Detection of Robust Cells from Brain Tumor Images using Sparse Reconstruction Technique

Shubham Rajput[1], Shreenath Medeboyana[2], Shubham Tupkari[3], Neha N.Gaikwad[4]
[1, 2, 3, 4] Department of Electronics and Telecommunication
[1, 2, 3, 4] JSPM's Imperial College of Engineering and Research

Abstract- *First of all, the proposed paper deals with accurate cell detection i.e. proper location and identification of the nucleii of the cell. The drawbacks faced during the design of paper are the shape of the cell and the overlapping of the cells. So, the proposed method uses sparse reconstruction technique to avoid the overlapping of the cells. The current detection method is pre-processed by extracting the essential features such as line, edge, point, etc. This image is segmented into constituent parts and will be experimented for detecting the different brain tumor patches using sparse reconstruction. The proposed method automatically detects the cells and avoids overlapping of the cells. The method also divides the input image according to their intensity levels i.e. forms a cluster. The discussed method also checks the mathematical accuracy of the given algorithm. The method given is open source and it is comparable with the previous studies.*

Keywords- Magnetic Resonance Image (MRI), Brain Tumor Segmentation, Mean Shift Clustering, Sparse Reconstruction.

I. INTRODUCTION

Nowadays, Brain tumor has become the severe cancer type which has increased recently. Overall they occur in about 10 in 1000 people each year. Normally MRI or CT scan of head is the test being done to observe the Brain tumor. The proposed method uses the MRI images due to its following advantages:

i. To scan and detect the abnormalities or discontinuities in the soft organ such as brain and heart.
ii. MRI images do not produce any harmful radiation. So very safe to use.
iii. Also gives the detail flow of blood inside the brain and heart.

Its Symptoms may include headache and feeling sick. In this project, the proposed method is to identify the severity of the tumor for various parameters such as C7.The input image is pre-processed by extracting the essential features such as line, edge, point, etc. This image is segmented into constituent parts and will be experimented for detecting the different brain tumor patches using sparse reconstruction.

The main aim of the method is to detect the accurate cells along with its location of the nuclei. But there are several drawbacks faced during detection of robust cells:

i. Variation in shape.
ii. Overlapping of cell.
iii. Dull cell contour.

So to overcome the above drawbacks we have proposed a method which detects the strong cells i.e. not affected by tumor as well its position automatically.

First of all, input image is being divided into several blocks using block processing method to detect the unhealthy cells. The input image is then plotted against different angles (Theta). The Sinogram is found out for proper reconstruction of the input image. Phantom checks the mathematical accuracy of the given algorithm. Back projection provides a platform for detection of robust cells. The input image is clustered based on threshold values, according to its intensity values. So, after clustering it is very easy to detect the unhealthy cells from the brain image.

The paper is organized as follows: Section 1 discusses Detection of brain tumor cells using sparse reconstruction technique i.e. introduction. In section 2 we have discussed the work done, achievements and the drawbacks of the previous work on the topic i.e. Literature review. Section 3 Introduces the system specification .The explanation of the block diagram regarding detection of brain tumor cells is given in Section 4. The discussion of system design is in Section 5. Section gives results, advantages, applications and conclusion of the topic discussed below.

II. METHODOLOGY

In this paper, we have implemented the technique for detection of robust cells from brain MRI scans using sparse reconstruction technique. The whole method can be described in different sections: Pre-processing, Feature extraction, Tumor segmentation, Mean shift clustering, sparse reconstruction, Reconstructed Image.

A. Pre-processing:

At training stage, we manually crop image patches and each patch contains one cell located in the centre. This image is given as input to the pre-processing block for further processing. The main function of Pre-processing is as follows:-

1. Filtration
2. Image Enhancement
3. Image Restoration

The main aim of image pre-processing block is to improve as well as enhance certain features of images for further processing. The block also carries geometrical operations such as scaling, rotation and translation. The methods of pre-processing can be used to calculate the intensity values of the neighboring pixels i.e. brightness of the image. It also includes additional features such as block processing. The technique for the same is discussed below.

Block Processing:

The technique used for dividing of image is block processing. The technique considers the image as a block and processes the whole block at a time i.e. image is divided into rectangular blocks and some operation is performed on each block individually so as to determine the pixel intensity value in the neighboring block of output image. The matlab function used for performing the block processing on given image is blockproc. While performing this operation care has to be taken that no two blocks should overlap.

B. Feature Extraction:

Before segmentation some features are needed for image which is to be extracted like line, edges boundaries, texture, dust, etc. Interpretation & description is one of the important block of human understanding system it gives the relation or the difference between the captured scenes. Feature extraction is broadly classified as low level feature extraction and high level feature extraction. We have defined low level features to extract the basic features from an image. Most common form of low level feature extraction is thresholding and high level feature extraction deals with finding shape of different objects in an images. To detect the edges of the object from an image we have to take the first order differentiation of the given image and for more accuracy second order differentiation of the given image is being performed.

During the feature extraction of tumors, we obtain different features that describe the nature of the tumor and they are used in segmentation of tumor. They are Phantom, Sinogram, and Back-Projection.

1) Phantom:

In image processing phantom is nothing but a specially defined object that is used in medical field imaging techniques to evaluate and see the various performance characteristics of the image scanning devices. The phantom is easily available and it gives more accurate output then with the use of a living subject to risk it directly. In the past old days phantoms were used in radiography or fluoroscopy and now in the most recent days phantoms have been developed for 3D imaging techniques such as MRI, CT, Ultrasound, PET etc. These latest techniques are used for desired image characteristics.

2) Sinogram:

Sinogram is used for the proper reconstruction of the input image that is used for sparse reconstruction. Sinogram is plotted using an angle , this can be decided from the input image. Sinogram is 3D plot that is plotted on the basis of the input image. It is also used to locate the abnormal openings in different parts of the body.

3) Back-Projection:

Back Projection is a method of recording that how much clearly the pixels of the input image fit in the histogram model. In other words we can say that for back projection we calculate the histogram of a feature and then it is used to find the features in the input image. Back projection is obtained from different angular and parallel projection. This projection obtained provides a platform for Nuclei segmented image

i) Filtered Back projection using convolution in spatial domain:

We obtain a back projection output image in the previous step which can be filtered to obtain a clear view of the nuclei. Thus this back projection output is filtered using convolution technique in spatial domain. As filtration is being done the edges of the nuclei have been clearly observed.

ii) Filtered Back projection using 2-D FFT:

In the previous step we filtered the image in spatial domain that deals with the spatial visible pixels in the image, but if the image is filtered in frequency domain we can achieve better result. Thus for filtration of image in frequency domain we use Fast Fourier Transform (FFT) which is very easy to handle and provide us with accurate result within very less time. Therefore by using FFT we filter the back projection output for achieving better contrast of the image. Also the region of the cell is being clearly seen, so it becomes very easy for the user to detect a particular cell.

iii) Filtered Back projection using Central slice theorem:

The FFT filtration technique has some drawbacks that is the lower frequency pixels and reconstructed accurately but the higher frequency pixels are not accurately reconstructed. Thus for proper reconstruction of image we use Central Slice Theorem that uses IFFT in a different technique. Thus by filtering the back projection output using Central Slice Theorem we achieve better reconstructed image.

C. Tumor Segmentation:

In this Block we represent the proposed cell detection algorithm based on sparse reconstruction with trivial templates. Different tumor cells or tissues are being included in brain tumor segmentation which is Cerebrospinal Fluid (CSF), gray matter and white matter. The study of the brain tumor segmentation includes the existence of abnormal cells or tissues. The main aim of the brain tumor segmentation is that the given brain image should be divided into number of regions and the pixel intensity values within that particular region should be uniform in accordance with pre-defined criteria.

From the past studies of the scientists in the field of bio-medical imaging, they have achieved many different things in the field of brain tumor segmentation. The scientists have proposed both semi-automatic and automatic way to detect the tumor. From the reference of different papers this is one of the automatic techniques proposed to detect the unhealthy tissues in the brain. Brain tumor segmentation broadly classified into three main parts:

i) Manual segmentation:

It involves manual drawing the region of the tumor and various different required structures. Experts not only make use of information given in the image but also required additional knowledge. Manual segmentation is the time consuming process because the user actually draws the region which is required by him. The validation of manual segmentation deals with ground truth.

ii) Semi-automatic segmentation:

Semi-automatic segmentation is the segmentation technique which is a combination of both manual as well as automatic segmentation. The main three elements in the semi-automatic segmentation are interactive part, user part and computational part. There is actual interface between the user and the computer and the input device of which is controlled by the user. The user checks the information which is displayed on the monitor and accordingly reacts to the information which is displayed on the screen i.e. gives feedback.

iii) Automatic segmentation:

As the name suggests automatic segmentation, solely the entire work is done by the computer without any user interface. It requires the prior knowledge of the algorithms and the models used. It overcomes all the drawbacks faced by the user to learn things in machine learning and pattern recognition.

D. Mean Shift Clustering:

Mean shift clustering develops the clusters or groups based on threshold value decided. As the clusters based on threshold values are being calculated it becomes very easy for the user to identify the unhealthy tissues from the given image. It is also called as mode-seeking algorithm. It overcomes the disadvantages of K-mean clustering such as no assumptions were made depending on the numbering of the clustering. Main idea for the development of this algorithm is to develop the Probability Density Function (PDF) of the dense region in feature space.

E. Sparse Reconstruction:

Cells with same shape and size are allocated in same area. To the area considered structuring element window should be align to a particular cell.

$$\mathrm{B}_c = c_1 b_1 + c_2 b_1 + \cdots + c_q b_q$$

If the structuring element is not aligned to a particular cell, then the above equation does hold well. Structuring element is provided as a combination of different patches from dictionary so as to differentiate unhealthy cells from the background. In a patch if a cell is located in middle it will have a low sparse reconstruction error and on the contrary if the cell is not present in the centre of the patch produces large sparse reconstruction error.

F. Reconstructed Image:

The main aim is to locate the cells at the correct position. These located cells are nothing but the robust cells. The detected cells can easily be distinguished from each other. As shown in figure there is no overlapping of cells that means the algorithm developed is working in a correct manner. It also specifies the line, boundary, edges and region of a cell. So detection of robust cells using sparse reconstruction technique works on an automatic algorithm and overcomes all the previous disadvantages.

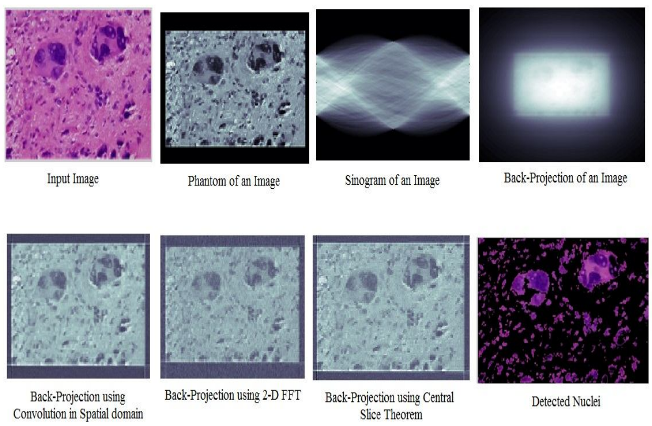

Figure 1. Shows the procedure of the entire model.

III. CONCLUSION

In this way, we have proposed a general, automatic cell detection algorithm using Sparse reconstruction with trivial templates. By computing the sparse reconstruction with trivial templates, the algorithm is robust and capable of handling multiple cells in one image patch. It also works for different images containing cells exhibiting large various in appearances and shapes.

REFERENCES

[1] N. Malpicaet al., “Applying watershed algorithms to the segmentation of clustered nuclei,” J. Cytometry, vol. 28, pp. 289–297, 1997.

[2] A. Hafiane, F. Bunyak, and K. Palaniappan, “Fuzzy clustering and active contours for histopathology image segmentation and nuclei detection,” in Proc. Adv. Concepts Intell. Vis. Syst., 2008, pp. 903–914.

[3] O. Schmitt and M. Hasse, “Radial symmetries based decomposition of cell clusters in binary and gray level images,” J. Pattern Recognit., vol. 41, no. 6, pp. 1905–1923, Jun. 2008.

[4] E. Bernardis and S. Yu, “Finding dots: Segmentation as popping out regions from boundaries,” in Proc. IEEE Conf. Comput. Vis. Pattern Recognit., Jun. 2010, pp. 199–206.

[5] H. Chang et al., “Invariant delineation of nuclear architecture in glioblastoma multiforme for clinical and molecular association,” IEEE Trans. Med. Imag., vol. 32, no. 4, pp. 670–682, Apr. 2013.

[6] A. Kårsnäs, A. L. Dahl, and R. Larsen, “Learning histopathological patterns,” J. Pathol. Informat., vol. 2, 2011.

[7] G.M. Faustino, M.Gattass, S.Rehen, and C. de Lucena, “Automatic embroyanic stem cell detection and counting method in fluorescence microscopy images,” in Proc. IEEE int. Symp. Biomed. Imag., From Nano to Marco, 2009, pp.799-802.

[8] D. Comaniciu, V. Ramesh, and P. Meer, “Kernel-based object tracking,” IEEE Trans. Pattern Anal. Mach. Intell., vol. 25, no.5, pp. 564-577, 2003.

[9] J. Cheng and J. Rajapakse, “Segmentation of clustered nuclei with shape markers and making function,” IEEE Trans. Biomed. Eng., vol.56, no. 3 pp. 741-748, Mar. 2009.

[10] B. Liu, J. Huang, L. Yang, and C. Kulikowsk, “Robust tracking using local sparse appearance model and k-selection,” in Proc. IEEE Conf. Comput. Vis. Pattern Recognit., 2011, pp. 1313-13120.

[11] N.N.Gaikwad, V.M.Mane, “Detection of hard exudates using K-mean clustering for screening of diabetic retinopathy” in International Conference On ARTcom 2013.