Artefact Removal and Skull Elimination from MRI of Brain Image

Sudipta Roy, Sanjay Nag, Indra Kanta Maitra, Prof. Samir Kumar Bandyopadhyay

Abstract: Detection of brain abnormalities form magnetic resonance imaging (MRI) of brain image is very important task. Many different artefacts are present in MRI and due to this artefact degraded the image quality and also the diagnostic quality. Detection of abnormalities in brain like tumor and edema, skull elimination important otherwise it has been treated as an abnormality in automated system or may hamper the intelligence system. Here a method of artefact and skull removal has been proposed which is combination of statistical and computational geometric approach.

Keywords: *Artifact Removal, Binarized Image , Convex Hull , MRI of Brain, Skull Elimination, Standard Deviation.*

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1. Introduction: Automated detection of brain tumor edema, hemarage or any kind of abnormalities is a very vital and important work in present days for accurate detection and faster computation of diagnosis. The uses of automated process are increases in day to day life. But automated detection from magnetic resonance imaging (MRI) are affected due to artefact and skull portion, some affecting the diagnostic quality, while others may be confused by intelligence system. Thus artefact and skull removal is very essential task for accurate detection of brain abnormality from MRI of brain. Thus elimination of this a problematic area like artefact and skull of brain improve the diagnosis quality of brain by intelligence system.Here artefact and skull elimination processes by the automated system has been proposed.

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The proposed methodology is very simple, and combination of statistical, some intermediate step and computational geometric approach. Statistical methods like standard deviation are used to calculate the global threshold to binarize the image which is very efficient for detection of skull and artefact, after some intermediate steps at last a computational geometry like convex hull is used to produce final output (MRI without artifact and without skull).The proposed methods produce very efficient results for large number of data set and which will improve the abnormality detection quality. Thus the proposed methods helps to automated detection and diagnosis any disease from MRI of brain and no longer look to MR imaging to provide only structural information, but also functional information of various kinds such that information about brain tumor, edema, hemarage, perkinson diseases.

The rest of this paper is organized as follow: in ***section 2***, short review of some other methods has been described; after that in the ***section 3***, proposed methodology has been described; and in the ***section 4,*** results and discussion section has beenwritten; and the conclusion part has been describe in the ***section 5;*** and reference are in ***section 6***; at last in ***section 7***, some other output by proposed methodology has been shown.

2. Brief Review: Artefact and skull in a MRI image can degraded the diagnosis quality that's why artefact and skull removal are the preprocessing steps for the automated abnormalities detection from MRI of brain. The large expansion in MR imaging field are attributable to rapid technologic advances in several medical areas, in stride with the rapid technologic advances, there has been extraordinary growth in the number of applications for MR imaging.L J Erasmus [1] (2004) et. al. describe different type of MRI artefact, cause of artefact and their origin in MRI images. Also describe the different effect of the signal processing in MRI images very briefly. Philip J. Allen et. al. in 2000 *[2]* describe a methodology for elimination of artefact from continuous EEG recorded during functional MRI and remove the artefact. Philip J. Allen et. al. developed a signal processing methodology, which uses estimation of an averaged artifact waveform followed by adaptive noise deletion to reduce this artifact effectively and it validate in recordings from five subjects using two fMRI sequences by measurementof residual artifact, spectral analysis, andidentification of spike-wave complexes in the correctedEEG.Bradley G. Goodyear et. al. in 2004 [3] proposed a technique that based on the Stockwell transform (ST), a mathematical operation that provides the frequency content at each time point within a time-varying signal. Using this technique, 1D Fourier transforms (FTs) are performed on raw image data to obtain phase profiles and results; navigator echo correction is successful at removing phasefluctuations due to physiological processes such as respiration.The ST filter, on the other hand, does not perform well nor is it designed to alter phase oscillations at such low frequencies. S Roy et. al. [4] proposed methods for brain tumor detection and use a MRI without artefact as an input, for quantification of tumor skull create some problem. Thus artefact and skull removal is important task for brain abnormalities detection.

3. Proposed Methodology:

First a binarization method has been proposed and a global threshold value has been selected by standard deviation of the image. Global threshold value has been chosen due to the large intensity variation of the whole image i. e. the large variation of back ground and foreground of the MRI of brain image. As extraction of brain portion from artefact and skull are the main goal, so binarization part is very important for the proposed work. Global thresholding using standard deviation gives very good results and binarize each component of the MRI image. Then complement of binarize image is done as a result the skull, brain and other pixels change to zero and the gap in between them which was zero in the previous binarized image becomes one. Then two dimensional wavelet decompositions is done using '*db1*' wavelet [8, 9, and 10] up to second level. Re-composition of the image is done using the approximate coefficient, the objectives of these two steps is to remove the detailed information from the complementary image which helps to extract skull portion from the brain portion. The previous process had done due to separation of skull to the brain portion as skull and brain may or may not connected, thus previous process gives the surety that skull and brain portion are not connected and results in decrease in size of the complementary image to half of the original image, moreover due to reduction of size and removal of detailed information the white pixel of the complementary image come closure and form a complete ring.This complete ring is the skull of brain image. Then interpolation method is used to resize the image of the previous step to the original sizethen re-complement of the image is done and this results in the complete separation between brain and skull. Then labeling of the image is done using union find method.Then maximum area of all the connected components is found out from the array because maximum area represents the actual brain image. Then except maximum area all other component are removed, and in this process skull and other artefact are removed. Thus after all other component except maximum component the image contains only the discrete (wrong evaluation) structure of brain portion. That is the image contains only the brain portion as one pixel. As the image contains one pixels structure are discrete (wrong evaluation) in nature that's why Quickhull Algorithm for Convex Hulls is used here to generate original image. Here a Quickhull algorithm [11] is used because Quickhull algorithms computes less time complexity and performs very good results for proposed methods.It is computed for these one pixel and the entire pixels inside the convexhull are set to 1 and outside it are set to zero. Here if some of the brain part where set to zero during the binarization stages due to wrong evaluation this step ensure that the error is corrected. Then obtained binarized image is multiplied with the original image by pixel wise and produce the desired results i.e. MRI of brain image without artefacts and boarder.

3.1. Algorithm:

1. Binarize the image using the statistical standard deviation method.
2. The complement of binarized image is done.
3. Two dimensional wavelet decompositions is done using 'db1' wavelet up to level two.
4. Re-composition of the image is done using the approximate coefficient of previous step.
5. Interpolation method is used to resize the image of the previous step to the original size.
6. Re-complement of the image in the last step is done.
7. Labeling of the image is done using union find method.
8. The maximum area of all the connected components is found out which represents the brain.
9. All other components except the maximum component are removed from the image.
10. The image obtained contains only the brain as 1 pixel.
11. Convex hull is computed for these 1 pixel and the entire pixels inside the convexhull are set to 1 and outside it are set to zero.
12. The image of the previous step is multiplied to original image pixel wise and thus segmented brain is obtained.

3.2. Complexity analysis: Assume input image has m number of row and n number of column and if number of row = number of column = n then to compute the binarized image $O(n^2)$time required. Selection of maximum area require $O(n)$ time, convexhull computation takes $O(nlogn)$ time and multiplication of each image pixel require $O(n^2)$ time. Thus the total time complexity: $T(n) = O(n^2) + O(n^2) + O(nlogn) + O(n) \approx O(n^2)$.

4. Results and Discussion: Proposed methods give satisfactory results for different MRI of brain images. The procedure of proposed methods has been described above and figures below shows each functional step of the proposed methods. A input MRI image has been shown in *Figure 1:(A)* and corresponding binarized image using statistical standard deviation has been shown in *Figure 1:(B)* the advantage of this binarization is that it binarized the MRI of brain properly and as global threshold value has been selected that's why it binarized all the foreground with respect to background. In this step the goal of the proposed methods to binarized artefact, skull and brain portion has been successfully executed. Then the complemented binary image has been shown in *Figure 1:(C)* and the wavelet decomposition using the 'db1' wavelet up to level two has been shown in *Figure 1:(D)* which helps to detect the skull portion. Due to reduction of detailed information using this 'db1' wavelet the white pixel of the complementary image come closure and form a complete ring and this white pixel separatethe skull from brain portion. After performing deduction of area except highest area, then Quickhull algorithms for convexhull is applied and converting each pixel inside the convex hull one and outside the convex hull zero is shown in *Figure 1:(E)*.Then final out put without artefact and boarder is shown in *Figure 1:(F)*. Thus the proposed algorithms perform very well for boarder deletion as well as artefacts removal.

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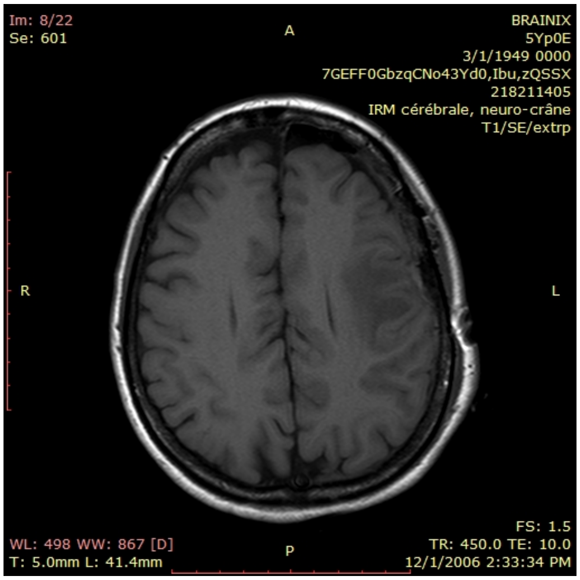

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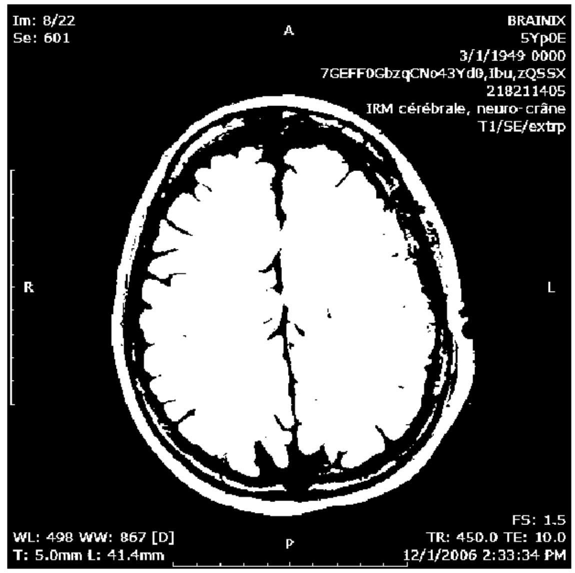

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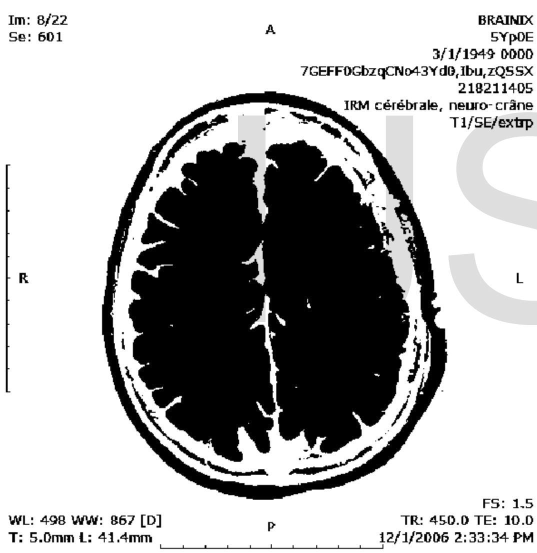
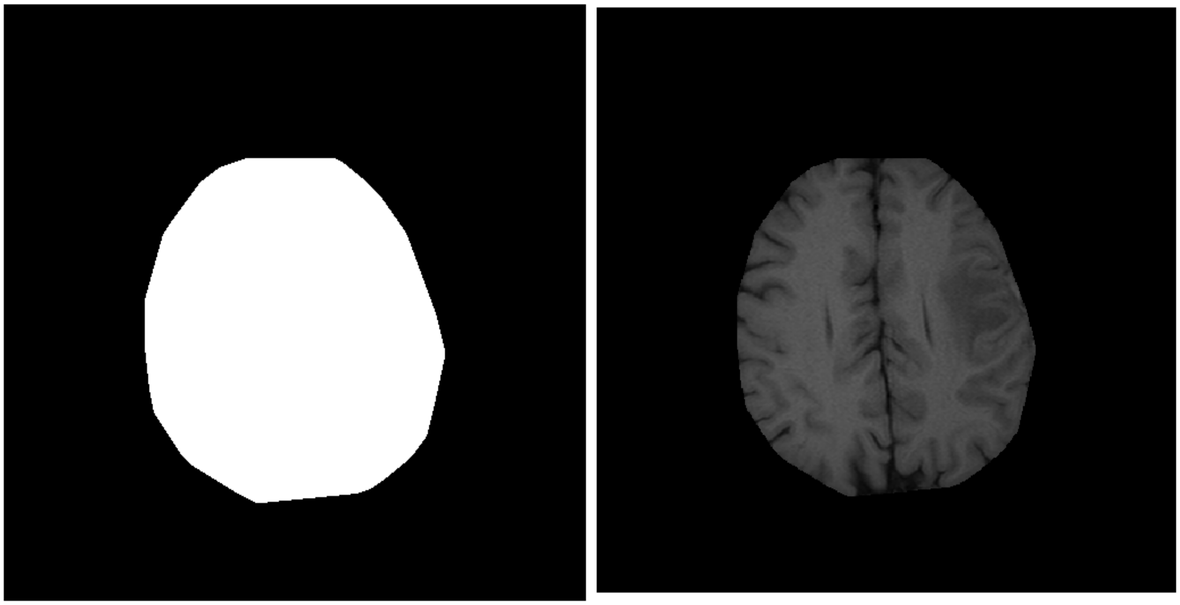


(C)

(D)



(E) (F)

Figure 1: *(A)is the original MRI image, (B)is the binarized image, (C) is the complemented binary image, (D) is the output after using* wavelet decompositions using 'db1', (E) is convex image and (F)is the final output image without any artefact and skull.

5. Conclusion:

Artefact removal and skull elimination are very important assignment for automated detection of brain abnormalities. Here intelligence system for artifact removal on MRI of brain has been implemented and the proposed method work very efficiently for large number of MRI of brain image. Proposed methods fail only for connected artefact with the brain portion. The results show that the proposed method can overcome the shortcomings of the previous methods and improve the artifact and skull elimination methodology in the sense of automated brain abnormalities detection.

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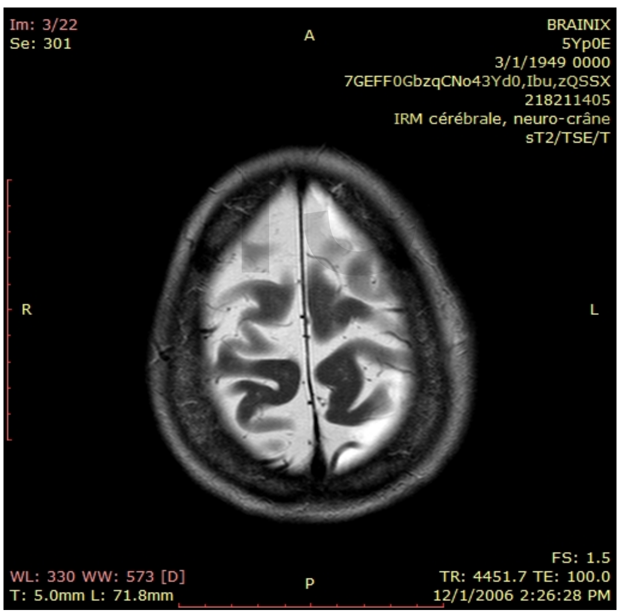
Appendix:



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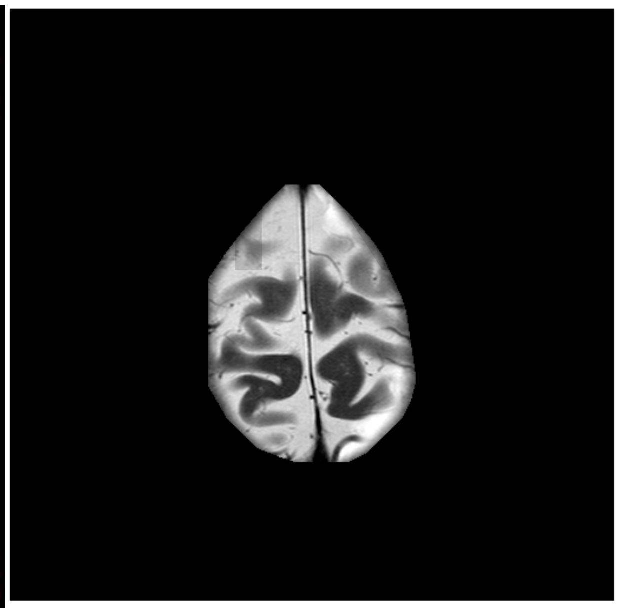

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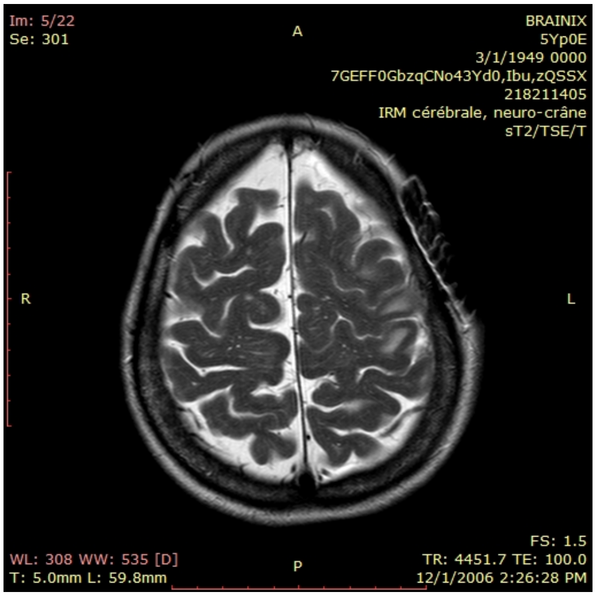
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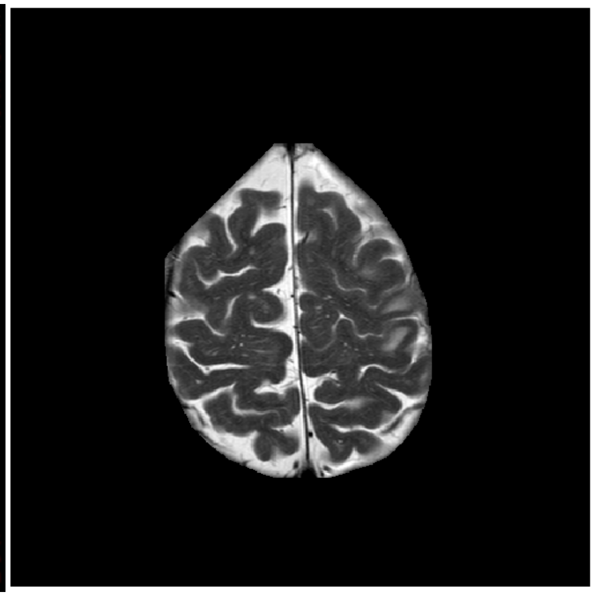

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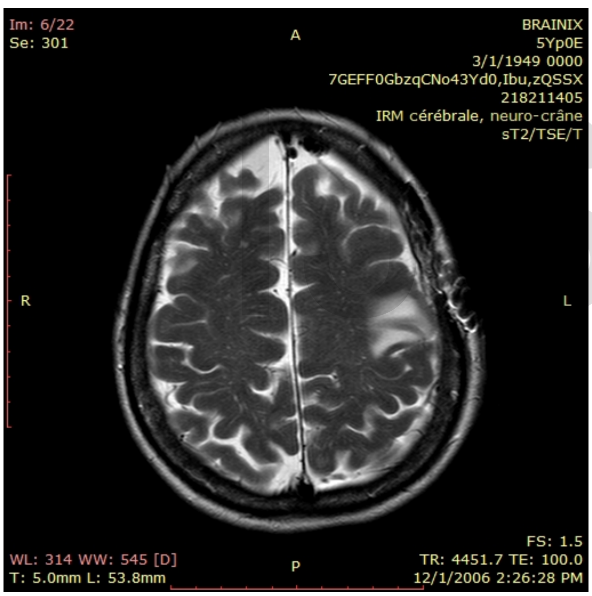
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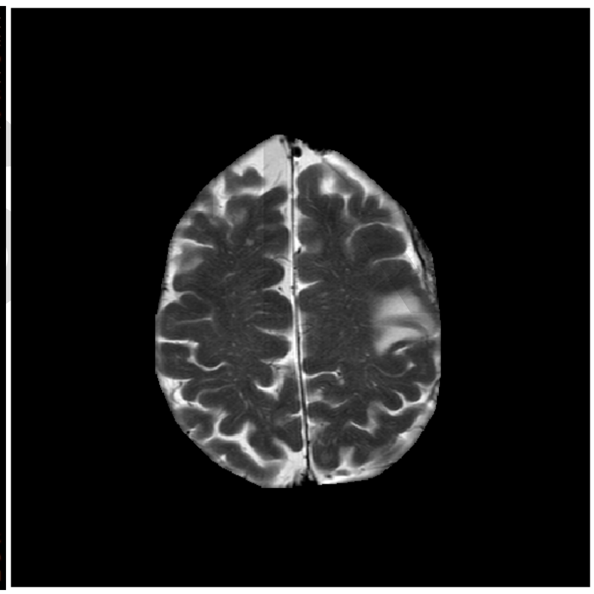
(I-3)



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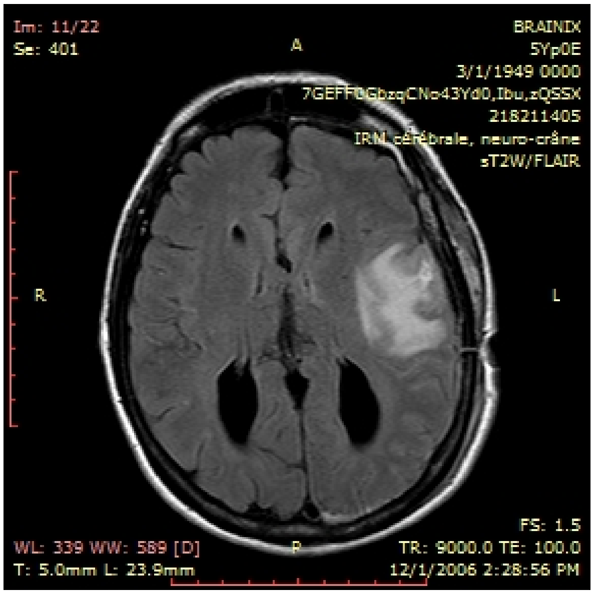

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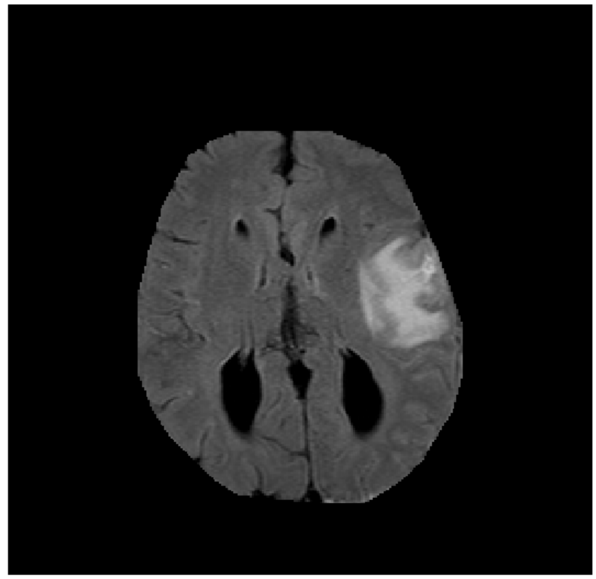

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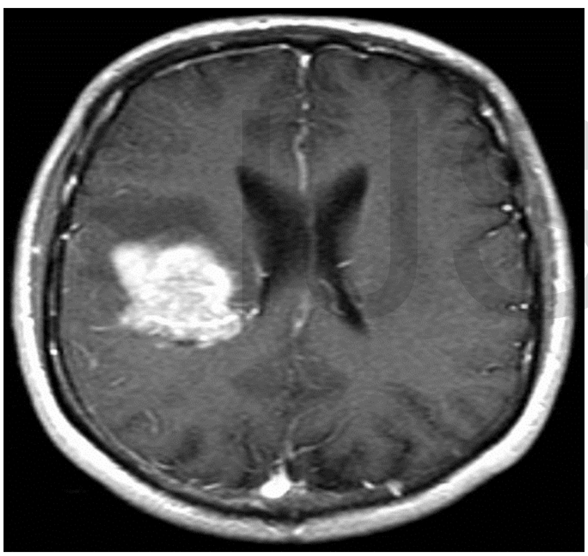

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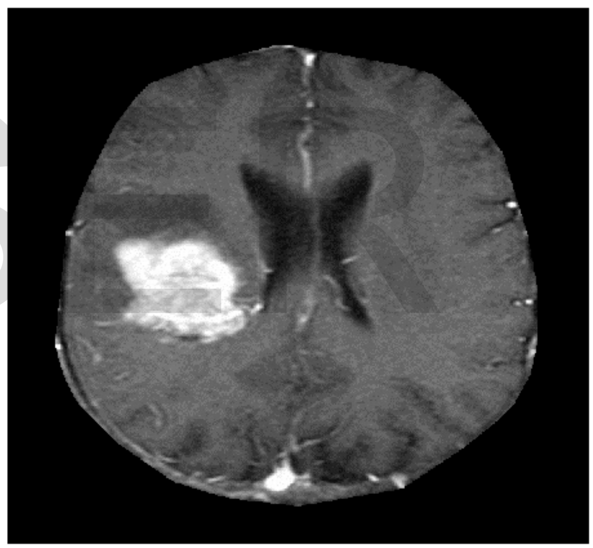

(O-5)

***Figure 2*:** (O-1, O-2, 0-3, 0-4, 0-5) are the Output MRI image without artefact and border and (I-1, I-2, I-3, I-4, I-5) are the corresponding Input MRI image.