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A NEW IMAGING ARTEFACT REMOVAL FROM MRI OF BRAIN IMAGE

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ABSTRACT: MRI brain images are extensively utilised in medical applications for research, diagnosis, therapy, surgical planning and image guided procedures. These MR brain pictures are commonly damaged with numerous imaging aberrations and may impact the efficiency of brain image processing algorithms. In this article, we listed and identified the sources of the prevalent imaging artefacts in MR brain pictures. Many distinct artefacts may arise during magnetic resonance imaging(MRI), some lowering the diagnostic quality, while others may be misinterpreted with disease. Thus to identify any abnormalities in brain like tumour, edoema artefact must be eradicated else it will considered as an anomaly in automated system or may obstruct the intelligence system. This research provided an approach to eliminate the artefacts from MRI of brain. The suggested technique is extremely easy with the combination of statistics and computational geometric approach. Statistical approaches like standard deviation are utilised to establish the global threshold to binarize the image and computational geometry like convex hull is used to generate final output (MRI without artefact) (MRI without artefact).

Keywords: Brain MRI with artefacts, standard deviation, global threshold, and convex hull.

I. INTRODUCTION

Fast advances in computerised medical image processing and computer-aided diagnosis have elevated the area of medical imaging to a position of prominence in scientific imaging.1. In the medical profession, the most often used imaging technology is MRI, which uses radio waves to create an image using magnetic fields. It does not use ionising radiation, such as x-rays, and is noninvasive and flexible. Soft tissue information that cannot be seen from the outside is revealed. An MRI may be used to differentiate between normal and abnormal tissue in the field of medicine. An MRI of the brain, also known as an MR scan of the brain or a scan of the head, is a neurological examination that yields a high-resolution picture of the head. To get an accurate picture of the brain and surrounding tissues, doctors use an MRI scan, which uses a magnetic field and radio waves. MRI is a more flexible and precise tool than a CT scan, and it can detect even the tiniest of details.

In order to look for signs of brain illness in people who have neurological problems, CT scans are often utilised.

It is well accepted that Magnetic Resonance Imaging (MRI) is a strong tool for diagnosing disease. Artefacts may arise in any imaging technique, resulting in a lowered picture quality and thereby compromising the accuracy of an imaging assessment. In photography, an artefact is anything that appears in a photograph but does not exist in the real world. Magnetic resonance imaging (MRI) is plagued with artefacts, some of which damage the quality of the scan and others of which may be mistaken for disease. Artefacts are often divided into three categories: patient-related, signal processing-dependent, and hardware (machine)-related, depending on their point of origin. In order to increase the identification of suspicious regions in Magnetic Resonance Images, artefact reduction methods are used (MRI). Since the artefact has been removed from MRI of brain picture using the statistical approach, the suggested method has been executed effectively, and the results are excellent. The MRI of the brain may be used to diagnose any condition. Structural and functional information on blood flow, heart function, biochemical activities (including tumour metabolism), and blood oxygen levels are now common uses for magnetic resonance imaging (MRI) (for mapping of brain function).

Artifacts found in MR brain images, part two

In photography, an artefact is anything that appears in a photograph but isn't present in the actual subject. There are many types of artefacts, some of which are obvious and others of which are so subtle that they may go unnoticed. Brain MRIs are prone to artefacts of numerous types. Imaging of the brain is susceptible to a variety of aberrations that might influence diagnostic accuracy, while others can be mistaken for pathology3,4. Calibration issues, software mistakes, and physiological events (motion, blood flow) are the most common causes of artefacts in brain MRI.

flow) and Physics limitations (Gibbs and susceptibility, chemical shift, metal).

There are primarily three types of MR brain images, T1, T2 and PD, which focus on different contrast characteristics of the brain tissues. A Sample of the same slice on the three types are shown in Fig.

1. These image types can also be taken in three orientations, axial, corona and sagittal (see Fig. 2). The axial orientation of the MR head image is viewed from neck to head. The coronal orientation begins at the tip of the nose and ends at the back of the head. The sagittal orientation extends from ear to ear. By interpreting these various types and contrast that are produced, a radiologist or other physicians can help to make diagnoses of medical conditions.

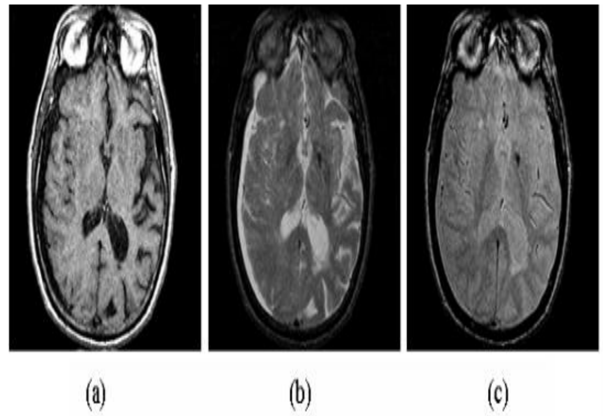


Fig1: Types of MRI axial scan (a) T1 scan (b) T2 scan (c) PD scan of the same subject

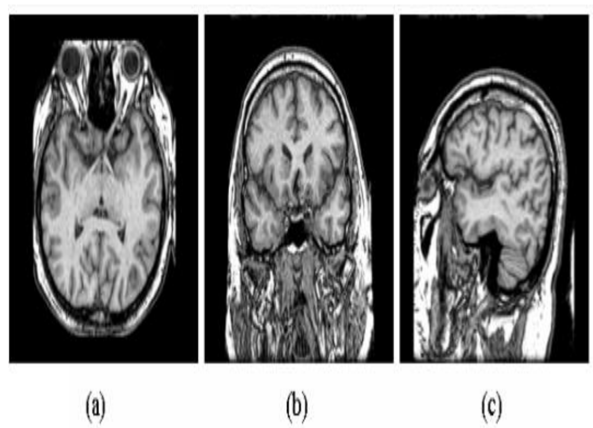


Fig2: Types of MRI orientation on T1 –weighted images (a)axial (b)coronal (c)sagittal

Based on the findings of the yearly Media Mark Research (MRI) Study - The Survey of the American Consumer, EASI presents a Life Stage cluster analysis. More than 26,000 personal interviews are conducted each year in the continental United States by Media Mark, which provides strategic insights, consumer feedback, and other valuable data. targeting and other aspects of marketing and advertising. The Internet, telephone, and postal samples may all be used to create a custom study. When reducing picture artefacts, we utilised the EASI

MRI Database. The first step is to determine a threshold value across a binary picture. The threshold value is determined using a statistical approach, such as standard deviation [10]. Foreground and background photos are separated using statistical descriptions in this processing step. The intensity of each grey pixel in a digitised picture is given by the expressions I[m,n] and h. As a result, the following equation describes the overall visual intensity

$$T = \sum_{I} h[I]$$

The average intensity of the image is defined as the mean of the pixel intensity within that image and the average intensity is defined as Iavg by:

$$I_{avg} = \frac{1}{T} \sum_{(m,n)\epsilon I} I[m,n]$$

The standard deviation Sd of the intensity within a image is the threshold value of the total image is defined by:

$$S_d = \sqrt{\frac{1}{T-1} \sum_{m,n\epsilon I} (I[m,n] - I_{avg})^2}$$

$$S_d = \sqrt{\frac{1}{T-1} \sum_{m,n\epsilon I} I^2[m,n] - T{I_{avg}}^2}$$

We use the threshold intensity as global value i.e. the threshold intensity of the entire image is unique. The standard deviation of the image pixel of a image I[m,n] or matrix element for I[m,n] is given by :

$$I[m,n] = 1 \quad if I[m,n] \geq S_d$$
$$I[m,n] = 0 \quad if I[m,n] < S_d$$

Because of the existence of artefacts, only a fraction of the original MRI brain picture may be used in the aforementioned technique, which then begins the second step. After labelling all of the related components, we follow a generic technique [11, 12] in the second stage. An image is first run-length encoded, and then scans are performed to assign preliminary labels and record label equivalences. Then, the equivalence classes are resolved and the runs are redistributed according to the equivalence classes that have been established for each run. For each linked component, calculate its area. Then, identify the components with the largest area. To get rid of the artefact, this procedure is used. For one, the brain and skull are linked, and the artefacts are mostly letters, causing them to take up space. a smaller surface. Using this ratio, we may determine whether the brain and skull are part of a single component or two separate components. As a result, if a ratio is low, the second-highest component has an area close to or equal to that of the second-highest component; if a ratio is large, both components are in one and the second-highest component is a piece of artefact. Since the ratio result indicates that the greatest component is best, we maintain that component plus a second one. As a result, an artifact-free binary image is created. We can get the final result by computing a convex hull using just the one pixels in our binarized picture. When the convex hull of the binarized image has been set to one, the binarized image matrix is multiplied position-wise to the original picture in order to remove artefacts from the MR image. Metal-related susceptibility and Gibbs artefact are reduced with the usage of convex hulls. Convex Hulls Quickhull Algorithm is applied here. The Quickhull Algorithm [13] for Convex Hulls employs merged facets to ensure that the output is unambiguously convex and runs quicker when the input includes nonextreme points. This is the pseudo-code for an algorithm:

The grayscale MRI brain picture is taken as input in the first step. In step 2, the standard deviation of the picture is used to compute the threshold value.

Step 3: The threshold value is used to binarize the picture. , for example, if the threshold is set to 1, then any pixels with a value larger than the threshold are set to 1.

A B is the size of I; BI is zeros (a,b); STD is std2(I); FORi is 1 to A. COMPLETE FOR j=1 to B COMPLETE

Set BI(i,j)=1 if I(i,j) is greater than or equal to STD.

END FOR END*/

Step 4: Using equivalence classes, the binarized picture is labelled and the areas of related components are determined.
Step 5: Identify the related components with the largest and second-largest surface areas.
if the ratio is high (signifying that the skull and brain are one component as discussed above), and if the ratio is low (signifying that they are not one component), the ratio is computed (signifies the skull and brain are two different component as explained above).
As a result of this ratio calculation, only one component is maintained and all others are have been thrown away. are deleted, unless the ratio is low, in which case only those components with the largest and second-largest areas are retained.
The convex hull of the one pixel in the picture is computed and all areas inside the convexhull are set to one.
The image matrix created in the previous step is multiplied with the original image matrix in order to create a picture that solely contains the brain and skull.

Correctness

invariant in a loop:

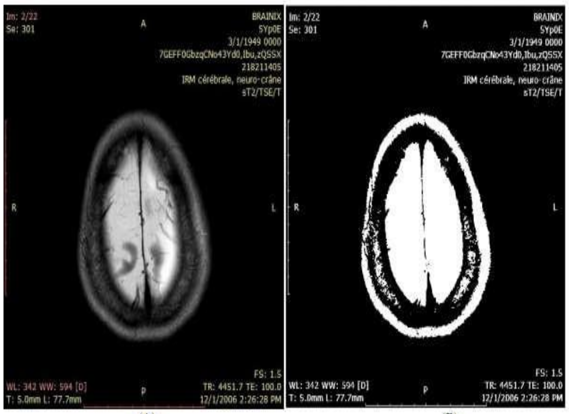
For each iteration of the outer loop, the image's rows 1 and 2 are equal to 1, 2, and so on; for each iteration of the inner loop, the image's columns 1 and 2 are equal to 1.
The steps are the same.
This means that the inner loop's invariant holds true at the beginning, and certain variables are initialised to their finite size and dimension, which is true for the outer loop as well.
The invariant is moved to the next row in the loop by incrementing the loop variable in each consecutive iteration. Image I + 1][j], Image I + 2][j], Image I + 3][j] and so on are all moved by the loop.
When the outer loop is completed, the outer loop is finished as well.
>height, i.e. the whole picture row has already been visited.

Analysis of Complexity

The execution time for both for loops is O(n n) for all situations if the height is equal to the width.
Each level of recursion needs O(n) time for partitioning. As long as partitions are guaranteed to be identical in size to a specified percentage, the worst-case time would be O (n log n). O(n) partitions do not meet these conditions, though (they are not balanced). Because of this, the worst-case execution time is O (n 2). O(n 2) and O(n 1) are the worst-case and best-case times, respectively (n log n). It takes O(n n) computation time to determine the area of each component. O(n log n) + O(n 2) = O (n 2).

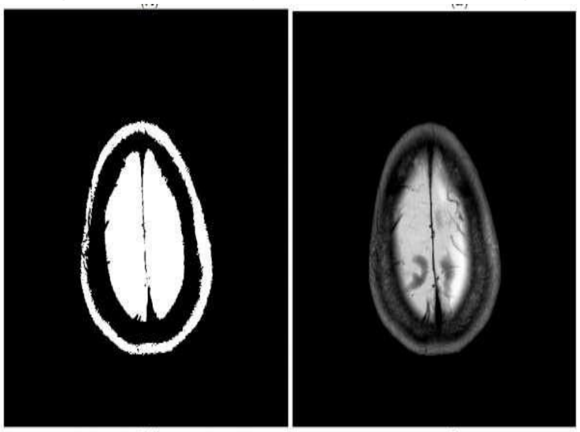
THIRD PARTY CONCLUSIONS AND OUTLOOK:

There are now mostly letter or metal artefacts or Gibbs artefacts in existence today. Most brain MRI pictures include a letter artefact because the patient's information is incorporated in them. Metal-related and susceptibility artefacts are quite rare because to the high quality of MRI machines. According to the presented methodology, the following three results are shown. As illustrated in figure1 (A), the original MRI picture is displayed in figure1 (A) whereas a binary image is shown in figure1 (B). In this binary image, a global threshold value is picked by the image standard deviation. The background and foreground parts of the MRI picture may be clearly seen in this binarized image. Remove the artefact from the MRI scan. Figure 1 illustrates the process of removing artefacts by calculating each component and the binarized result (C). It is possible to remove the maximum amount of artefacts (mostly letters) in this stage, however Quickhull convex hull must be used in order to eliminate any metal or Gibbs artefacts (see figure1) (D). Figure 1(D) shows no artefacts, since suggested techniques eliminate all artefacts.



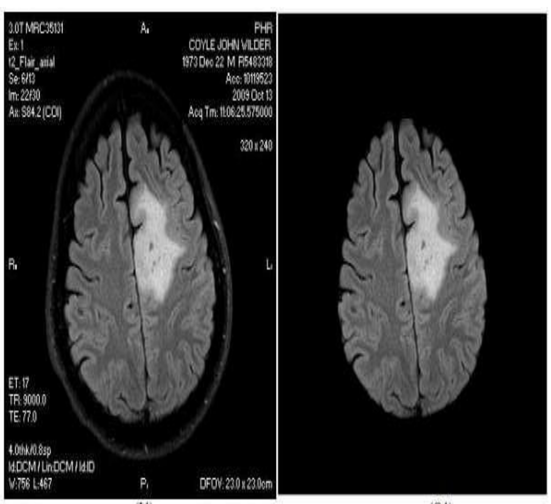
(A) (B)

Fig3: A) is the input MRI of brain image with

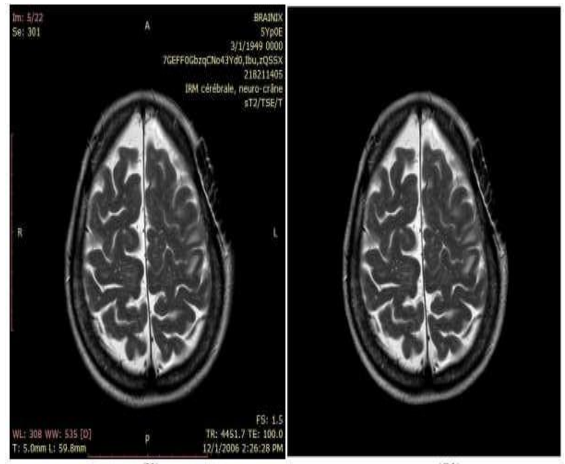


(C) (D)

artefact; (B) is the binarized output by global thresholding method using standard deviation approach; (C) is the binarized output without major artefact; (D) is the desired output image without any artefacts.



(I4) (O4)



(I1) (O1)

Fig:4 : I1, I4 are the input MRI of brain image with artefact and O1, O4 are the corresponding output MRI of brain image without any artefact.

II. CONCLUSION

In order to identify any abnormalities in an MRI of the brain, it is necessary to remove artefacts before the scan is processed. The artefact removal method for MRI of the brain has been implemented here. The automated approach uses a low time complexity to eliminate artefacts. MRI brain pictures may be analysed using a variety of statistical and geometric approaches, and the findings are impressive across the board. The proposed approaches were evaluated on a large dataset and produced outstanding results, except for a linked artefact with the original brain region picture. Using the new approach, the researchers were able to overcome the flaws of the prior methods and enhance the artefact removal method in the sense of detecting anomalies in the brain.

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