Improvement of Classification and Clustering of Images using Evolutionary Techniques

Vikas Gupta, Rahul Malhotra

Abstract: Segmentation of medical images is significant as it aids in mining the region of interest, such that the body part under analysis is extracted. Medical image segmentation helps in treatment of diseases, in surgeries and also aids in medical diagnosis. Various performance factors like Volumetric Overlap Error, Relative Volume Difference, Average Symmetric Surface Distance, Root Mean Square Symmetric Surface Distance, Maximum Symmetric Surface Distance. were evaluated which shows that outlier detection technique provides better results as compared to the implementation done without using this technique.

Index Terms: Computed Tomography (CT) Images, Segmentation, Outliers, E-ABC.

I. INTRODUCTION

Segmentation of medical images plays a vital role in diagnosis and dividing an object under consideration from other parts of body in the image under consideration. Medical images can be two dimensional or three dimensional. In a two dimensional image each element is represented as pixel while in three dimensional medical images each element is called voxel [Sharma, N. and Aggarwal, L.M., 2010]. Frequently used images for the purpose of diagnosis are Magnetic Resonance Imaging (MRI) Images, Computed Tomography (CT) images [Norouzi, A. et.al, 2014]. Automatic image segmentation provides accurate results over manual process by involving previous knowledge, result validation and error correction [Zhao, F. and Xie, X., 2013].

Computed Tomography (CT) images find application in diagnosis of brain, chest and liver, as this technique is cheap, sensitive and easily available. Thus computer-aided diagnosis plays an important role in medical diagnosis with better accuracy and in a lesser time [Sharma, N. and Aggarwal, L.M., 2010].

Medical image segmentation is based on features like texture, varying shades of gray level, colour, contrast and brightness. Popular techniques used for segmentation of computed Tomography (CT) images are on the basis of threshold, region, fuzzy or neural networks. Types of medical image segmentation techniques depend on their use, types of image and more significantly are dependent on the body part under consideration. So, selecting an algorithm for segmentation of medical images is still an area of research using which a solution can be derived which is correct as per the judgment of medical experts.

This paper has been organized into various sections wherein first section introduces the concept and significance of segmentation of medical images, second section provides an insight into the survey of research work and innovations that have been done or are in process in the area of medical image segmentation, section 3 deals with the introduction and implementation of the proposed segmentation technique for segmentation of medical images, section 4 provides the results obtained on implementing the proposed technique of medical image segmentation and finally the last section concludes the proposed work.

II. LITERATURE SURVEY

Medical images like Magnetic Resonance Imaging (MRI) Images, Computed Tomography (CT) images are extensively being used for the purpose of medical diagnosis of various diseases. Processing of medical images by utilizing image segmentation has contributed a lot in the surgical process, wherein tissues are extracted using various techniques like thresholding and region growing which are region based or are based on features like gray levels where segmentation can be amplitude based, edge based and region based [Sharma, N. and Aggarwal, L.M., 2010] and classified using techniques like k-nearest neighbor and maximum likelihood [Norouzi, A. et.al., 2014]. Further clustering could be done using algorithms like K-means, Fuzzy C-means and expectation maximization [Norouzi, A. et. al., 2014]. Moreover different hybrid methods like graph cut [Norouzi, A. et. al., 2014] can also be used to segment medical images.

Research on techniques used for segmentation of medical images have evolved since years and thus have been categorized into three generations [Withey, D. J. and Koles, Z. J., 2008]. First generation utilizes techniques like thresholding and region growing for medical image segmentation, while second generation includes image models, uncertainty models and optimization techniques for medical image segmentation. The third generation includes integrating supervised knowledge in the techniques used for segmentation of medical images.

Various issues that affect the process of segmentation are noise that causes variation in intensity, fractional volume outcome which is due to exclusive pixel volume of a certain body part not matching with pixel volume any other part of body, existence of certain objects called artifacts and proximity of gray levels of other body parts due to intensity variation [Sharma, N. and Aggarwal, L.M., 2010].

Revised Manuscript Received on July 05, 2019.

Vikas Gupta, Electronics and Communication, IKGPTU, Kapurthala, India.

Rahul Malhotra, Electronics and Communication, IKGPTU, Kapurthala, India.

III. SEGMENTATION TECHNIQUES

Thresholding: Technique of thresholding based segmentation is dependent on the varying intensities and certain other medical features. When thresholding of an image is carried out, it differentiates regions having different intensities. This technique has limitations that it creates only two classes (with values above and below the threshold value) and is sensitive to noise and intensity variation [Pham, D. L., et. al., 2000], which may cause misclassification.

Region Growing: In this technique the location of seed in an image is very significant. The technique works on the principle of homogeneity. The conditions for homogeneity are predefined. This principle of homogeneity is applied on the neighboring pixels. The neighboring pixels that satisfy the conditions of principle of predefined homogeneity become a part of the region. The repetition of the process causes the region to grow. The entire region thus formed constitutes the volume of connected pixels.

IV. PROPOSED SEGMENTATION TECHNIQUES

An outlier in an image may be due to the inaccuracy in the intensity of pixels. An outlier deviates from other images of the sample in which it occurs. The deviation can be due to human error, loss of calibration of instrument, change of measuring instrument. Thus finding outliers during image analysis is necessary to observe variations in images. The classification process is based mainly on selection of features and error rate. Thus extraction of outlier images helps in cleaning the set of images to be processed. Clustering techniques can also be used to detect outliers. This classification is based on low medium and high level of the outlier detection. High level of the outlier images will be removed from the list and only those images are taken which are having low level of the outlier. This will give higher rate of segmentation success for the liver from CT image. The proposed algorithm of E-ABC, which is hybrid of fuzzy and ABC, is used in segmentation of CT images of liver. Various steps are followed for segmentation of the liver from the CT image.

i. Input the image of the CT into the segmentation program.
ii. Normalize the image for post processing phase.
iii. Extract the shape prior features of image trained using training set.
iv. Extract the liver based on features extracted after training of the liver sizes and shapes.
v. Extract the performance parameters for performance comparison for both the scenarios with and without outlier classification.

V. EXPERIMENTAL RESULTS.

In order to evaluate the proposed segmentation method, the experimentation was done on MATLAB R2017b installed in a computer with Intel Core 2 Duo CPU, T6600 @ 2.20 GHz, 3GB RAM. The testing data contains images from UCI repository. Five error measures, namely Volumetric Overlap Error, Relative Volume Difference, Average Symmetric Surface Distance, Root Mean Square Symmetric Surface Distance, and Maximum Symmetric Surface Distance are used for segmentation evaluation.

Fig. 1 to Fig. 5 shows the graph for the Comparison for VOE, RVD, ASSD, RMSD and MSSD for segmentation with outlier detection and without outlier detection. The result is compared for different CT images, which shows that the segmentation results are better with technique using outlier detection.

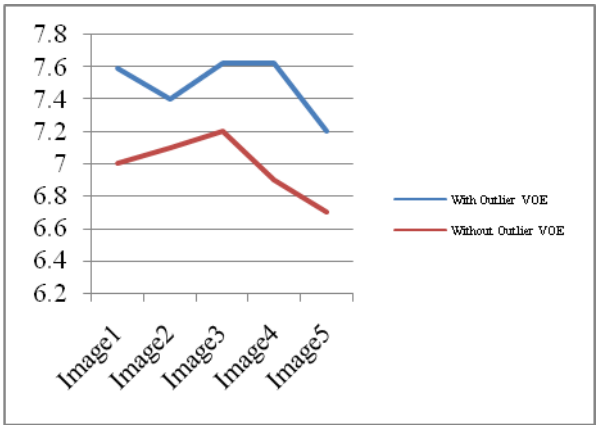

Fig. 1 VOE Comparison Graph

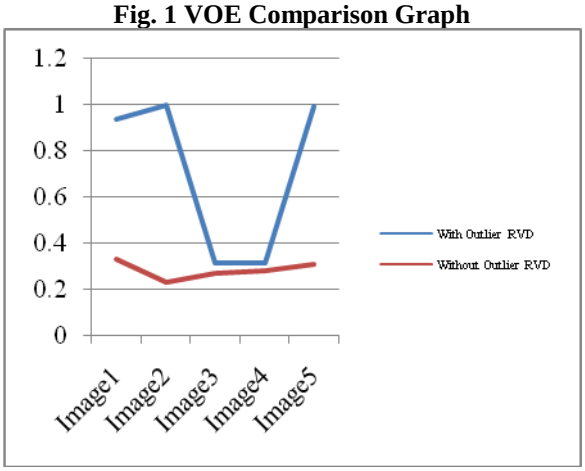

Fig 2 RVD Comparison Graph

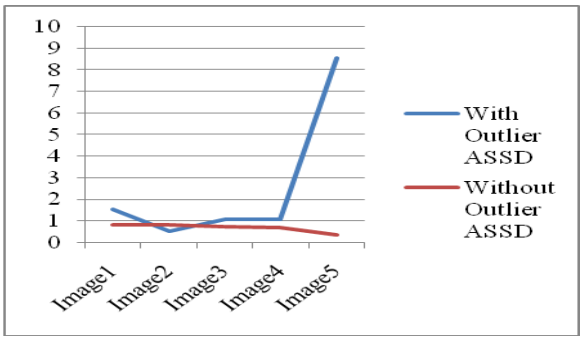

Fig.3 ASSD Comparison Graph

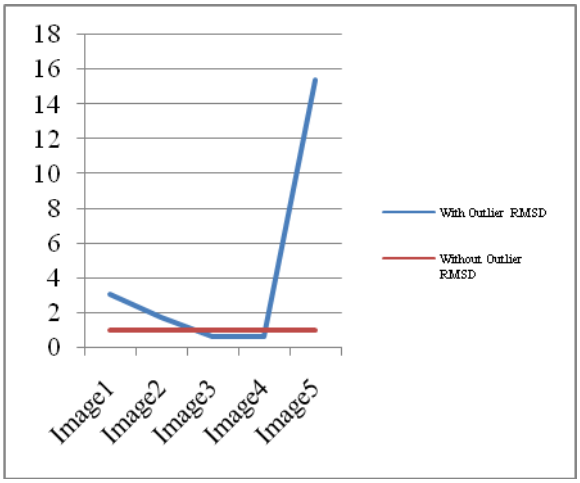

Fig. 4 RMSD Comparison Graph

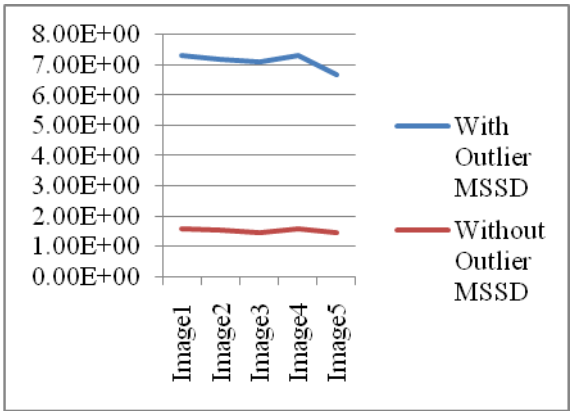

Fig. 5 MSSD Comparison Graph

Further the quality of image can be checked by using the following parameters:

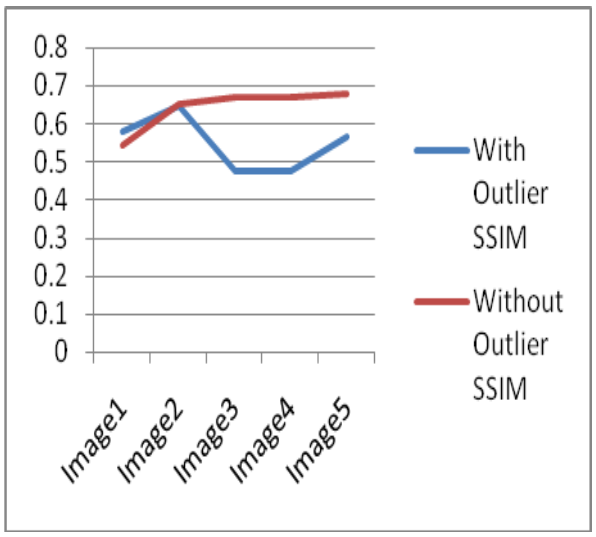

Fig. 6 SSIM Comparison Graph

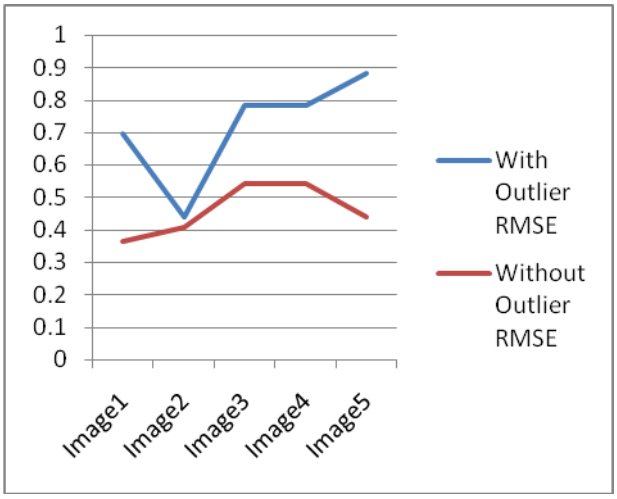

Fig. 7 RMSE Comparison Graph

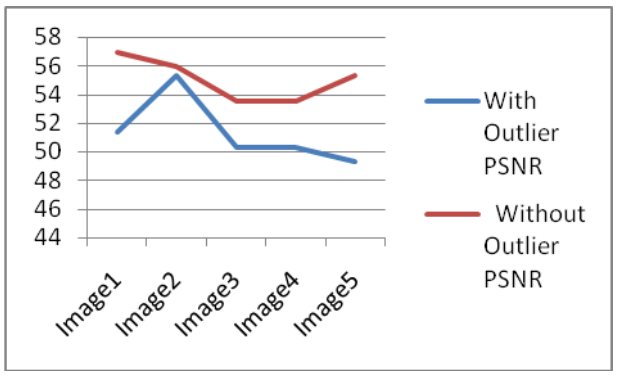

Fig. 8 PSNR Comparison Graph

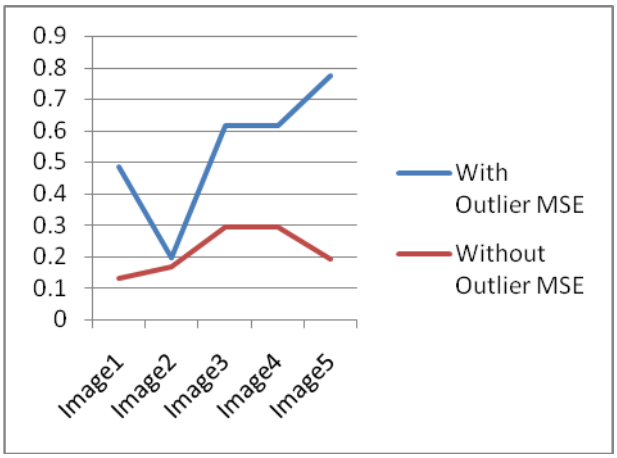

Fig. 9 MSE Comparison Graph

Fig. 6 to Fig. 9 shows the graph for the Comparison for SSIM, RMSE, PSNR, and MSE for segmentation with outlier detection and without outlier detection. The result is compared for different CT images, which shows that the segmentation results are better with technique using outlier detection.

VI. CONCLUSION

Segmentation for medical image for identification of certain organ is very complex issue. Various researches are being done in identification of liver from CT image. But the success rate for the segmentation has large variance, due to different type of image quality and different types of noises in the image. Various performance factors like VOE, RVD, ASD, RMSD, and MSD were evaluated which shows that outlier detection technique using E-ABC provides better results as compared to the implementation done without this technique.

REFERENCES

1. Norouzi, A., Shafry, M., Rahim, M., Altameem, A., Saba, T., Rad, A.E., Rehman, A, and Uddin, M., (2014), "Medical Image Segmentation Methods, Algorithms and Applications," IETE Technical Review, 31(3), pp.199-213.
2. Sharma, N. and Aggarwal, L.M., (2010), "Automated Medical Image Segmentation Techniques," Journal of Medical Physics, 35(1), pp. 3-14.
3. Pham, D. L., Xu, C., and Prince, J. L., (2000), "Current Methods in Medical Image Segmentation," Annual Review of Biomedical Engineering, 2(1), pp. 315–337.
4. Fu, K. S. and Mui, J. K., (1981), "A survey on image segmentation," Pattern Recognition., 13, pp. 3–16.
5. Haralick, R. M. and Shapiro, L. G., (1985), "Survey: Image segmentation techniques, Computer Vision Graphics," Image Proc., 29, pp. 100–132.
6. Pal, N. R. and Pal, S. K., (1993), "A review on image segmentation techniques," Pattern Recognition, 26, pp. 1227–1249.
7. Maintz, J. B. A. and Viergever, M. A., (1998), "A survey of medical image registration," Medical Image Analysis, 2, pp. 1–37.
8. Wong K.P., (2005), "Medical Image Segmentation: Methods and Applications in Functional Imaging," Handbook of Biomedical Image Analysis. Topics in Biomedical Engineering International Book Series. Springer, Boston, MA., pp. 111-182.
9. Withey, D. J. and Koles, Z. J., (2008), "A review of Medical Image Segmentation: Methods and Available Software," International Journal of Bioelectromagnetism, 10(3), pp. 125-148.
10. Zhao, F. and Xie, X., (2013), "An Overview on Interactive Medical Image Segmentation," Annals of the BMVA, 2013(7), pp. 1-22.
11. Vese, L. A. and Chan, T.F., (2002), "A multiphase level set framework for image segmentation using the Mumford and Shah model," International Journal of Computer Vision, 50(3), pp. 271–293.
12. Vehkomäki, T., Gerig, G., & Szekely, G. (1997), "A user-guided tool for efficient segmentation of medical image data," International Conference on Computer Vision, Virtual Reality and Robotics in Medicine and Medical Robotics and Computer-Assisted Surgery, 1205, pp. 685-694.
13. Elnakib A., Gimel'farb G., Suri J.S., El-Baz A., (2011), "Medical Image Segmentation: A Brief Survey," Multi Modality State-of-the-Art Medical Image Segmentation and Registration Methodologies. Springer, New York, NY, pp. 1-39.
14. Maulik, U., (2009), "Medical Image Segmentation Using Genetic Algorithms," IEEE Transactions on Information Technology in Biomedicine, 13(2), pp. 166–173.
15. Ma, Z., Tavares, J. M. R. S., Jorge, R. N., & Mascarenhas, T., (2010), "A review of algorithms for medical image segmentation and their applications to the female pelvic cavity," Computer Methods in Biomechanics and Biomedical Engineering, 13(2), pp.235–246.

AUTHORS PROFILE

Vikas Gupta did his Bachelor's of Technology in Electronics and Instrumentation from IKGPTU, Kapurthala in 2003. Then he did his Masters of technology in Electronics and Communication from IKGPTU, Kapurthala in 2010. Now he is a research scholar at IKGPTU, Kapurthala. His area of research includes Evolutionary Computing Techniques, Image Processing, Fuzzy Logic, Neural Network and Optimization. He has published more than 25 research papers in conferences, National and International Journal of repute.

Dr. Rahul Malhotra did his Bachelor of Electronics and Telecommunication Engineering from Amravati University Amravati, in year 2001. He did Masters of Technology in Electronics and Communication Engineering from Giani Zail Singh College of Engineering and Technology, Bathinda and Doctorate of Philosophy in the faculty of Engineering and Technology from Punjab Technical University in collaboration with Thapar University Patiala. His area of research includes Evolutionary Computing Techniques, Wireless Adhoc Networks, Fuzzy Logic, Neural Network and Optimization. He has published more than 110 research papers in National and International Journal of repute. He has guided more than 85 research thesis at Master's level and completed 04 Doctoral level of Research. He is a Fellow Member of Institution of Engineers, Calcutta, Institution of Electronics and Telecommunication Engineering, New Delhi and senior member of CSI and ISTE.