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CT Imaging System

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Abstract. In this paper, we study the reconstruction imaging of CT system. Using FBP algorithm to filter the receive information of medium and back the projection. Then we get a 362 x 362 absorption rate matrix. Form the surface absorption by the absorption rate of the spline interpolation. Finally, we use Matlab to draw the picture of media's absorption rate. We can get media's geometrical shape and its location in the square tray.

Introduction

Computed Tomography (CT) is a technology which can get transection information by multiply perspective the object.Now,the main CT algorithm is analytic method and iterative method.In these methods there is a very famous reconstruction algorithm called Filted Back - the Projection (FBP) which can first filter and then back the projection.The basic theory of FBP is the central slice theorem.

This papaer mainly introduced the FBP algorithm and use it to solve a practical problem.And we will describe the algorithm from two part,what is FBP and the application of FBP.

Filted Back - the Projection (FBP)

FBP is a widely used CT image reconstruction method,it can get the internal structure informations in the case of cause no physical damage.

The Effect of Filtering in FBP--Eliminate the Asteroid Trace. The nature of FBP to reconstructed image is put the ray from finite medium space evenly inverse projection onto the infinite space of the ray.

To eliminate the asteroid trace,this paper use filter function ω to filter the data of projection before back-projection reconstruction.Then put the adjusted data into FBP to get the result.

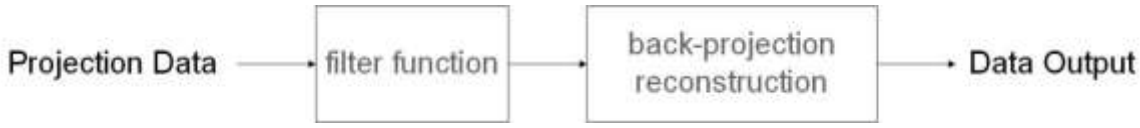

Figure 1. The process of reconstruction

Basic Theory of FBP--the Central Slice Theorem. The central slice theorem is the basic theorem of inverse projection method.Suppose $f(x,y)$ as the medium absorption distribution function,and $f(x,y)$'s one-dimensional Fourier transform $\rho(\omega)$ is equal to its two-dimensional Fourier transform $F(u,v)$ upward a slice along the parallel direction of the detector.

There fore,enough projection data (receive information) getting from the launch - receiver device of the CT system by rotation process and take the Fourier transform,when data are full of the whole (u,v) plane, $F(u,v)$have been function, So you get the original function of the medium.

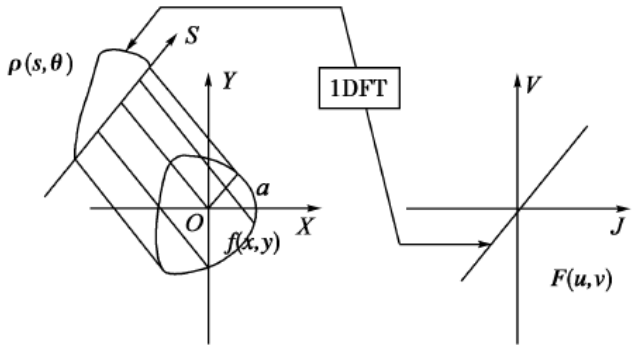

Figure 2. The schematic diagram of the central slice theorem

Algorithm Steps of FBP. Based on the central slice theorem, combined with the function of filter function, this paper adopts the filter inverse projection method to reconstruct the medium A. The steps are as follows:

Find the one-dimensional Fourier transform of receiving information.

$$S_\theta(k) = \sum_{m=-N/2}^{N/2} \rho_\theta(m) e^{-j\frac{2\pi}{N+1}mk} \tag{1}$$

In the frequency domain, the transformed set is multiplied by the filter function, and then the Fourier inverse transform is returned to the time domain.

$$Q_\theta(m) = \frac{1}{N+1} \sum_{m=-N/2}^{N/2} S_\vartheta(k) \left| \frac{k}{N+1} \right| e^{j\frac{2\pi}{N+1}mk} \tag{2}$$

sum θ to gain $\hat{f}(x,y)$,then get the original function of medium

$$\hat{f}(x,y) = \frac{\pi}{K} \sum_{i=1}^{N} Q_{\theta_i}(x\cos\theta_i + y\sin\theta_i) \tag{3}$$

Determination of the Properties of Medium

The received information in Annex 3 is introduced into the filter inverse projection method to be calculated, and the energy absorption rate of each point on the medium A is obtained,by Matlab software. Because the length of tray corresponding to 362 detector units, so the absorptivity of the medium A was 362 × 362. In order to obtain the absorption rate which we need, the existing absorption rate is required to be interpolated to form energy absorption rate curved surface.

The serial number of the detector unit is converted to the corresponding physical length, and the absorption rate of 10 typical positions which is found on the energy absorption rate curved surface, as shown in table 2:

Table 2 The absorption rate of 10 positions

(A,B)	absorption rate	(A,B)	absorption rate
$(10,18)$	0.0245	$(50,75.5)$	1.5111
$(34.5,25)$	1.0051	$(56,76.5)$	1.2831
$(43.5,33)$	-0.0190	$(65.5,37)$	-0.0097
$(45,75.5)$	1.1815	$(79.5,18)$	-0.0550
$(48.5,55.5)$	1.0505	$(98.5,43.5)$	0.0219

Analysis of the absorption rate of 10 positions in table 2, Found that the absorption rate is slightly less than zero at $(45,75.5)$, $(98.5,43.5)$ and $(79.5,18)$ three positions, which was caused by the errors in the measurement and calculation process.So we approximate regarded negatives as 0,and we can get the new absorption rate of 10 positions as shown in table 3:

Table 3 The new absorption rate of 10 positions

(A,B)	absorption rate	(A,B)	absorption rate
$(10,18)$	0.0245	$(50,75.5)$	1.5111
$(34.5,25)$	1.0051	$(56,76.5)$	1.2831
$(43.5,33)$	0	$(65.5,37)$	0
$(45,75.5)$	1.1815	$(79.5,18)$	0
$(48.5,55.5)$	1.0505	$(98.5,43.5)$	0.0219

The four vertices of the surface are retained, and the absorption rate of 256×256 is obtained by selecting 254 equidistant points from each edge to discretize the curved surface . Taking the vertex of the lower left corner of the pallet as the origin, the medium absorption rate of 256×256 is drawn, and the reconstructed image of the medium is obtained. As shown in Fig. 3, We can determine the geometric shape of A medium and its position in the tray.

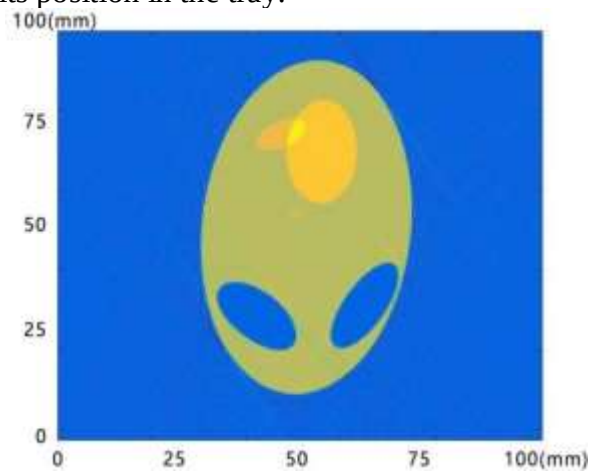

Figure 3. reconstruction image of the medium

Summary

Based on the data of CT system,this papaer establishes a Filted Back - the Projection model to get the absorption rate of positions which we need.And in the process of modeling,we introduced some definition such as eliminate the asteroid trace and the central slice theorem.In addition, we also use Matlab to calculate the result and draw the picture of medium.

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