Tomographic system for transparent objects using visible light as a source of radiation

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Abstract - In this paper we present a tomography system for transparent objects using visible light radiation sources. Transparent objects are used so that visible light can penetrate objects. Objects are rotated by moving angle of 2 ° per step to get a full rotation or 360 °. Each object moves by 2 ° then the detector will capture images that have been irradiated by visible light and obtain an original image of 180 images. Of the 180 images, a cross-sectional sinogram image is made in the center of the object. The synogram is then reconstructed using the backprojection method to produce tomographic images. The results of this research are a tomographic system consisting of light sources, cameras and reconstruction software. This system succeeded in making a tomographic image in the form of a cross-sectional image from a glass bottle.

1. Introduction
Tomography is a method of imaging the inside of an object. Imaging data is obtained from the total value of transmission, emission or reflection by objects from various angular projection directions obtained from a series of pairs between sources and detectors [1-3]. This imaging data is called a synogram. A synogram consists of a set of projection data wherein a projection data consists of a series of raysum. Raysum is a counted data value generated by a pair of sources and detectors. From the synogram, the image can be reconstructed by iteration or reverse projection methods [4-5]. Computer tomography developed rapidly with the development of image processing [6-7].

In its development, the tomography system can be applied in the field of medicine and industry, in the medical field, namely tomography is used to detect abnormalities or as a disease diagnostic tool in the human body [8]. In the industrial field, tomography is used for object detection and identification which is often referred to as non-destructive testing [9-10]. Examples of the modes of tomography technology that have been developed in the medical world are of various kinds, namely CT scan (nuclear radiation), MRI (ultra-high magnetic field), PET (nuclear particle radiation), ultrasonography (ultrasonic) and many more. Because of the many benefits of computer tomography, then computer tomography has been studied and developed throughout the world, including in Indonesia.

X-ray radiation to the human body is very dangerous, it can cause decreased production of blood cells, decreased sperm production and infertility, digestive disorders of the small intestine, cause infection and irritation of the skin, have a bad impact on the eyes, cause pneumonitis and lung disorders. Although the dose of X-ray radiation can be reduced by reducing the number of projected irradiation and applying an interpolation algorithm [11-15], X-rays are still dangerous. With the various side effects of frequent exposure to X-rays and the importance of studying them, another source of radiation is needed to be able to study tomography which is safer if the body is exposed to radiation, namely visible...
light. By utilizing visible light and using the basic principles of a CT scanner, we can study tomography more deeply.

2. Methods
In principle, the tomography system consists of two parts, namely the scanning and reconstruction process. The scanning process produces a synogram and the reconstruction process produces a tomography image. Sinogram is an arrangement of object projections at all angles of the irradiation. From the synogram obtained, a reconstruction process which is the inverse of the Radon transformation can be carried out. Radon transformation is a direct approach to the problem of image projection and reconstruction because the Radon transformation represents an image as a collection of one-dimensional signals from the projection of the image at various orientation angles. The reconstruction process produces a cross-sectional image of the object.

The system consists of a computer set, a Logitech C 270 camera, 28BYJ-48 stepper motor, ULN2003 driver, white screen, 18W downlight lamp, Arduino microcontroller and object table. The microcontroller functions to control the stepper motor which is assisted by the driver so that it can move according to the desired angle, the webcam camera functions for image capture. Downlights as a source of radiation. The object used in this research is clear perfume bottle. The perfume bottle tube serves as an object for the scanning process.

The device settings of the computer tomography system can be seen in Figure 1. In this image, you can see a box where objects and detectors are placed, number 2 is the object and number 3 is the webcam as a detector, number 4 is the object table connected to the stepper motor, number 1 is a source of radiation, namely the 18W downlight, and number 5 is a computer.

![Figure 1. The device settings](image)

The image capture process is carried out when the tools are connected to each other, namely the downlight lamp has been connected to a voltage source, the stepper motor is connected to the driver and the microcomputer that has been placed on the object table, namely the clear perfume bottle. After it is confirmed that the device used can work optimally, the next process can be carried out, namely data collection. Data retrieval can be done by connecting the hardware with the computer, the hardware connected to the computer will be by the computer so that the hardware can work in accordance with the desired process, namely getting images per 2 ° in three hundred and sixty degrees so that the image obtained is 180 images.

3. Results and discussion
Scanning performed on an object in the form of a perfume bottle can be seen in figure 2. This figure provides several examples of the selected slice, the resulting synogram, and the reconstruction results of the slice.
The reconstruction results show that the original image or phantom is a combination of solid objects that do not penetrate light and objects that can penetrate light or are transparent. Shown in the picture, the first column is the slice selected from the object in the form of a perfume bottle, the second column is a synogram which will later be reconstructed a cross section (third column). Reconstruction results when visible light does not penetrate the light is shown otol. In the third and fourth rows, the reconstructed image shows a circle with different thicknesses. In the fourth row, the circles are thicker because they are almost closer to the bottom of the bottle. If you look more closely, the reconstructed image in the third and fourth rows, in the middle of the circle there is a black dot. The nipple is a small tube used to spray perfume.

4. Conclusion
From the research results, it can be concluded that tomography can be done using a light source with a transparent object. The computed tomography system can produce a synogram which, if reconstructed, can produce a cross-sectional image. The tomography system that is built can be used for learning the CT scanner system using the Radon transformation and the inverse Radon transformation using simple equipment and using transparent objects. To get maximum results, a gear rotation is needed so that the rotation of the object is more precise and does not experience major shocks, and uses a camera that has a high resolution so that the reconstruction results obtained are clearer.

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