SCIENCE AND INNOVATION
INTERNATIONAL SCIENTIFIC JOURNAL VOLUME 3 ISSUE 6 JUNE 2024
ISSN: 2181-3337 | SCIENTISTS.UZ

EFFECTIVE METHODS OF RESTORATION FROM THE SHADOW OF THE IMAGE

Khatamov O.Y.
2[st] year PhD student of Samarkand State University named after Sharof Rashidov
https://doi.org/10.5281/zenodo.11659799

Abstract. *In this paper, we address the problem of improving image reconstruction methods for forming a real image from the projections of one image, which is relevant to X-ray computed tomography (CT) imaging. Improving medical signals, i.e. images, is a complex process and is still the most widely studied, and today it is one of the main areas of digital image processing and improvement in medicine. Also, in this article, the problem of image restoration is studied by analyzing the projections of different degrees on the image, and the problem of image formation and restoration by X-ray computed tomography is solved. It has been seen that by sending light from different angles we can re-project the image and create a 3D volume, and that repeating this process through many angles and adding back projections can bring the texture of the image in question into a 3D image.*

Keywords*: computer tomography, X-ray, back projection, reconstructed image, single object, picture, shadow, trajectory, digital image.*

Introduction

Nowadays, the problem of increasing the clarity coefficient of files and images and restoring images is simple in principle, and it can be explained in a qualitatively simple, intuitive way without using mathematical equations. First, let's look at Figure 1-(a) to understand the essence of the image. To physically approach the following explanation of a single object on a single background, let's assume that this image is a cross-section of a 3-dimensional region of the human body. the same but with higher X-ray absorption properties.

Suppose we then pass a thin, flat beam of X-rays from left to right (through the image plane) as shown in Figure 1(b) and assume that the energy of the beam is absorbed by the object. Using a line of X-ray absorption detectors on the other side of the normal imaged background provides a signal (absorption profile) whose amplitude (intensity) is proportional to absorption. We can treat any signal point in the image as a summation. Absorption values along a single beam in a beam spatially corresponding to this point (such a summation is often called a raysum). At this point we see that all the information we have about the object is the one-dimensional absorption signal [1].

In order to improve the quality of the resulting image, and since there is no way to determine whether we are working with a single object through a single projection or with many objects along the beam path, we can perform the reconstruction only by creating an image based on this information. we present that the problem can be solved.

This approach is implemented by projecting a one-dimensional signal to and from the incident side, as shown in Figure 1(c). The purpose of this is to create a two-dimensional image. The process of back-projecting a one-dimensional signal onto a two-dimensional field is sometimes called field-overlaying [2].

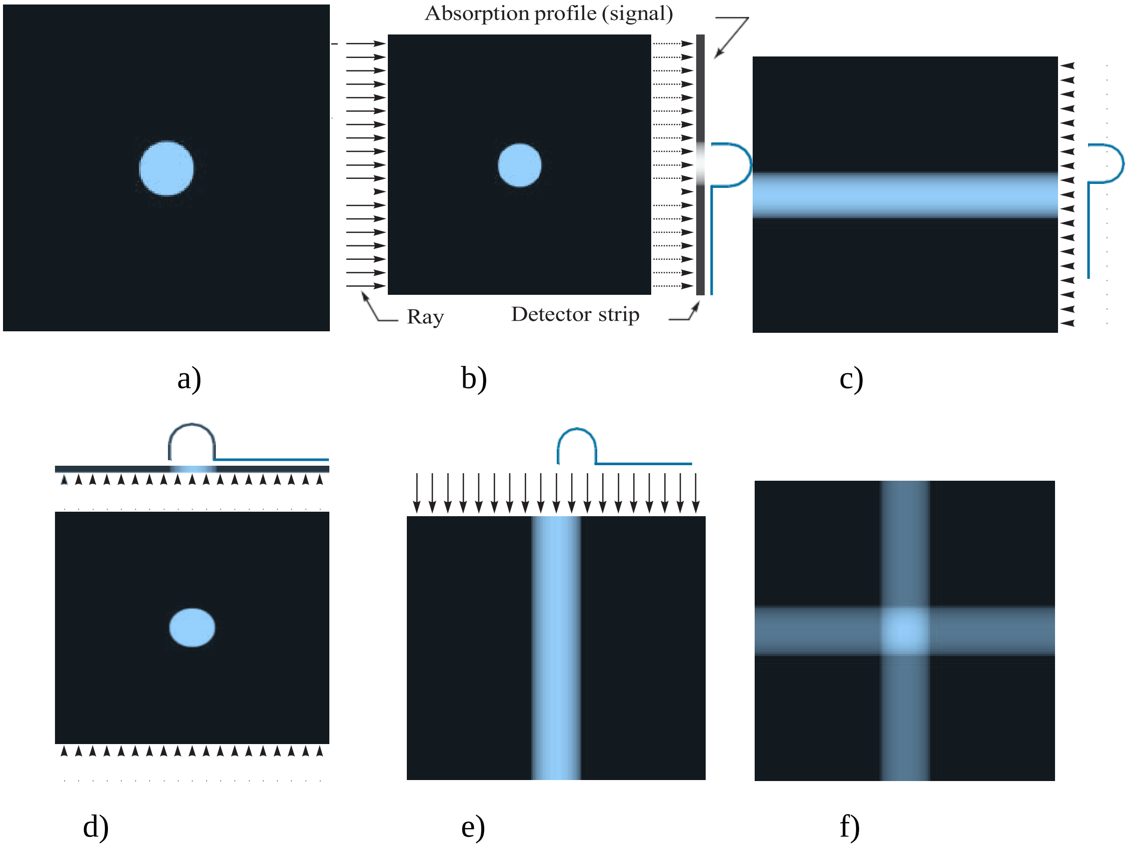


Fig 1. a) flat field with one object, b) parallel beam, detector line and one-dimensional absorbance signal profile, c) reverse projection of the absorption profile, d) beam with an angle of 90 °, e) projection for the background, f) sum of sharpness of images (c) and (e).

The intensity and clarity at the intersection of the background projections appears to be twice the intensity of the individual background projections.

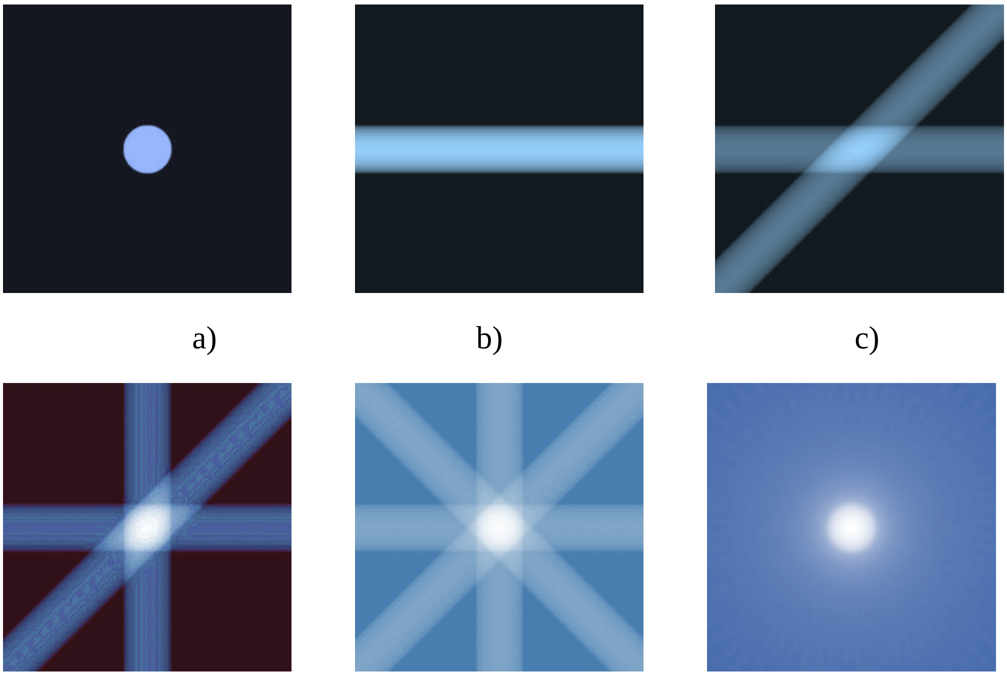
Due to the capabilities of digital images, the same one-dimensional signal is reproduced across this image perpendicular to the direction of the beam. For example, Figure 1(c) is generated by multiplying the one-dimensional signal in all columns of the reconstructed image. As you can see, the approach described above is called back projection because it is possible to look from the back.

To continue the study, let us assume that we rotate the position of the source-detector pair by 90°, as in Fig. 1(d). Repeating the procedure explained in the first part of the study allows obtaining a back projection image in the vertical direction, as shown in Figure 1(e).

We continue to reconstruct the image by adding this result to the previous back projection, resulting in Figure 1(f). Now we begin to suspect that the object we are looking for is located in the region of the indicated field, because its amplitude is twice the brightness amplitude of the individual back projections due to the addition of signals.

As shown in Figure 2, we can obtain more information about the shape of the object in question by using more of the method described above.

By increasing the number of shadows created by the beam, that is, the number of projections, the amplitude power of the non-intersecting back projections decreases compared to the intensity power of the regions where several back projections intersect.



a) b) c)

d) e) f)

Figure 2. (a) Case of Figure 1- (a), b)-c)-d)-e) reconstruction using one to four back shadows at 45° intervals, f) reconstruction with 32 back projections at 5.625° intervals.

The net effect is that the resulting brighter areas dominate, and back projections with little or no intersection fade into the background when scaled to display the image. Figure 2(f), constructed from 32 reverse projections, illustrates this concept and can be seen to blur its image.

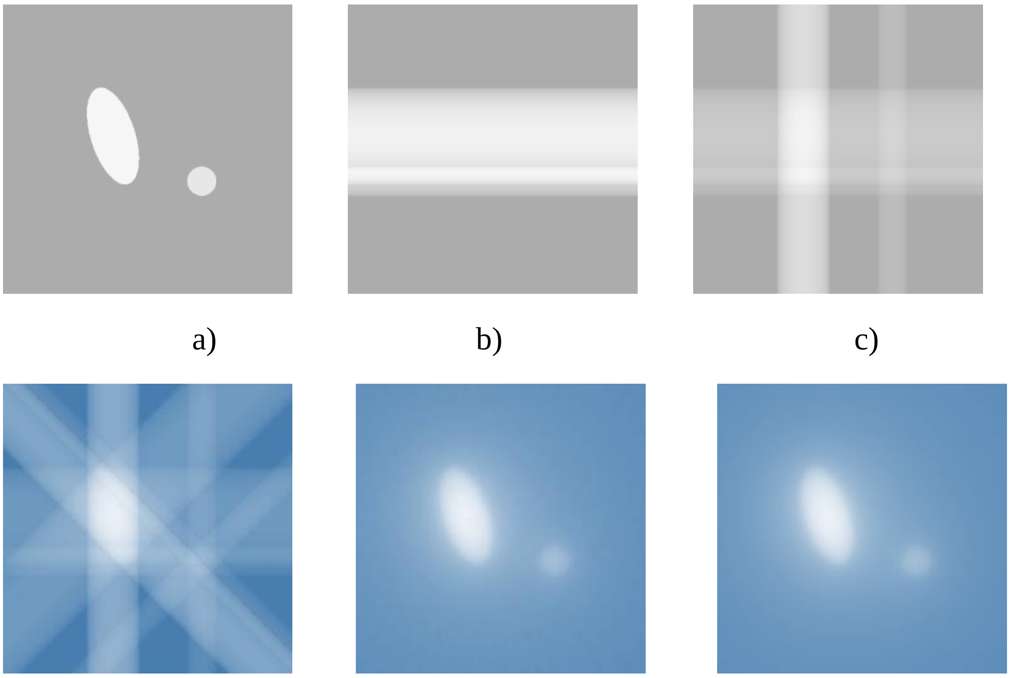
It is worth noting that although this reconstructed image closely approximates the shape of the original object, it can be seen that the resulting image is blurred by a "halo" effect, the formation of which can be seen in the progressive processes in Figure 2. For example, the halo in Fig. 2-e) appears as a "star", whose intensity is lower than that of the object, but clearly higher than the background [3].

As the number of views increases, the shape of the halo becomes circular, as in Fig. 2f). Blurring is an important issue in CT recovery and reconstruction, and its solution is considered. As a result, we conclude from the discussion of forms. Figures 1 and 2 are images of back projections that are 180° apart, so to create all the back projections needed for reconstruction, it is necessary to consider only the angular increase in half of the circle.

The advent and development of principles of x-ray computed tomography

Also, as with the Fourier transform for images, digital computer-based processing of the basic mathematical concepts required for CT began many years ago. CT was first developed as a theory in 1917 and was originally developed by Johann Radonga as a method of projecting a partially 2D object along parallel rays onto line integrals.

Forty-five years later, Allan Cormack, a physicist at Tufts University, partially "rediscovered" these concepts and applied them to CT as an early scientist, and his results meant that cross-sectional images of the body could be reconstructed from X-ray images taken at different angles. showed how it can be used for recovery.



a) b) c)

d) e) f)

Fig 3. a) Two areas with different absorption properties. b)–c)–d) reconstruction using 1, 2 and 4 back projections each shifted by 45°, e) reconstruction with 32 back projections each shifted by 5.625°, f) 2 each Reconstruction with 64 back projections varying by 8125°.

A CT prototype was created to demonstrate the practicality of his ideas, giving him the mathematical formulas needed for reconstruction. Engineer scientist Godfrey N. Hounsfield and his colleagues from London developed a similar solution and built the first medical CT machine [4]. Cormack and Hounsfield were awarded the Nobel Prize in Medicine in 1979 for their contributions to the medical use of tomography.

Discussion

The most effective method for obtaining a 3-dimensional image of the internal structure of an object is X-ray computed tomography, the purpose of which is an image formed by X-rays of the object from different directions. The sensitizing plate is intended to increase the object's X-ray sensitivity and efficiency, and imagines a conventional chest X-ray obtained by "sharpening" a person with cone-shaped X-rays. After that, the X-ray plate forms an image whose light intensity at a point is proportional to the energy of the X-ray rays that will affect this point after passing through the object, that is, the human body, which serves to increase the reliability of the image. and this picture is what we call the 2-dimensional equivalent of the projections discussed above. We will then show that this image can be reprojected and a 3D volume created. Repeating this process through multiple angles and adding back projections while emitting rays from different sides results in a 3D image of the breast cavity structure [5]. Computed tomography allows you to try to get the same information (or localized parts of it) by creating slices from the body. Then, by assembling the pieces, we are able to create a 3D image. reliable and rapid acquisition of information, and economically, it is more cost-effective to implement CT, since the number of detectors required to obtain a high-resolution slice is the foundation for creating a full 2-D projection of the same size it should be noted that it is much smaller than the number of detectors.

hence, the computational burden and X-ray doses are similarly reduced, making one-dimensional projection CT a more practical approach [6].

The entire resulting image can be re-projected and a 3D volume created. By repeating this process through multiple angles and adding back projections, the image is enhanced, resulting in a 3D image of the breast cavity structure. Computed tomography (CT) approaches obtain the same information (or local parts of it) by creating slices of the area of the body that a person is looking at. Then a 3D image can be obtained by collecting parts of the area under consideration. The implementation of CT is much more economical, since the number of detectors required to obtain a high-resolution slice is known to be much smaller than the number of detectors required to develop a projection based on full-scale shadows of the same size. ladi Increasing image resolution and reconstruction reduces the computational burden and correspondingly lower X-ray doses, making 1-D projection CT a more practical new approach.

Development of the Computed tomography image enhancement sequence

The development of a CT image enhancement sequence, in turn, includes several steps, and we write this sequence as follows:

First-stage CT scanners use a "pencil" X-ray beam and a single detector, as shown in Figure 3a). As a source for a given turning angle, the pair of detectors is gradually restored along the indicated linear direction [7]. As in Figure 1, the shadow and projection are generated by measuring the output of the detector at each increment of the translation. After a complete linear translation, the source/detector assembly is rotated and the procedure is repeated to create another projection at a different angle [8]. To generate a complete set of projection images, the procedure is repeated for all desired angles in the range [0°, 180°], from which one final cross-sectional image (slice through the 3-D object) is obtained. in the previous chapter [9].

Second-stage CT scanners work on the same principle as first-stage scanners in Figure 1b), but the beam used is in the form of a shadow. This allows the use of multiple detectors, thus requiring less reconstruction of the detector pair as a source.

The third stage. At this stage, scanners are significantly improved compared to the previous two generations of CT geometry. As can be seen in Figure 3c), the scanners at this stage use detector arrays with a length of 1000 individual detectors sufficient to cover the entire field of view of the beam in the wider case. Thus, each increment of the angle creates a whole projection, eliminating the need to regenerate the source-detector pair, as in the scans of the first and second stages.

Stage 4 scanning goes one step further, where only the source loop is created using a circular loop of emitters for 5000 individual detectors. The main advantage of stage 3 and stage 4 scanners is speed, and their main disadvantages are cost and bulk. is X-ray scattering. Secondly, the relative difference between the first and second stages is that higher doses of X-rays than scanners are used to achieve similar signal-to-noise characteristics.

The fifth stage. At this stage, new methods of scanning began to be used. For example, CT scanners, also known as electron beam computed tomography (EBCT) scanners, have eliminated all mechanical motion by using electromagnetically guided electron beams. By limiting the tungsten anodes surrounding the patient, these beams form X-rays, which then pass through the patient and become background light that excites a ring of detectors, as in stage four scanners.

The sixth stage. The traditional way of obtaining CT images is that it is important to keep the patient in a stationary position during the scan required to create a single image, so the scan is stopped when the position of the patient, that is, the pose, is increased in a direction perpendicular to the image plane using a motorized table. Then the last image is taken and the process is repeated again for the number of increments needed to cover a certain part of the body. Although the image can be acquired in less than a second, procedures that require the patient to hold their breath during image acquisition exist in the case of abdominal and chest scans [10]. Performing these procedures for, say, 40 images may take several minutes. An increasingly used approach is spiral CT, sometimes referred to as the sixth process or sixth generation CT. The basic approach to this stage is that it can be seen that third or fourth stage scanners are configured using slip rings, which eliminate the need for electrical and signal cables between the source/detectors and the processing unit. The source/detector pair is then continuously rotated through 360° while the patient moves at a constant speed along an axis perpendicular to the scan. The result is a continuous spiral volume of data that is then processed to obtain individual slice images.

The seventh stage. These stage scanners are also called multislice CT scanners, which use "thick" background beams in conjunction with parallel banks of detectors to simultaneously collect volumetric CT data. That is, 3-D cross-sectional "slabs" are generated in the X-ray burst rather than single cross-sectional images. In addition to significantly increasing detail, this approach has the advantage of more economical use of X-ray tubes, thus reducing costs and dose.

In the following discussion, we develop the mathematical tools necessary for formulating image projection and reconstruction algorithms. Our focus is on the image- processing fundamentals that underpin all the CT approaches just discussed. Information regarding the mechanical and source/detector characteristics of CT systems is provided in the references cited at the end of the chapter.

Results

It is worth noting that G(v, u) uses the one-dimensional Fourier transform of g(r, u), which is the only projection taken at a fixed angle. The full, back-projected image f (x, y) means that:

1. Computes the one-dimensional Fourier transform of each projection.

2. All one-dimensional Fourier transforms are multiplied by the filter transfer function v multiplied by the matching window as explained above.

3. The inverse Fourier transform of each filtered result is obtained.

4. The sum of all 1-dimensional inversions in step 3 is integrated.

Because a filter function is used, this approach to image reconstruction is appropriately called filtered back projection. In practice, the data is discrete, so all frequency domain calculations are performed using a one-dimensional FFT algorithm, and filtering is performed using the same basic procedure for two-dimensional functions. Alternatively, later shows that filtering can be performed in the spatial domain using convolution.

Conclusion

In conclusion, the results of image reconstruction based on shadows and projections in this study show that image degradation can be modeled as a linear, position-invariant process, followed by additional noise unrelated to the image values. based on the assumption that it can be Although these assumptions are not entirely valid, useful results can often be obtained using methods developed in previous studies. Our research, based on image reconstruction from projections, although introductory, is fundamental to the image processing aspects of this field. As mentioned in the introduction to the study, computed tomography (CT) is the main field of application for image reconstruction from projections. Although we focused on X-ray tomography, the principles established in the study are effectively applied to ultrasound examinations based on other CT imaging methods, such as single photon emission tomography, positron emission tomography, magnetic resonance imaging, and some methods.

Currently, we do not know how clear and bright CT images can be used commercially for disease analysis and diagnosis, and for reliable decision making. Today, we believe that the digitalization of medical images is more useful and efficient than the previous X-ray images, and it is very true that the disease can be quickly diagnosed and treated effectively. We base this on the promising proof-of-concept we have seen and future improvements in algorithms for digitizing CT images and bioinformatics.

REFERENCES

1. Xintao, D., Yonglong, L., Liping, S., and Fulong, C. [2014]. “Color Balloon Snakes for Face Segmentation,” Int’l J. for Light and Electron Optics, vol. 126, no. 11, pp. 2538–2542.
2. Feng, J., Cao, Z, and Pi, Y. [2013]. “Multiphase SAR Image Segmentation With Statistical-Model-Based Active Contours,” IEEE Trans. Geoscience and Remote Sensing, vol. 51, no. 7, pp. 4190 – 4199.
3. Thurley, J. M. and Danell, V. [2012]. “Fast Morphological Image Processing Open-Source Extensions for GPU Processing With CUDA,” IEEE J. Selected Topics in Signal Processing, vol. 6, no. 7, pp. 849–855.
4. Kaushik Roy, K., Bhattacharya, P., and Suen, C. Y. [2012]. “Iris Segmentation Using Game Theory,” Signal, Image and Video Processing, vol. 6, no. 2, pp. 301–315.
5. Krizhevsky, A., Sutskever, I., and Hinton, G. E. [2012]. “ImageNet Classification with Deep Convolutional Neural Networks,” Advances in Neural Information Processing Systems 25, NIPS 2012, pp. 1097–1105.
6. Beyerer, J., Puente Leon, F. and Frese, C. [2016]. Machine Vision—Automated Visual Inspection: Theory, Practice, and Applications, Springer-Verlag, Berlin, Germa New York.
7. Yu, H., Barriga, E.S., Agurto, C., Echegaray, S., Pattichis, M.S., Bauman, W., and Soliz, P. [2012]. “Fast Localization and Segmentation of Optic Disk in Retinal Images Using Directional Matched Filtering and Level Sets,” IEEE Trans. Information Tech and Biomedicine, vol. 16, no. 4, pp. 644 – 657.
8. Zhang, Q. and Skjetne, R. [2015]. “Image Processing for Identification of Sea-Ice Floe Size Distribution,” IEEE Trans. Geoscience and Remote Sensing, vol. 53, no. 5, pp. 2913–2924.
9. Hochbaum, D. [2010], “Polynomial Time Algorithms for Ratio Regions and a Variant of Normalized Cut” IEEE Trans. Pattern Anal. and Machine Intell. vol. 32, no. 5, pp. 889–898.
10. Nielsen, M. A. [2015]. Neural Networks and Deep Learning, Determination Press. (Only available online at http://neuralnetworksanddeeplearning.com/index.html.)