Brain Tumor Detection using Segmentation and Morphological processing

Vikash[1], Karamjeet Kaur[1], Mahesh Kumar[1], Yogendra Narayan[2]

Amity University, Haryana[1]

Chandigarh University, Mohali, India[2]

Corresponding author: Vikash, Email: vksyadav@gmail.com

One of the most well-known cancers, which is spreading throughout the world and steadily raising mortality rates, is the brain tumor. It has a likelihood of survival of about 75–90% when discovered in the early stages. The majority of cases are found when they are well advanced, largely because it takes so long to refer patients to brain cancer specialists and because the symptoms are not widely known. The advancement of image based machines that can be identify possible malignant high eminence brain diseases that increase the risk of emerging cancer presents substantial prospects for the advancement of brain disease screening for early recognition and behavior continue the most operative interferences in improving outcomes for brain cancer. This work proposes a segmentation and morphological approach utilising S-transform to maintain the prominent features and edge details of the MRI image. In order to maintain edge details and prominent characteristics of the MRI image, a segmentation and morphological algorithm is proposed in this study. Utilizing segmentation and morphological processing, locate the brain tumor and catch it early. This algorithm could be used to find tumors in these photos. Even when pre-processing is used on images, over-segmentation occurs. Despite being pre-processed, applying pre-processing to photos causes over-segmentation. The simulation results of cross-correlation and normalized cross correlation values is discussed in table-1.

Keywords: Brain tumor, Segmentation, DOST, Morphological processing

2023. In Satyasai Jagannath Nanda & Rajendra Prasad Yadav (eds.), *Data Science and Intelligent Computing Techniques*, 509–516. Computing & Intelligent Systems, SCRS, India. https://doi.org/10.56155/978-81-955020-2-8-47

1. Introduction

To grow a good indication of the distillation when processing digital photographs, we might desire to isolate the simulated object from the image. Segmenting images helps with this distribution process. Each pixel in this procedure receives a label, and then its attributes are dispersed. Segmentation technique is used in the medical image for cancer detection. Because after segmentation the image qualities improve [1-3]. Acquiring visual content for a given application when requested. A method for compiling visual material for organizing and recovery. It is suitable for the commutative states when requested for an explicit applications. The two categories for feature extraction are 1'st and 2'nd order. Processes are statistics in the 1'st order and are based on the value of the pixel. Processes measured neighbour relationships and a single pixel in the second order [4-6].

2. Discrete S-Transform

Every mathematical tool must be discretized as a result of the development of discrete systems in order to broaden the range of applications possible. Taking a discrete form of the continuous data $x(t)$ is expressed as $x[kT]$ where, $k = 0,1,2,\ldots,N-1$ and the sampling time is denoted as T, its discrete Fourier transform (DFT) is expressed as [7-9]

$$X\left[\frac{n}{NT}\right]=\frac{1}{N}\sum_{k=0}^{N-1} x[kT]\exp(-\frac{j2\pi nk}{N}) \qquad (1)$$

where, $n=0,1,2,\ldots,N-1$. Using (1.2), the ST of a discrete case $x[kT]$ can be defined [10] as

$$X\left[iT,\frac{n}{NT}\right]=\sum_{m=0}^{N-1} x\left[\frac{m+n}{NT}\right]\exp\left(-\frac{2\pi^2 m^2}{n^2}\right)\exp\left(\frac{j2\pi mi}{N}\right); \quad n\neq 0 \qquad (2)$$

For $n = 0$, it is defined as

$$X[iT]=\frac{1}{N}\sum_{m=0}^{N-1} x\left[\frac{m}{NT}\right] \qquad (3)$$

where, $i, m \text{ and } n=0,1,2,\ldots,N-1$. Equation (3) gives the continuous average of time into the zero-frequency voice, thus promising the invert is same. The inverse DST (IDST) is defined as

$$x[kT] = \sum_{n=0}^{N-1}\left(\frac{1}{N}\sum_{i=0}^{N-1} X[iT,\frac{n}{NT}]\right)\exp\left(\frac{j2\pi nk}{N}\right) \qquad (4)$$

Other definitions of discrete ST were subsequently documented in literature. One such formulation is given here, known as discrete orthogonal ST (DOST) [11,12], and it is distinct in rapports of a basis vector of length 'N' as follows

$$X[kT]_{[v,\beta,\tau]}=\frac{1}{\sqrt{\beta}}\sum_{f=v-\beta/2}^{v+\beta/2+1}\exp\left(j2\pi\frac{\tau}{\beta}f\right)\exp\left(-j2\pi\frac{k}{N}f\right)\exp(-j2\pi\tau) \quad ; \quad k=0,1,2,\ldots,N-1 \qquad (5)$$

On simplification, it results into

$$X[kT]_{[v,\beta,\tau]}=\frac{\exp\left(-j2\alpha(\frac{2v-\beta-1}{2})\right)-\exp\left(-j2\alpha(\frac{2v+\beta-1}{2})\right)}{2\sqrt{\beta}\sin\alpha}j\exp(-j2\pi\tau) \quad (6)$$

where, $\alpha=\pi\left(\frac{k}{N}-\frac{\tau}{\beta}\right)$ is a centre of the sequential window for k^{th} vectors.

2.1 Image Segmentation

When processing digital images, we may essential to separate a virtual item from the medical image data in order to get good indication of the mixture. Picture segmentation aids in this distribution. In this process, each pixel is given a label, after which the attributes of the pixels are redistributed. Cancer detection in the medical field frequently makes use of segmentation. We have utilised the segmentation of the image [1-14] as a result of these segmentation qualities. a process for gathering visual content for organization and recovery. When asked for a specific application, it is valuable for the commutative estate [15,16]. First order and second order feature extraction are the two categories. The 1'st order and 2'nd order feature extraction are the two categories. Measures are statistics of the first order, and they can only be computed with pixel data. Second-order metrics that take into account relationships include single pixels and neighbour relationships.

2.2 Morphological operators

Morphological operators are used in many other applications besides image processing, including texture recognition, noise reduction in images, and edge extraction. Morphological image processing can be used for extract digital image features in order to represent and describe the shape, borders, and skeletons of regions. The morphological technique is used to examine many types of photographs, such as moonscapes and square-shaped images. It utilised a number of pixels. Dilation and erosion, two crucial actions that add and delete pixel values from the object, are a part of this process [18-20]. The erosion of X by Y is express as

$$X \theta Y = \{(i, j) : Y (I, j)\} € X \quad (7)$$

where, X and Y is the binary image and structuring element respectively and (i, j) is the center pixel of structuring element.

3. Methodology

Firstly, original image data is captured, and convert into gray scale image. In the pre-processing we have applying a high pass filter to enhance the quality of the image. In order to view the picture's true nature, this is done. Their further step is to apply discrete S-tockwell transform (DOST) to transferred time domain data into time-frequency domain and removed the nose. DOST is used to improve quality of the medical image texture. After that, segment the image and apply dean thresholding to each section [17]. Still, one of the straightforward methods for image segmenting is thresholding. That one is an effective approach for segmentation. Following border identification, the morphological process is applied, and the result is a tumor region.

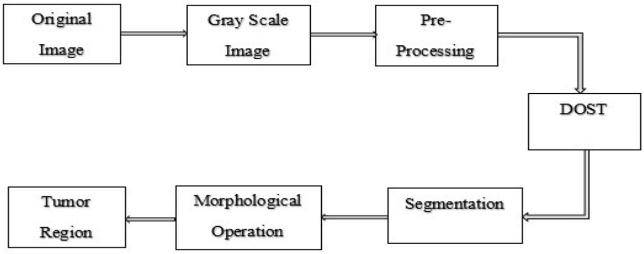

Fig.1: Segmentation Steps.

The image processing is a process of converting an image into a digital format in order to extract all of the picture's useful information. In order to employ an image processing algorithm, operations like CT scans and MRI images are blurred. It improves the image and raises its quality, which aids in the detection of cancers when they are present. This method required a few unique processes, as indicated in Fig. 1. Initially, apply pre-processing and thresholding to the supplied picture data. Pre-processing is a method by which we can get rid of or extract unwanted components and enhance a feast picture, which is necessary for particular applications. A pre-processing on image is carried out to produce superior outcomes. It improves the picture's clarity of vision.

4. Results Discussions

Utilizing filtering, segmentation, and morphological image processing, the work is stimulated in MATLAB. The DOST is used to eliminate the nose, shift time-domain data into time-frequency domain, and improve image quality. By modifying the medical image data, morphological medical image processing provides us with a precise image or an enhanced medical image. The original MRI image is shown in Figure 2, and the filtered image, following gray scale and pre-processing, is shown in Fig.3

Fig. 2: Original image

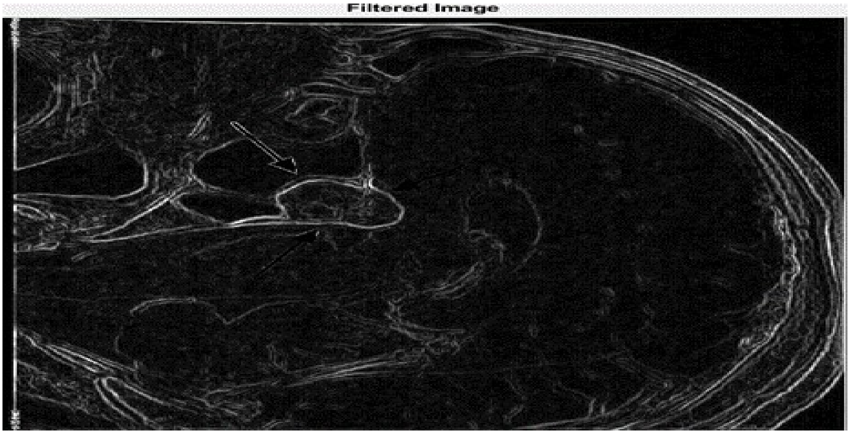

Fig. 3: Filtered Image

Fig.4: Edge Detected image

Fig. 5: Threshold Segmentation

Fig. 6: Watershed Segmentation

Fig.7: After morphological operation

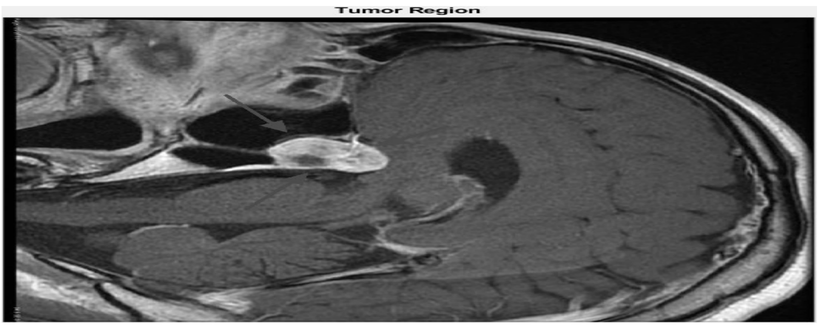

Fig.8: Tumor Region

In the Fig. 4 is finding the edge detection of the MRI image. Thereafter, find the different segmented image in Fig. 5 and Fig.6. After the morphological operation Fig. 7 is obtained. Thereafter, a enhance tumor region is identify in Fig.8. This method required a few unique processes, as indicated in Fig. 1. Initially, apply pre-processing and thresholding to the supplied picture data. Pre-processing is a method by which we can get rid of or extract unwanted components and enhance a feast picture that is necessary for particular requests. A primary processing is carried out to produce superior outcomes. It improves the picture's clarity of vision. Thereafter, a enhance tumor region is identify in Fig.8. Hyper boundaries were improved given the display on the endorsement set. It is noted the effects of the basis versus injury dissection task. The effective model has been implemented using an enhanced working model, the test images in Fig. 8 depict the anticipated veil yields and their true covers. In table-1 find the simulation results of cross-correlation and normalized cross correlation values.

Table: 1. Cross-Correlation and normalized Cross Correlation

Cross Correlation value	0.8187
Threshold Segmentation	0.6312
Watershed Segmentation	0.4211
K-means clustering	Cluster-1: 0.4570 Cluster-2: 0.1732

5. Conclusion

In this paper, demonstrates a new method of segmentation and morphological process of the medical image data. This enhanced method is used to help us efficiently identify the brain tumor. With the use of this improved technique, we can successfully locate the brain tumor. This procedure produces an easy-to-read, improved image that is used to identify tumors before surgery, when it is still possible for the surgeons to perform surgery and segments were too small for the detection but using morphological image processing, the shapes of the tumor are enhanced, which helps the surgeon identify the tumor. MATLAB simulation is used to implement the suggested strategy, improving image processing. The suggested approach is more accurate, efficient, and simple to use. The image's enhanced pixel count makes cancer easier to spot. The pixels of the image are increased, which helps to detect cancer easily. It makes the classification of the tumor simple which will help the doctors to know the tumor accurately and then take the preferable steps to cure cancer. Segmentation is used to improve the input image that is presented in the output.

References

[1] K. Hu, X. Gao, and Y. Zhang, "Markov multiple feature random fields model for the segmentation of brain MR images," Expert Syst. Appl., vol. 134, pp. 79–92, 2019.

[2] S. Ray, V. Kumar, C. Ahuja, and N. Khandelwal, "Intensity population based unsupervised hemorrhage segmentation from brain CT images," Expert Syst. Appl., vol. 97, pp. 325–335, 2018.

[3] Selvapandian and K. Manivannan, "Fusion based Glioma brain tumor detection and segmentation using ANFIS classification," Comput. Methods Programs Biomed., vol. 166, pp. 33–38, 2018.

[4] Y. K. Dubey, M. M. Mushrif, and K. Mitra, "Segmentation of brain MR images using rough set based intuitionistic fuzzy clustering," Biocybern. Biomed. Eng., vol. 36, no. 2, pp. 413–426, 2016.

[5] Y. Wang, C. Li, T. Zhu, and J. Zhang, "Multimodal brain tumor image segmentation using WRN-PPNet," Comput. Med. Imaging Graph., vol. 75, pp. 56–65, 2019.

[6] J. Li, Z. L. Yu, Z. Gu, H. Liu, and Y. Li, "MMAN: Multi-modality aggregation network for brain segmentation from MR images," Neurocomputing, vol. 358, pp. 10–19, 2019.

[7] R. Ranjan, N. Jindal, and A. K. Singh, "Fractional S-Transform and Its Properties: A Comprehensive Survey," In Wireless Personal Communications, vol. 113, Issue 4, pp. 2519–2541, 2020.

[8] R. Ranjan, A. K. Singh, and N. Jindal, "The identities of n-dimensional S-transform," Multimedia Tools and Applications, vol. 81, pp.16661–16677, 2022. https://doi.org/10.1007/s11042-022-12757-8.
[9] R. Ranjan, N. Jindal, and A.K. Singh, "A sampling theorem with error estimation for S-transform," Integral Transforms and Special Functions, (2019) 1-21.
[10] Rajeev Ranjan, N. Jindal, and A.K. Singh, "A Sampling Theorem for Fractional S-transform with Error Estimation," Digital signal processing, vol. 93 (2019), pp. 138-150.
[11] R. Ranjan, et al., "Convolution theorem with its derivatives and multiresolution analysis for fractional S-transform," Circuits, systems, and signal process, (2019) 1-24.
[12] S. K. Chandra and M. K. Bajpai, "Fractional Crank-Nicolson finite difference method for benign brain tumor detection and segmentation," Biomed. Signal Process. Control, vol. 60, pp. 102002, 2020.
[13] M. Mittal, L. M. Goyal, S. Kaur, I. Kaur, A. Verma, and D. Jude Hemanth, "Deep learning based enhanced tumor segmentation approach for MR brain images," Appl. Soft Comput. J., vol. 78, pp. 346–354, 2019.
[14] M. A. Naser and M. J. Deen, "Brain tumor segmentation and grading of lower-grade glioma using deep learning in MRI images," Comput. Biol. Med., vol. 121, no. 10, pp. 37-58, 2020.
[15] L. Rundo et al., "A novel framework for MR image segmentation and quantification by using MedGA," Comput. Methods Programs Biomed., vol. 176, pp. 159–172, 2019.
[16] E. Sert, F. Özyurt, and A. Doğantekin, "A new approach for brain tumor diagnosis system: Single image super resolution based maximum fuzzy entropy segmentation and convolutional neural network," Med. Hypotheses, vol. 133, no. September, p. 109413, 2019.
[17] R. Ranjan, N. Jindal and A. K. Singh, "Multiplicative Filter Design Using S-Transform," *2nd International Conference on Micro-Electronics and Telecommunication Engineering (ICMETE)*, 2018, pp. 260-263.
[18] R. Wang et al., "Automatic segmentation of white matter lesions on magnetic resonance images of the brain by using an outlier detection strategy," Magn. Reson. Imaging, vol. 32, no. 10, pp. 1321–1329, 2014.
[19] R. Ranjan, and A. Thakur, "Image Segmentation and Semantic Labeling using Machine Learning," International Journal of recent technology and Engineering (IJRTE), ISSN: 2277-3378, vol. 7 Issue-5S2, 2019.
[20] R. Ranjan, Abhishek. "Image encryption using discrete orthogonal Stockwell transform with fractional Fourier transform" Multimedia Tools and Applications, 2022.