Tuberculosis Segmentation Based on X-ray Images

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ABSTRACT
Tuberculosis or TB is an infectious disease caused by the bacteria Mycobacterium tuberculosis. This disease usually attacks the lungs, but can also affect other organs such as the kidneys, bones and brain. TB is highly contagious, and can spread through the air when someone who is infected coughs or sneezes. Risk factors that can increase a person’s chances of developing TB include a weak immune system, such as people with AIDS, diabetes, or people taking immunosuppressant drugs. And people who live or work in environments with high rates of TB transmission are also at risk of infection. Symptoms of TB are usually a cough that lasts more than three weeks, unexplained weight loss, fever, night sweats and persistent fatigue. In more severe cases, TB can cause coughing up blood, chest pain and difficulty breathing. One of the examination tools that can be used to detect TB disease is X-rays. Which produces X-Rays to help and confirm the diagnosis of TB disease, to see the chest part of the body which is used as medical record documentation. In X-ray photos, random dark and light spots of noise are often found which are caused by several factors. Based on the facts above, image segmentation is an important task for doctors in diagnosing disease. Automatic detection or segmentation of lung images from chest X-ray images is the initial stage of the diagnosis process. This research aims to implement a segmentation method to determine edge detection in clearer images using several segmentation methods, namely the Canny Edge Detection method, Sobel reading chest X-ray results for tuberculosis. And canny edge detection with segmented RGB image (otsu’s thresholding) produces the highest value, namely 230,466.0 pixels and a lesion volume of 14,818.625 mm³.

1. Introduction
One of the serious health problems in the world is tuberculosis. Tuberculosis is a disease caused by the bacteria Mycobacterium tuberculosis which attacks the respiratory system, especially the lungs. This disease is highly contagious and can spread through the air when an infected person coughs, sneezes, or even talks.

According to data from the World Health Organization (WHO), in 2020 it is estimated that there will be around 10 million deaths out of 8,005,176,000 people [1], which are related to tuberculosis throughout the world every year. This disease is also the number one cause of death in the world, with around 1.5 million people dying from TB every year.

Although it is a global problem, tuberculosis is usually more common in developing countries, especially in low and middle income countries [2], [3]. Risk factors that contribute to the spread of this disease include poor socio-economic conditions, limited access to health care, and low levels of awareness and education about TB disease. During the course of infection, various features of pulmonary disease lesions may appear simultaneously in the same host [4].

Tuberculosis can attack the respiratory system and cause symptoms such as cough with phlegm, fever, weight loss, fatigue and chest pain. If left untreated, this disease can become severe and spread to other organs such as the kidneys, bones or brain.
To overcome this tuberculosis problem, WHO and its member countries have taken various preventive and treatment steps. This includes efforts to increase awareness about TB disease, expand access to treatment services, and develop new medicines.

However, despite efforts to control this disease, complex challenges remain. For example, increasing resistance to tuberculosis drugs, especially in the case of multidrug-resistant tuberculosis (MDR-TB), adds to the difficulties in treating and controlling the disease.

In an effort to overcome this problem, global collaboration between countries and organizations involved in treating tuberculosis is very important. Only through cooperation and shared commitment can this disease be effectively controlled and eliminated throughout the world for the sake of survival [5], [6], [7], [8].

The focus of this research is TB in the lungs. Lung disorders are quite serious disorders which can attack the human respiratory system and can be fatal if not treated seriously. This can cause sufferers to have difficulty breathing, difficulty carrying out activities, and lack of oxygen, even if not treated quickly it can cause death [9].

In the medical world, one way to identify abnormalities in the lungs is to look at images of the lungs obtained from x-rays (X-Ray).

2. Research Method

The type of research used is image segmentation, with the Sobel. The model can be used to calculate the size of lesions on lung images or other medical images. However, there are several considerations that need to be taken into account.

Lesion detection rate. This program relies on thresholding and contour search to detect lesions. The success rate of lesion detection is highly dependent on the characteristics of the medical images used. Some medical images have low contrast levels or lesion features that are difficult to identify. Lesion detection methods in medical images often require more sophisticated approaches, such as the use of deep learning or segmentation algorithms and image resolution measures. The canny edge detection model obtains the highest lesion size pixel values and is a machine learning method inspired by the structure and function of human biological neural networks in chest x-rays (X-Ray).

Where we test the model with an image like the one below which we previously filtered using color image processing techniques, separated the color channels, removed noise, and produced better initial accuracy as in Figure 1.
original X-ray image, converting it to a grayscale image, normalizing it and then removing noise. The image cropping process aims to take an image without noise. The next process is edge detection, color modification, segmentation and calculating pixel resolution and lesion volume.

The use of Roberts, Prewitt, and Sobel edge detectors to diagnose various images such as images of brain tumors [10] and so on. In this study, three edge detection methods were used, namely: sobel X detection, felzenswalb, and canny edge detection. Color Modification At this stage, modifications are made to the RGB values. There are original images, grayscale images and original RGB images.

The next stage is segmentation of all images. Segmentation divides an image into a number of regions or objects. Segmentation in this research is based on the discontinuity intensity value property. The approach taken is to split or sort the image based on changes in the image edges. The purpose of segmentation is to measure resolution and carry out the process of filling in the holes in the lesion volume. This process is based on morphological reconstruction operations on binary images. Calculate the area value of the number of pixels in the region calculated with the size parameter. And calculation of lesion volume on binary images.

From testing the canny detection model with an image like the one below which we previously filtered, color image processing techniques, separated color channels, removed noise, and segmentation produced better accuracy like the image below. With an accuracy value of segmented RGB image resolution (Otsu's Thresholding) of 230466.0 pixels and an image lesion volume of 14818.625 mm$^3$ which is presented in Figure 3.

<table>
<thead>
<tr>
<th>No</th>
<th>Method</th>
<th>GrayScale Image (Pixels)</th>
<th>SRGB Image (Pixels)</th>
<th>Gray Scale Lesi (mm$^3$)</th>
<th>RBG Lesi (mm$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tanpa Noise</td>
<td>150000.0</td>
<td>173382.0</td>
<td>1345.375</td>
<td>15465.00</td>
</tr>
<tr>
<td>2</td>
<td>Sobel X</td>
<td>151956.0</td>
<td>170826.0</td>
<td>7386.750</td>
<td>8166.125</td>
</tr>
<tr>
<td>3</td>
<td>Felzenswalb</td>
<td>138750.0</td>
<td>184458.0</td>
<td>6796.750</td>
<td>8961.000</td>
</tr>
<tr>
<td>4</td>
<td>Canny Detection</td>
<td>132020.0</td>
<td>230466.0</td>
<td>9002.000</td>
<td>14818.625</td>
</tr>
</tbody>
</table>

Figure 3. Results of Testing The Canny Detection Model

The research methods used and the results are presented in Table 1.

The original X-Ray image using the chain code method with dilation operations, erosion operations, opening operations, and closing operations produces the image presented in Figure 4.

X-Ray image from canny edge detection to the chain code method with dilation operations, erosion operations, opening operations, closing operations produces the image presented in Figure 5.

Figure 4. Original X-Ray Image to Chain Code Method

Figure 5. X-Ray Image from Canny Edge Detection to Chain Code Method

3. Result and Discussion

Tuberculosis (TB) can involve several key aspects relevant to the management and understanding of the disease. Which includes the challenges of detecting TB
early, considering that the symptoms are often non-specific. Early identification allows for rapid and appropriate treatment, which is critical to achieving positive results. The use of X-ray images and segmentation techniques in the diagnostic process is well explained. The method details the use of image segmentation techniques, such as Canny, Sobel X, and Felzenszwalb edge detection, to improve the clarity of X-ray images for the diagnosis of tuberculosis. A more in-depth discussion of the advantages and limitations of each segmentation method could be provided, providing insight into their effectiveness in different scenarios. This could address strategies to improve the public's and health professionals' understanding of symptoms and early screening. The phenomenon of antibiotic resistance is a major concern in TB treatment. Discussions may involve efforts to reduce antibiotic resistance and ensure effective treatment. The role of vaccination, especially the BCG vaccine, in preventing TB. Further understanding of the effectiveness of vaccination and research related to developing new vaccines could be an important part. The relationship between TB and HIV/AIDS infection is an aspect that needs to be considered. Details strategies for treating these two diseases simultaneously and how TB control efforts can be integrated with HIV/AIDS programs. Covers the importance of research and development to identify faster diagnostic methods, more effective treatments, and better vaccines. Form the basis for strategic planning and implementation of more effective programs in treating TB globally. Effectively addresses the importance of tuberculosis diagnosis, the role of image segmentation, and the global impact of this disease. Further explanation of segmentation methods, comparison with existing techniques, and areas of future research would add depth to the discussion.

4. Conclusion

TB is an infectious disease caused by the bacteria Mycobacterium tuberculosis. This disease can attack various organs, especially the lungs, and has symptoms such as prolonged cough, weight loss, fever, night sweats, and prolonged fatigue. Some risk factors that can increase a person's chances of getting TB include a weak immune system (such as in people with AIDS, diabetes, or taking immunosuppressant drugs) and living or working in an environment with a high rate of TB transmission. X-ray is one of the examination tools used to detect TB. In this research, image segmentation was carried out to assist the diagnosis process. Segmentation methods involve edge detection using methods such as Canny Edge Detection, Sobel X, and Felzenszwalb. The segmentation method using Canny Edge Detection with segmented RGB image (Otsu's Thresholding) produces an image resolution accuracy value of 230466.0 pixels and an image lesion volume of 14818.625 mm³. Color modification is carried out at certain stages, including modification of the RGB value, grayscale image, and original RGB image. The segmentation stage involves splitting the image based on changes in the edges of the image and the aim is to measure the resolution and carry out the process of filling in the hole in the lesion volume. The results of this research can help medical personnel, especially doctors, in reading chest x-ray results for TB more effectively and accurately. Image segmentation through edge detection and color modification can facilitate the interpretation of x-ray results and support the initial diagnosis process. This research contributes to developing a segmentation method to support the TB diagnosis process through chest x-ray image analysis. That controlling TB requires a holistic approach involving various sectors, including health, education and the environment. This strategy must include early detection, effective treatment, and prevention of transmission. That investment in research and development of new drugs, vaccines and diagnostic methods is the key to overcoming TB. These efforts will help improve the effectiveness of treatment and prevention globally.

References

[1] Data World Population Review per pekan kedua februari 20