Metal Artifact Reduction in CT images of Head by Image Processing Techniques

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Abstract

Metal artifact is one of the major problems in CT images. To overcome this problem a new algorithm has been suggested in this research. This algorithm has five steps means: a) Extraction the metal region from the image, b) Filtration the extracted metallic region, c) Segmentation and accurate extraction of metallic pieces by FCM (Fuzzy C Means) method, d) Using the interpolation on the sinogram and finally e) Insert the corrected metallic section of image to the original image. The results of this research showed, by using this new algorithm the output image has better contrast, signal to noise ratio and visibility with much less consumed time than the other reported methods.

Keywords: Metal artifact; Computed tomography imaging; Image processing.

1. Introduction

The CT study is used to detect the anatomy defects of human body, especially in the head, legs and etc. Before starting the CT study the patient should remove the metallic pieces from his body. But some pieces such as metallic implants inside the legs, head, femur and teeth cannot be removed from the body for CT study. These metallic implants produce metal artifact. Metal artifact is one of the major problems in CT imaging, which comes from the fact that X-ray in the diagnostic energy range is strongly attenuated after passing through metal pieces, and much fewer signals are detected by the detectors in these regions. Due to its important, many research works have been done for reducing the metal artifacts in CT imaging.

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The main idea is to fill in the incomplete projection data resulted from metal attenuation. Most of them are interpolation-based due to the easy implementation and effectiveness. The recent suggested methods have some shortcomings in duration time of processing, reproduction of new artifacts, reducing the contrast and spatial resolution and reduction the visibility of edges in the image.

2. Materials and Methods

The suggested algorithm in this research has the followings five steps:

- **First:** extraction the metal region from the image
  
  The metal region was extracted to get the best segmentation metallic pieces [1].

- **Second:** filtration
  
  After extraction the metal region, morphological opening for removing annoyed areas in ROI was performed.

- **Third:** Metallic object segmentation
  
  By using the FCM (Fuzzy C Means) technique [2], the metallic objects from the image FOV (Field of View) was segmented and the image of metallic area was obtained.

- **Fourth:** Interpolation
  
  In this step, metallic area of image was transformed into sinogram domain and metallic trace in sinogram domain was obtained. Then by recognition the metallic trace, the corrupted projection (metallic trace) was removed from the original sinogram and finally the values in the removed areas were replaced by another interpolation method [3].

- **Fifth:** Metallic pieces addition
  
  Then the image, was reconstructed by traditional FBP (Filtered Back Projection) method from interpolated image. After that the metallic pieces were added to the reconstructed image.

3. Results

To evaluate the performance of the suggested algorithm, it was examined by using the real CT datasets of head regions. These images were obtained from the CT center of Alzahra hospital.

Comparison between the proposed algorithm and other existing metal artifact reduction methods [4-6], which are based on iterative reconstruction was done. As an instant the corrupted CT image by the metal artifact has been shown in Fig.1 (a). In Fig.1 (b) the corrupted image has been corrected by iterative reconstruction method and in Fig.1(c) the correction of corrupted image has been done by the proposed algorithm in this research. The results showed that the proposed algorithm can effectively reduce shade and streak artifacts better than other methods.

4. Conclusion

In this paper, it has been shown that proposed method produces good quality image by precisely identifying metal, better contrast, signal to noise ratio and visibility with much less consumed time than the other methods. The suggested method is also able to keep the sharp edges of the underlying object for clinical diagnosis.

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Fig. 1. (a) The original CT image, (b) The corrected image by iterative method, (c) The corrected image by the proposed algorithm.

References


