The overview of tomographic algorithms used in medical imaging equipments

Huynh Luong Nghia[1], Tran Anh Quang[1]

[1] Le Quy Don Technical University /Biomedical electronic Department -100 Hoang Quoc Viet, Hanoi, Vietnam

Abstract— **The article presents the overview study of computerized tomographic algorithms. They include all of physical principles, mathematical methods and technical means used for defining the parameters of internal structures of different objects without breaking the whole of them when is measured.**

Keywords— **Tomography, computed tomography, algorithm, back projection, absorption coefficient.**

I. INTRODUCTION

Nowadays, medical imaging equipment is more and more broadly used because they bring many benefits in diagnosis and therapeutic. These devices are based on three fundamental factors:

a/ Physical inventions as X-ray, nuclear magnetic resonance phenomenon, ultrasound wave, radioactivity….

b/ The development of hi-technologies such as specialized high-speed computers, high quality sensors, and semiconductors….

c/ Tomographic algorithms

To determine structure parameters of the body, the last one will be affected by following physical fields:

1. Roentgen rays (gamma ray, X-ray): The basic parameter measured is here the intensity of X-rays before and after they go through the body. The main structure parameter of the body is the density distribution of tissues in volume.
2. Radioactive rays: radiopharmaceuticals that have short decay half-life time, are entered into the body by injection or through the digestive system. The temporal distribution of the radiopharmaceuticals in body is a main structure factor. It's measured from the intensity of gamma rays that are released from the body. Also the gamma absorption rate of tissues in volume is defined too.
3. Electromagnetic field: This kind of affection is used in computed tomography (MRI) in the form of nuclear magnetic resonance signal.
4. Ultrasound wave: Essentially the density distribution of tissues in volume is here defined. However, this technique also allows to solve other parameters such as the rate of blood flow distribution in vessels…
5. Other physical fields: laser, light, electric field, magnetic field…

After applying physical fields on the bio-object and using proper sensors in order to receive signals responded, the most important thing remains to do is employing proper tomograpic algorithm to reconstruct the object relying on received signals.

II. THE TOMOGRAPHIC ALGORITHMS

In accordance with each kind of above stated physical fields, medical imaging equipments are divided to following types:

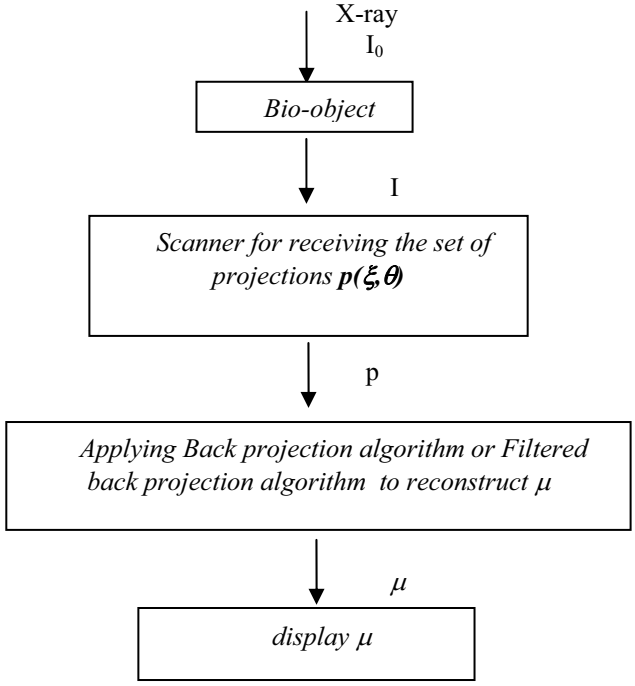

Figure 1. The diagram of Roentgen computed tomography algorithm

1 Roentgen computed tomography (CT-scanner)

2 Radioactive computed tomography (SPECT and PET)

3 Magnetic resonance imaging (MRI)

4 Ultrasound computed tomography (Ultrasound scanner)

5 The devices operating on the principle of computed tomography

A. Roentgen computed tomography algorithm

When the body is radiated by Roentgen rays, these rays will be partly absorbed by tissues in the body. This property is defined by a attenuation coefficient μ. Received rays form a set of projections $p(\xi,\theta)$ that are used to reconstruct the internal structure of the body. Therefore, the basic problem of Roentgen computed tomography is to represent the linear absorption coefficient $\mu(x,y)$ through a set of projections $p(\xi,\theta)$ (The diagram of Roentgen computed tomography algorithm is indicated in Figure 1). This is also the basic problem of all types of computed tomography.

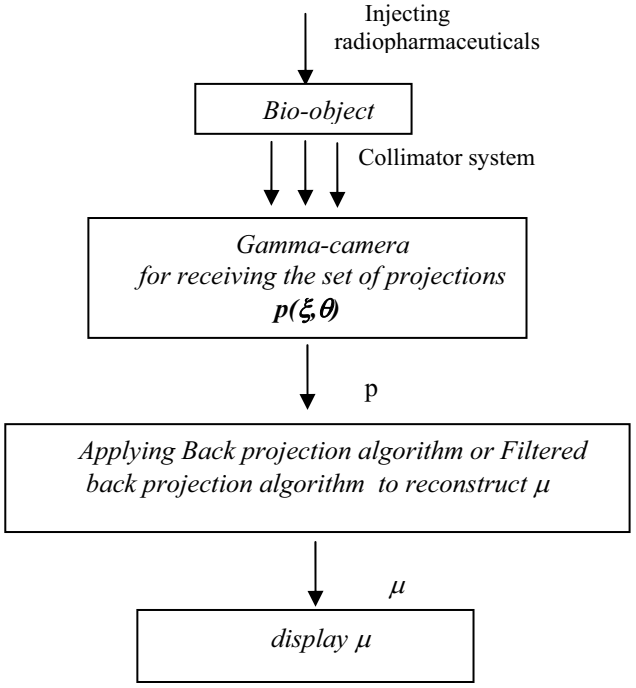

Figure 2. The diagram of Radioactive computed tomography algorithm

B. Radioactive computed tomography algorithm.

In radioactive computed tomography, radio-active isotopes are injected into the body, then gamma sensors are used to receive the intensity of released radioactive rays. Cylinder and cone collimators are used to determine the absorption coefficient and the distribution of radioactive isotopes intensity in the body. Currently there are two types of typical radioactive computed tomography: Single photon emission tomography (SPECT) and Pozitron emission tomography (PET). The diagram of radioactive computed tomography is represented as in figure 2:

C. Nuclear magnetic resonance imaging algorithm

In magnetic resonance imaging (MRI), nuclear magnetic resonance (NMR) is stimulated in tissues of the body. Then, the radiosignals released from these tissues will be received by RF coil giving information of tissue distribution. The diagram of nuclear magnetic resonance imaging algorithm is represented as:

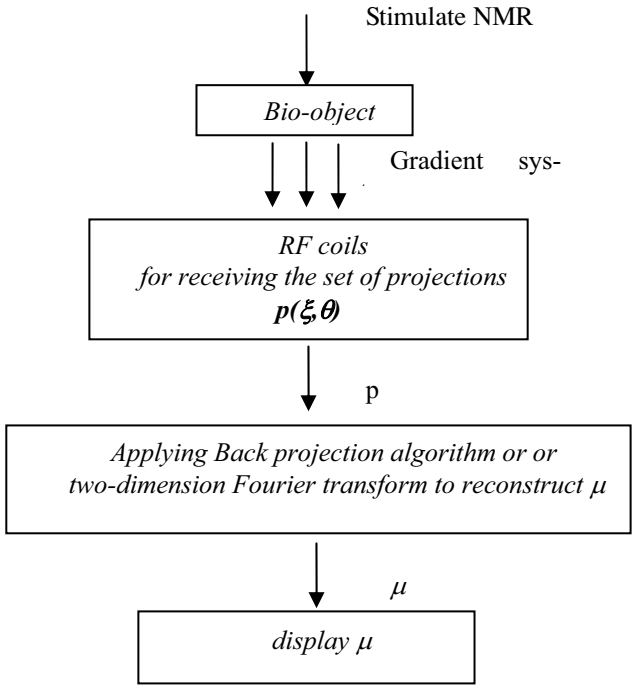

Figure 3. The diagram of nuclear magnetic resonance imaging algorithm

D. ULTRASOUND COMPUTED TOMOGRAPHY ALGORITHM

In Ultrasound computed tomography, the interaction between ultrasound wave and the body is used to determine the distribution of sound velocity c and the tissue density p. Ultrasound signals are stimulated and received by piezoelectric transducers. Received data is also processed by

above mentioned algorithms, i.e by applying Fourier transform algorithm in order to reconstruct internal structures of the body as indicated in the following diagram:

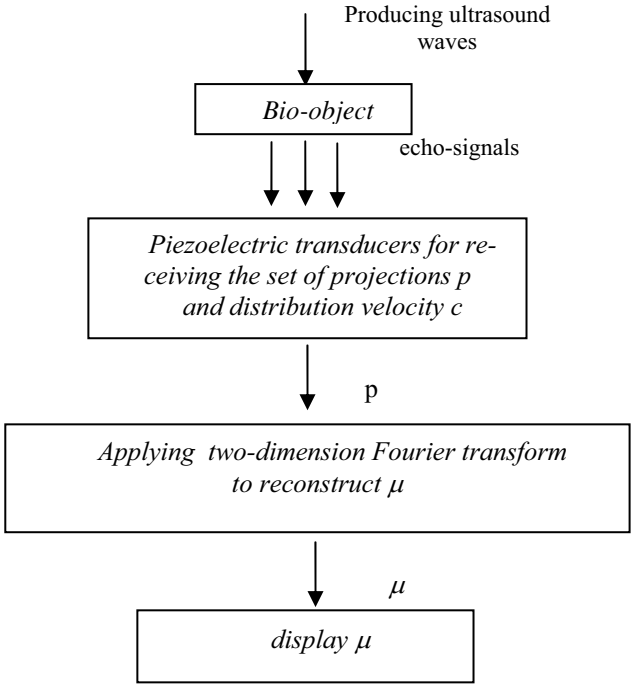

Figure 4. The diagram of Ultrasound computed tomography algorithm

E. .The devices operating on the principle of computed tomography

Nowadays, there have been many diagnostic and therapeutic-oriented devices that are very effective such as optical-laser scanner, near-infrared spectroscopy NIS, diagnostic and therapeutic-oriented devices DDFAO/ESG…In these devices computed tomography algorithms are applied in different aspects depending on the structural or functional diagnostic aim of the device.

III. CONCLUSIONS

This article has presented the overview of basic algorithms of currently computed tomography. While each type of the specific computed tomography algorithm is shown, the article find out their common base. It is *Applying Back projection algorithm or Fourier transform to reconstruct μ* after receiving the set of projections (raw data) by different ways. This allows constructing mathematical moderns and simulating algorithms in order to design and manufacture all types of medical imaging devices.

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