduce its overall file size. In order to save storage space, picture compression is used. Because the picture is smaller, the subsequent processing may be done more quickly. It's possible to employ a lossless compression method. Lossy or lossless compression methods are used to compress images. Huffman coding has been used for lossless compression to maintain the quality of images. [23]

b) **Edge detection [28, 29, 30, 31, 32]:** Edge detection refers to the procedure of identifying the boundaries of a picture. Edge detection is necessary for feature selection to occur with less picture data. Edge detection helps speed up the feature selection process by removing irrelevant parts of a picture. To speed things up, an edge detection approach has been implemented before feature selection. Moreover the employment of compression process will lower the size of picture.

c) **Feature selection:** Features are picked in order to detect the pattern. It is a technique through which relevant characteristics are picked from all the available features. Feature selection is vital in these days since it plays a big part in accuracy.

d) **Noise removal:** In order to improve the quality of image different noise removal mechanisms are applied. These noise removal mechanism improve the visibility and quality of graphical contents.

[2] Literature Review

A fuzzy-based method to feature selection has been used in a number of CBIR-related research projects. In addition, this article provides an overview of research that was carried out in the fields of image compression and edge detection.

In a world in which the best possible solutions to every search query are actively pursued, it was suggested by H. Abdel-Nabi et al.[1] that a trustworthy and lawful information retrieval framework is required. A CBIR system has a number of obstacles as a result of the well-known semantic gap problem associated with image representation. These issues are directly related to the system's dependency on derived picture characteristics for a similarity search between query visuals and database graphics.

CBIR is a tool that was first published by R.R. Saritha et al.[2], and it is used to identify and retrieve digital photographs from a vast database based on the content properties of the photos. In order to achieve the ultimate state of the quest, many different approaches to the extraction of visual features were used. Because of constraints on the amount of time available for computing, more sophisticated algorithms could not be used. It was discovered that the precision with which features were represented and similarity metrics were computed had a significant impact on the retrieval performance of a content-based image search engine.

L. Yan and colleagues [3] have finished their study on semantic characterization. Because individuals search for information on various forms of media based on its underlying semantics, it is necessary to create semantic characterisations before developing intelligent multimedia databases. Researchers wanted to show how layered intelligent search systems might be constructed, therefore they used structures and "digital keywords" in their investigation.

Research on the processing of multimedia photographs was carried out by M. Kumar and colleagues [4]. The proliferation of the internet and other forms of mass media has resulted in the production and consumption of an enormous number of photographs. Despite this, the problem of effectively preserving such a large and complicated database and making it accessible to the public continues to be a pressing one.

K. Konstantinidis and his colleagues have undertaken research on CBIR[5]. Images may be retrieved based on a number of criteria, such as colour, texture, and form, all of which go under the umbrella term "content-related image retrieval." Images can also be retrieved using keywords (CBIR). Histograms of colour images are used often and well in CBIR analysis. According to the findings of the tests that were conducted, this approach of creating a histogram proved to be more resistant to changes in the picture than its rivals.

The approach of constructing fuzzed-out colour histograms was suggested by O. Kucuktunc and colleagues[6] for the aim of doing content-based photo retrieval. An algorithm for colour histogram mapping was developed by using a fuzzy inference method modelled after Mamdani's approach. This method divides the colours that exist in the L*a*b* colour space into a number of fuzzy categories. As a first step, we investigated the L*a*b* colour space to determine which colours might result in a blurring of the colour histogram bins. This ultimately resulted in the clarification of membership functions and fuzzy rules.

Clustering is a method that was proposed by Timón et al. [7] to attempt to group together patterns that are similar to one another. The results suggest that the availability of computer resources is now the most significant barrier to the processing of massive datasets.

The purpose of content-based image retrieval, as described by V. Yadaiah et al. [8], is to recover semantically-relevant pictures from a picture collection with the assistance of automatically-derived image selections (CBIR). Many CBIR systems could only offer the most fundamental of descriptions of visible characteristics. Because of the subjective character of people's opinions and experiences, these indicators were nothing more than objective statistics. Because of this, there is a disparity between what something seems to be and what it really means.

According to the findings that Rahul Kher et al.[9] reported, methods from the field of soft computing may be used in a wide range of contexts, including image recognition and machine vision. The purpose of this study was to investigate the application of a wide variety of soft computing approaches to many distinct types of image processing.

The ubiquitous usage of smartphones and other digital devices was a factor that was considered by S.Sindu et al. [10] over the course of their research. They came to the conclusion that humans generate a great deal of visual imagery on a daily basis. These images were taken and then archived in various databases so that they may be used at a later time. It is crucial to discover the proper picture since there are a growing number of digital photos that have been saved. CBIR was a piece of computer vision software that was used to recover pictures from big datasets. It was used to do this by searching through the datasets.

The research that Amruta Rudrawar et al. [11] conducted on image retrieval was helpful in a wide variety of fields, including therapeutic determination and biometrics, to name just two of those fields. It considered information from a diverse assortment of sources, such as geological data, satellite frames, online searches, and in-depth investigations. Applications that relied on photographs faced brand new challenges and obstacles in the form of problems and issues with indexing, learning, and retrieval as a result of the significant growth in the size of the database.

There has been a rise in the total number of digital picture databases, as reported by ALI AHMED et al.[12]. [Citation needed] It was brought to the attention of many users that it was a challenging endeavour to search for and retrieve important photos from vast collections. In order to achieve this goal, a variety of retrieval methods that are both effective and efficient have been devised. The great majority of CBIR tactics depend on visual qualities in addition to other indirect methods in order to search through databases for photographs that are relevant to their inquiries.

[3] Challenges

CBIR has been incorporated into the diagnostic procedures of several studies for brain tumours that have been conducted in the fields of engineering and medicine. However, these investigations are being hampered by the high storage and processing requirements of big pictures, which are causing a significant backlog. When making a call, having pictures that have been compressed and edges that have been recognised might be helpful. According to the findings, the amount of time spent deliberating increases significantly with the size of the image. The removal of a picture's unnecessary components necessitates the use of several image processing methods, such as cropping, compression, edge detection, and others. On the other hand, the system might arrive at the incorrect conclusion if the visual data it is relying on is either faulty or no longer current. Therefore, it is very necessary to enhance the image quality during CBIR operations.

[4] Proposed Work

The current study that is being done on image processing and CBIR for the identification of brain tumours is being studied, and as part of the research process, the obstacles and anxieties that are brought by technology are being thought through. In addition, the purpose of this study is to investigate whether or not certain aspects of image processing might have an effect on the final picture's quality. Experimentation is going to be done using the technique suggested here. Following the selection of a picture to be processed, the image would next be compressed. Following this step, the method of edge detection would be used to the compressed picture. Noise reduction filters are applied to images in order to help enhance their overall quality. The current study takes picture datasets into consideration and resizes the images. Then several mechanisms for eliminating noise such as bilateral, median, blur, Guassian, and anisotropic

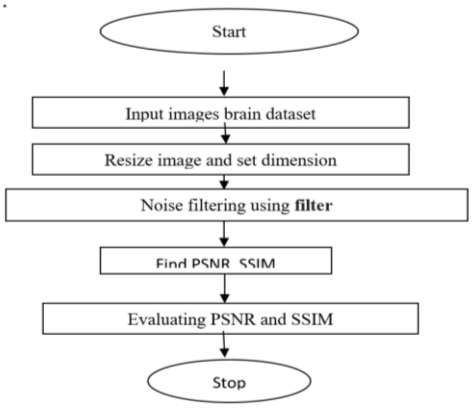


Fig 3 Flow chart to improve and evaluate the quality of brain image

.[5] Result and Discussion

Simulation result for quality enhancement

Different noise removal filters have been applied over images and PSNR and SSIM has been calculated. Following figure is showing output after noise removal.

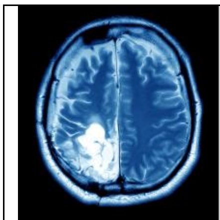
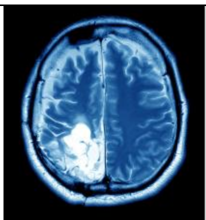
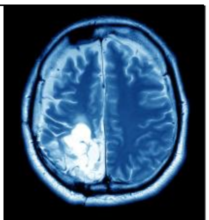
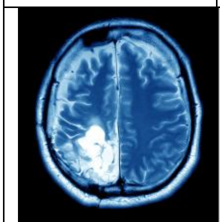
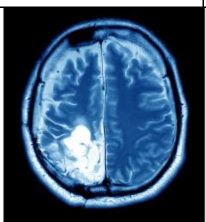
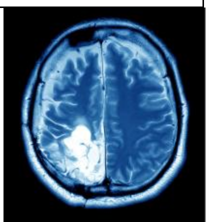
		
Normal image	Bilateral PSNR=35.33453	Blur PSNR=37.45435
		
Median PSNR=35.45533	Guassian PSNR=37.10000189 86	Anisotropic PSNR=34.9604009

Fig 4 PSNR after filtering Image

Calculation of PSNR and SSIM has been performed in order to compare the filters

Table 1 Comparison of PSNR and SSIM

Filter	**PSNR**	**SSIM**
Bilateral	35.33453	0.82376
Guassian	37.1000018986	0.89607
Median	35.45533	0.85736
Blur	37.45435	0.85332
Anisotropic	34.9604009	0.88307

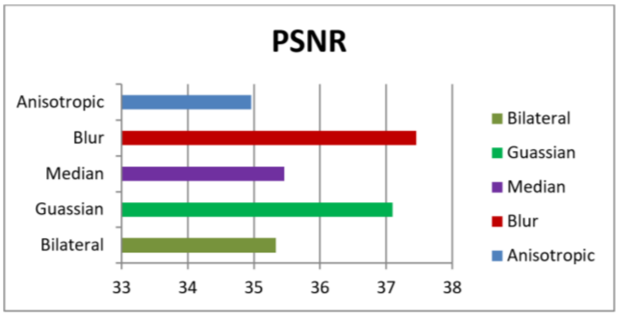


Fig 5 Comparison of PSNR

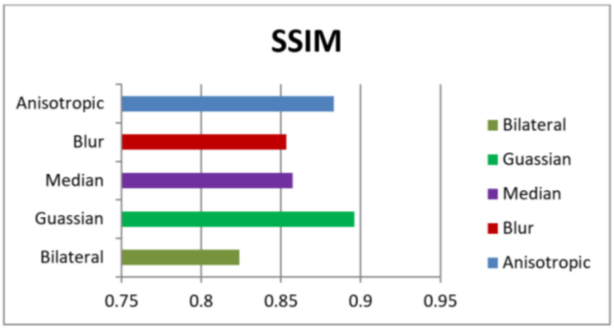


Fig 6 Comparison of SSIM

[6] Conclusion

The term "content-based imaging" refers to a kind of imaging technology used to locate and retrieve digital pictures based on their content, such as their hue, texture, or shape. In this study, we review some recent publications dealing with CBIR. Simulation results during quality enhancement shows that Guassian filter is providing better PSNR and SSIM.

[7] Future Scope

After preprocessing the quality of brain image is enhanced and such image could be trained and tested using CNN model in future work. Present work is supposed to improve the accuracy of brain tumor detection.

References

[1] H. Abdel-Nabi, G. Al-Naymat and A. Awajan, "Content Based Image Retrieval Approach using Deep Learning," *2nd International Conference on new Trends in Computing Sciences (ICTCS)*, 2019, pp. 1-8, doi: 10.1109/ICTCS.2019.8923042.

[2] R.R. Saritha, V. Paul and P.G. Kumar, "Content based image retrieval using deep learning process", *Cluster Computing*,2018, pp. 1-14.

[3] L. Yan, and Z. Ma, "Intelligent Multimedia Databases and Information Retrieval", Advancing Applications and Technologies, September - 2011.

[4] M. Kumar, P. Chhabra and N.K. Garg, "An efficient content based image retrieval system using BayesNet and K-NN", *Multimedia Tools and Applications*,2018, pp. 1-14.

[5] K. Konstantinidis, A. Gasteratos, I. Andreadis, "Image Retrieval Based on Fuzzy Color Histogram Processing", Optics Communications, vol.248, Issues 4- 6, pp.375- 386, 2005.

[6] O. Kucuktunc, and D. Zamalieva, "Fuzzy Color Histogram-based CBIR System", March - 2009.

[7] Timón, Isabel, Soto, Jesús, Pérez-Sánchez, Horacio, & Cecilia, José M., "Implementing fuzzy minimals clustering mechanism in parallel", Expert Systems with Applications, 48(15), 35–41,2005.

[8] V. Yadaiah and Dr. R .Vivekanandam, .Rajaram Jatothu, "Fuzzy Logic dependent Soft Computing mechanism for CBIR with help of Incremental Filtering Feature Selection to Identify Patterns", International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 5 (2018) pp. 2432-2442 © Research India Publications.

[9] Rahul Kher , Heena Kher, "Soft Computing Techniques for Various Image Processing Applications: A Survey". Journal of Electrical and Electronic Engineering 2020; 8(3): 71-80 http://www.sciencepublishinggroup.com/j/jeee doi: 10.11648/j.jeee.20200803.11 ISSN: 2329-1613 (Print); ISSN: 2329-1605 (Online), 2020

[10] S.Sindu, "Two Phase Content Based Image Retrieval with relevance ranking on classified images", 2019 International Conference on Computer Communication and Informatics (ICCCI -2019), Jan. 23 – 25, 2019, Coimbatore, INDIA

[11] Amruta Rudrawar, "CBIR using Bag of Visual Words Representation" , Proceedings of the Second International conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC 2018) IEEE Xplore Part Number:CFP18OZV-ART; ISBN:978-1-5386-1442-6, 2018

[12] ALI AHMED , AND SHARAF J. MALEBARY , "Query Expansion Based on Top-Ranked Images for Content-Based Medical Image Retrieval", IEEE, VOLUME 8, 2020

[13] . Kondylidis, M. Tzelepi, and A. Tefas, ''Exploiting tf-idf in deep convolutional neural networks for content based image retrieval,'' Multimedia Tools Appl., vol. 77, no. 23, pp. 30729–30748, Dec. 2018.

[14] R. Imbriaco, C. Sebastian, E. Bondarev, and P. de With, ''Aggregated deep local features for remote sensing image retrieval,'' Remote Sens., vol. 11, no. 5, p. 493, Feb. 2019.

[15] U. Erkut, F. Bostancioglu, M. Erten, A. M. Ozbayoglu, and E. Solak, ''HSV color histogram based image retrieval with background elimination,'' in Proc. 1st Int. Informat. Softw. Eng. Conf. (UBMYK), Nov. 2019, pp. 1–5.

[16] H. Hu, W. Zheng, X. Zhang, X. Zhang, J. Liu, W. Hu, H. Duan, and J. Si, ''Content-based gastric image retrieval using convolutional neural networks,'' Int. J. Imag. Syst. Technol., Aug. 2020, doi: 10.1002/ima.22470

[17] Han, J., & Ma, K. K., "Fuzzy color histogram and its use in color image retrieval", IEEE Transactions on Image Processing, 11(8), 944–952. doi:10.1109/TIP.2002.801585

[18] F. Long, H. Zhang, H. Dagan, and D. Feng, "Fundamentals of Content Based Image Retrieval" , Springer-Verlag, Berlin Heidelberg New York, 2003.

[19] V. Castelli, and L. Bergman, "Image Databases: Search and Retrieval of Digital Imagery", Wiley-Interscience, USA, 2002.

[20] Jensen, R. & Shen, Q, "Fuzzy-rough attribute reduction with application to web categorization. Fuzzy Sets and Systems" , 14, 469– 485, 2004.

[21] Palwinder Kaur, Dr. Rajesh Kumar Singh, "Content-Based Image Retrieval Using Machine Learning And Soft Computing Techniques",International Journal Of Scientific & Technology Research Volume 9, Issue 01, Issn 2277-8616, January 2020

[22] K.S. Aiswarya, N. Santhi, K. Ramar, "Content-based image retrieval for mobile devices using multi-stage Autoencoders", Journal of Critical Reviews, ISSN- 2394-5125, Vol 7, Issue 6, 2020

[23] Tingting Luan, Jihua Zhu, Siyu Xu, Jiaxing Wang, Shixuan and Bichen Li, "Huffman Coded Product Quantization for Image Hash Retrieval" [J] *Chinese Journal of Image Graphics* **24** 389-399, 2019

[24] Minzhu Yang, Zhipu Zou and Changpei Han, "Lossless Compression depending on single-frame interferogram", [J] *Modern electronic technology* **42** 57-60, 2019

[25]Songgang Zhang, Gaofeng, Fulei Yang and Xiaowei Liu, "Research on UAV compression of video depending on compression mechanism", [J] *Integrated circuit applications* **36** 39-40, 2019

[26]Aidong Liu, Zhiyu Li, Feng Wang and Linbo He, "A data compression technique to support embedded calibration system", [J] *Computer and Digital Engineering* **46** 2607-2610, 2018

[27]Leihong Zhang and Hualong Ye, "Study on image transmission method of correlation imaging mechanism depending on Huffman technique", [J] *Packaging Engineering* **40** 244-249, 2019

[28] Xiafeng Li, "Edge detection algorithm of cancer image based on deep learning", Bioengineered, Pages 693-707 | Received 06 Apr 2020, Accepted 03 Jun 2020, Published online: 21 Jun 2020

[29] Akbari Sekehravani, Ehsan & Babulak, Eduard & Masoodi, Mehdi, "Implementing canny edge detection algorithm for noisy image. Bulletin of Electrical Engineering and Informatics", 9. 1404-1410. 10.11591/eei.v9i4.1837, 2020.

[30] S. A. M. H. K. Vignesh, "Edge detection using Fractional derivatives and Information sets," Journal of Electronic Imaging, vol. 27, 2018.

[31] E. A. A. Nandal, "Image edge detection using fractional calculus with feature and contrast enhancemen," Circuits, Systems, and Signal Processing, vol. 37, pp. 3946–3972, 2018.

[32] Ghosh, Chinmoy & Majumder, Suman & Ray, Sangram & Datta, Shrayasi & Nath, Satyendra & Ghosh, C, "Different EDGE Detection Techniques: A Review" 10.1007/978-981-15-7031-5_84, 2020.

[33] C,-T.Huang, P-C, Tseng, and L,-G Chen, "Generic RAM-based architectures for two-dimensional discrete wavelet transform with line based method," IEEE Trans. on Circuits and Systems, vol. 1, pp. 363-366, 2002.

[34]Vinay A, "ORB-PCA based feature extraction technique for face recognition". Procedia Comput Sci 58:614–621,2015

[35] P. Mohanaiah , "Image Texture Feature Extraction Using GLCM Approach", International Journal of Scientific and Research Publications, Volume 3, Issue 5, May 2013