Jurnal JTIK (Jurnal Teknologi Informasi dan Komunikasi)

journal homepage: http://journal.lembagakita.org/index.php/jtik

Application of Spinal Disorders Detection on X-Ray Images Using Segmentation and K-Means Clustering

Muhammad Khairul [1*], Fauziah [2], Iskandar Fitri [3]

[1,2,3] *Informatics Study Program, Faculty of Communication and Information Technology, Universitas Nasional.*

a r t i c l e i n f o

Article history:
Received 12 August 2021
Received in revised form
3 September 2021
Accepted 2 October 2021
Available *online* July 2022

DOI:
https://doi.org/10.35870/jtik.v6i3.456

Keywords:
Spinal disorders; X-ray; Image processing; Image Segmentation; K-means Clustering.

a b s t r a c t

There are three types of spinal disorders, namely kyphosis, lordosis, and scoliosis. To find out spinal disorders, it is necessary to carry out X-rays from an early age. Spinal disorders are not only found in children but can be found in adolescents, adults, and the elderly. Along with the times, making information technology more sophisticated is the advancement of image processing technology. Image processing can help in the medical field to analyze X-ray results to diagnose internal disorders or diseases. This study makes an application for the detection of spinal disorders with several methods of image segmentation processes and using the k-means clustering algorithm on x-ray images of spinal disorders. This segmentation image processing stage requires five stages of processing including cropping, resizing, median filter, histogram equalization, thresholding, and binary edges, and k-means clustering process as a comparison. This application is expected to be useful in knowing the difference between spinal disorders of lordosis, kyphosis, and scoliosis.

Corresponding author. Email: muhammadkhairul@gmail.com [1].

1. Introduction

The function of the spine is to support the upper body and form posture. The spine is composed of several small bones from the pelvis to the cranial cavity. Normal bones have less curvature. Because it serves to suppress and help the body's movement system. The spine develops abnormally, resulting in changes in normal curvature or abnormal bone structure [1]. The term abnormalities in the bones are also known as spinal disorders. Spinal disorders include lordosis, kyphosis, and scoliosis. According to Helmi, lordosis is a bending of the spine towards the cervical lumbar curvature beyond the physiological limit [2]. According to Cinthya, Scheuermann's disease or kyphosis is a condition of the spine with back pain due to trauma or degenerative disease [3]. According to Suratun, scoliosis is a lateral spine disorder that causes an abnormal curvature of the vertebrae laterally [4].

X-rays were first discovered in 1895 by Wilhelm Conrad Roentgen and his radioactivity was recognized by Marie Curie and Henry Becquerel. X-rays are used as a tool to investigate causes and symptoms in a patient or diagnose a disease [5]. In addition, x-rays take pictures of the spine and help in finding diseases and injuries affecting the spine, joints, and discs between the bones. Spinal x-rays are most often used to diagnose problems related to the spine. Previous research designed a software system using Matlab software to process lung X-ray images [6]. Implementing local and global thresholding methods and applying the otsu, laplacian, k-means and canny methods have advantages in processing fish eye points so that they can be detected clearly [7]. Image segmentation is a field of research that has been widely carried out in recent years and almost all image analysis systems use segmentation. The Fuzzy K-Means method combined with the swarm optimization algorithm can be one example [8].

Segmentation with the k-means clustering method shows the best results in the number of clusters of 8 because at k = 8 the clustering results image shows clear color boundaries [9]. The source of the digital image will affect the results of Sobel detection, the digital image must be sourced from a binary image. The complexity of the segmented object is very decisive for the final result obtained, the simpler the object, the easier it will be to recognize and complex objects will be increasingly difficult to recognize. So it is necessary to develop using k-means [10]. The purpose of this study is to create an application system for detecting the level of curvature in abnormal spine disorders such as lordosis, kyphosis, and scoliosis. In this study, the author makes an application with Matlab software and uses several methods of image segmentation processes and uses the k-means clustering algorithm on X-ray images of spinal abnormalities. This application is expected to have benefits in knowing the differences in the spinal structure of lordosis, kyphosis, and scoliosis.

Researchers add references to sharpen the literacy of this research. Matlab (Matrix Laboratory) is a C/C++ programming language computing application developed by Math Works. Matlab functions as a programming language as well as a visualization tool, which is directly related to mathematics. The functions in the Matlab toolbox are made to facilitate calculations that can calculate matrices, plot functions, and data, create interfaces, and others. For example, Matlab can also be easily used to create image processing interfaces. Image processing,

The image is defined as a two-dimensional function f (x, y), where x and y are spatial coordinates, and the amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of the image at a point. the. Digital images consist of a certain number of elements, each element has a specific location and value. These elements are called picture elements, image elements, pels, and pixels. Pixel 14 is a term that is widely used to describe elements of a digital image. Image segmentation is a technique to separate objects from the background so that these objects can be used for other purposes. Along with the development of technology in applications that process an object such as three-dimensional object reconstruction, object recognition, writing recognition, face detection, object coding, and others, the segmentation process is becoming increasingly necessary. The results of the segmentation must also be more accurate because the inaccuracy of the segmentation results will affect the results of the next process. One method in image segmentation that is widely used is by utilizing edge detection, detecting the edge line of a part in the image because generally, the edge of a part has a pixel intensity around it.

The basis of image processing is processing RGB colors at certain positions. In image processing, color is represented by a hexadecimal value of 0x00000000 to 0x00ffffff.
R : element of red color
G : elements of green color
B : element of blue color

Data in the form of images that have been obtained through the acquisition process is still worth 24 bits because the image is an RGB image. RGB images have 24 bits because each of Red, Green, and Blue has 8 bits. At this stage, the RGB image with a value of 24 bits will be transformed to a grayscale image or an image with a grayscale. This grayscale image has a value of 8 bits, where the minimum value is 0 which is white and the maximum is 255, which is black.

The median filter works by replacing the middle value of the pixels covered by the filter area with a middle value (median) after being sorted from smallest to largest. Usually, the filter size is odd because it will provide a center axis, so it will be easier to process noise. Histogram Equalization is a method in image processing that increases the contrast of an image in general, especially when image data is represented by values that are close to contrast. Through this adjustment, the intensity of the image can be distributed better.

Besides being used to adjust the degree of gray in the image, thresholding is also used to separate the part of the image that corresponds to the object (foreground) and background (background), as well as converting image data into binary data (binary), with the aim of making the next process easier. Each image even though it contains the same object, of course, has different characteristics in its lighting properties. This makes it difficult to determine a suitable threshold value to be applied to all image conditions.

Because each image has its own threshold value, learning can be done in the form of knowledge of the properties of each image to be processed before determining the appropriate threshold value. Thus, after going through trial and error, a threshold value will be found, which is more or less suitable to be applied to all images. In general, the thresholding process for grayscale images aims to produce a binary image. Edge detection is improving the appearance of the boundaries of an area or object in the image. The first gradient operators used to detect edges in an image are the centered gradient operator, the Sobel operator, the Prewitt operator, the Roberts operator, and the Canny operator. Binary Image Binary image is an image that has only two values of gray level: black and white. The purpose of using binary images for the purposes of simple pattern recognition, number recognition, letter recognition, object recognition. To obtain optimal results, it is recommended to convert the grayscale image into a binary image, not from a color image into a binary image. This is based on the process of determining the degree of gray which takes the middle value. For an image with 256 degrees of gray, the median value is 128, so to convert it into a binary image.

K-Means Clustering an algorithm introduced by J.B. Mac Queen in 1976, is one of the general clustering algorithms that group data according to similar characteristics or shared characteristics (clusters). Data in a cluster has characteristics (or features, characteristics, attributes, properties) that are similar and not similar to data in other clusters. Stable clusters are formed when iterations or iterations of k-means do not create a new cluster as the center of the cluster or the arithmetic mean of all new clusters is the same as the old cluster. There are several techniques to determine when a stable cluster is formed or when the k-means algorithm ends. Euclidian Distance Space is used to determine the distance between the data and the center of mass of the cluster.

2. Methods

Software and Hardware
The hardware used is a laptop/PC with an Intel Core i5 CPU specification, 4GB DDR4 memory, Windows 10 Professional Operating System, NVIDIA GEFORCE 930mx VGA. The software used is Matlab R2016b with a GUI-based interface.

Application Flowchart

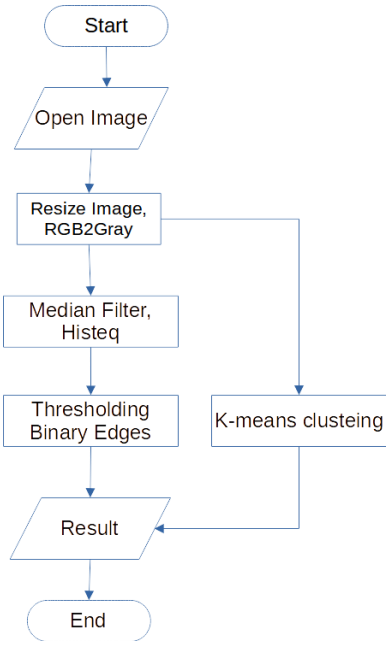


Figure 1. Application Flowchart

The program starts from:
Implementation of preprocessing includes:

1) Resezing the image to change the initial pixel value from 4020x4892 to 1530x1464 pixels. Next, change the dimensions of the image to 256x256 pixels for easy processing in Matlab. The image format is converted into jpeg to facilitate the preprocessing process.
2) Median filter to improve image from noise. Using the mask image convolution operation 3x3.
3) Histogram equalization aims to evenly distribute the intensity values in the image.
4) Thresholding aims to extract objects from the background.
5) Edge detection to get binary edges.
6) K-means clustering to see the results of the segmentation comparison

Application Development

Table 1. Tools needed

Menu Home	1 axes : for unas logo
	2 statistic text : for the title and description of the faculty
	3 pushbutton : for back, next, and cancel
Menu Aplikasi	6 axes : displaying all 6 images
	1 statistic text : for title
	2 panel : for background properties and processes
	5 pushbutton : for open image, reset, back, next, and cancel
	5 pushbutton : for preprocessing and k-means
Menu About	2 axes : for unas logo and photo
	2 statistic text : for faculty profiles and information

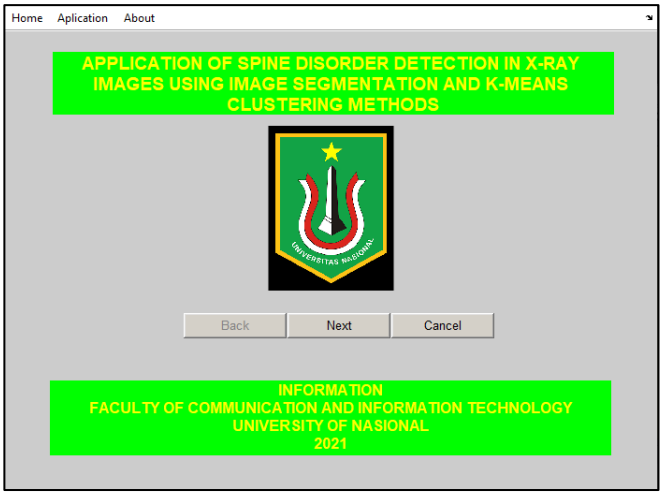


Figure 2. Home Menu Display

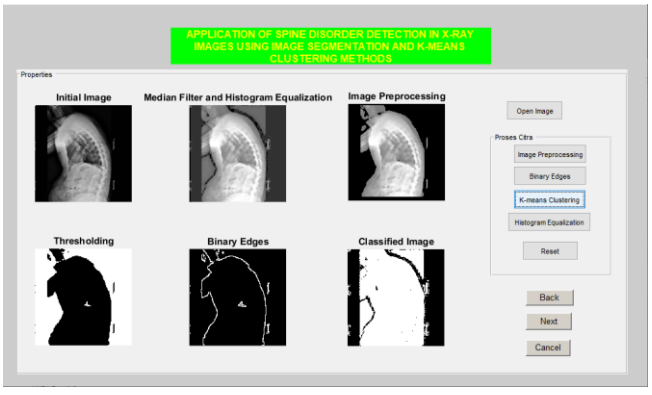


Figure 3. Application Menu Display

Figure 4. Menu About Display

3. Results and Discussion

Application Testing

At this stage, the author tests the application. Before doing the testing, the writer prepared 3 x-ray images, each of which was x-rays of the spine of lordosis, kyphosis, and scoliosis in (.jpg) format. This segmentation image processing stage requires five stages of processing including cropping, resezing, median filter, histogram equalization, thresholding, and binary edges and the k-means clustering process as a comparison.

(a)

(b)

(c)

Figure 5. Lordosis (a) Kyphosis (b) Scoliosis (c)
Source. biologyclassroom.home.blog

Image Input

The initial process is to input the image by running the home.fig file. After opening the display as below, then click next to go to the next menu file aplikasi.fig.

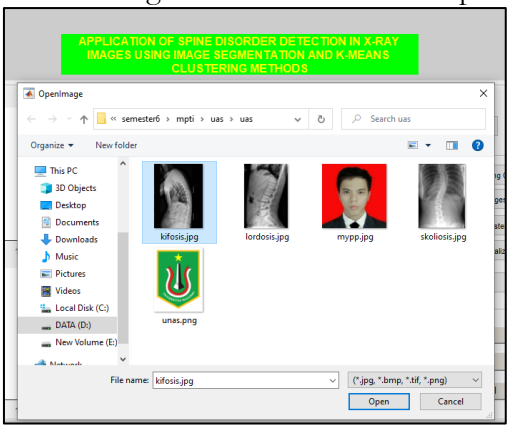


Figure 6. Open Image Display

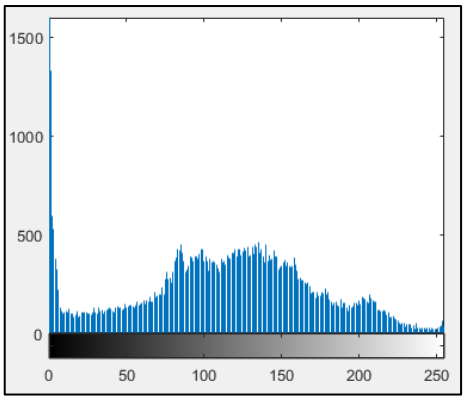
In open image, the image is changed RGB to Grayscale. After that, the image is resized to change the initial pixel value of 4020x4892 to 1530x1464 pixels. Next, change the image dimensions to 256x256 pixels for easy processing in Matlab.

Figure 7. Initial Image Display

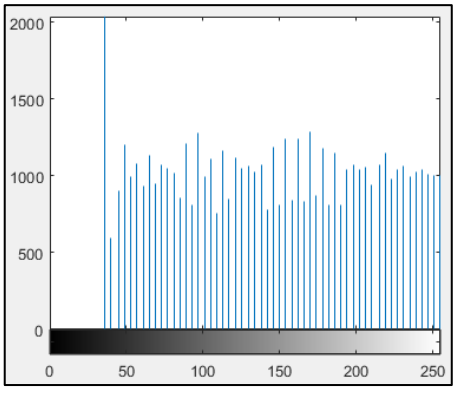
Median Filter Image and Histogram Equalization

At this stage, the resized grayscale image goes through the median filter process to improve the image from noise. Using a 3x3 mask image convolution operation and histogram equalization aims to evenly distribute the intensity values in the image.

Figure 8. Median Filter Image Display



(a)



(b)

Figure 9. Histogram of the original image (a) Histogram Equalization (b)

Image Preprocessing

At this stage image preprocessing is carried out.

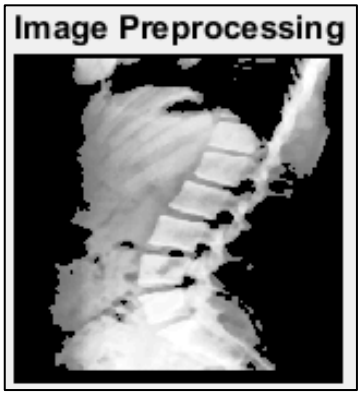


Figure 10. Image Preprocessing Display

Thresholding and Edge Detection

After going through image preprocessing, the thresholding method will be processed to extract objects from the background. Next through the edge detection process to get a binary edge.

Figure 11. Thresholding Display

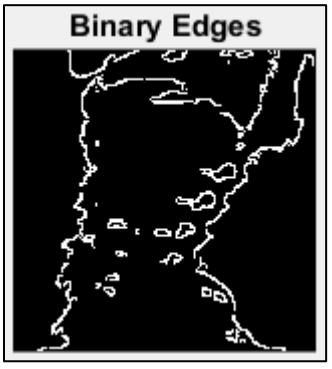


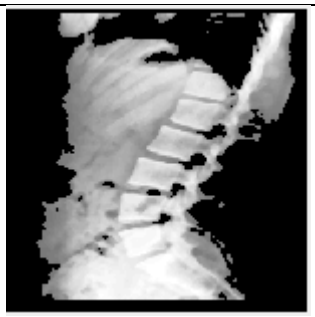
Figure 12. Binary Edges Display

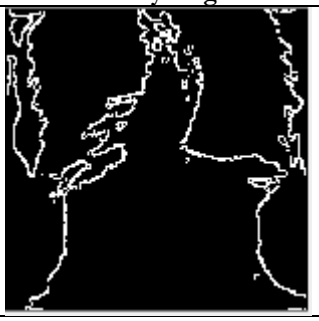
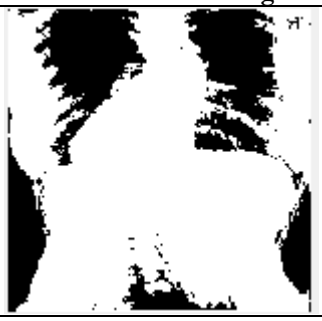
K-means Clustering Algorithm

In this process, the RGB image performs grayscale segmentation using the k-means clustering method. The k-means algorithm is used to partition two cluster regions. Select the cluster region that has the smallest area. This is done in order to obtain the region object.

Figure 13. K-means Clustering Display

Tabel 2. Processing K-means Clustering Algorithm

Note.	**Initial Image**	**Median Filter and Histogram Equalization**	**Preprocessing**
Lordosis			
Note.	**Thresholding**	**Binary Edge**	**K-means Clustering**
Lordosis			
Note.	**Initial Image**	**Median Filter and Histogram Equalization**	**Preprocessing**
Kyphosis			
Note.	**Thresholding**	**Binary Edge**	**K-means Clustering**
Kyphosis			

Note.	Initial Image	Median Filter and Histogram Equalization	Preprocessing
Scoliosis			
Note.	**Thresholding**	**Binary Edge**	**K-means Clustering**
Scoliosis			

4. Conclusion

Based on the results of the X-ray image research to see the segmentation of the spinal abnormality structure, the following conclusions can be drawn:

1) This segmentation image processing stage requires five stages of processing including cropping, resezing, median filter, histogram equalization, thresholding and binary edges and the k-means clustering process as a comparison.
2) The system can run well to perform image processing.
3) The k-means clustering algorithm performs grayscale segmentation using the k-means clustering method. The k-means algorithm is used to partition two cluster regions. Select the cluster region that has the smallest area. This is done in order to obtain the region object.

5. References

[1] Hasmyati & Aprilo, I. 2014. Analisis Pengukuran Foremetric Dan Myoline Atlet Pplm Universitas Negeri Makassar. Cakrawala Pendidikan, Juni 2014, Th. XXXIII, No. 2.

[2] Helmi, Z.N. 2013. "Buku Ajar Gangguan Muskuloskeletal". Jakarta: Salemba Medika.

[3] Suryabi, C.L. 2015. "Perancangan Media Pembelajaran Interaktif Tentang Sikap Tubuh Yang Benar". DKV, Fakultas Seni dan Desain, Universitas Kristen Petra.

[4] Suratun, dkk. 2008. "Klien Gangguan Muskuloskeletak: Seri Asuhan Keperawatan". Jakarta: EGC

[5] Suryani, Dwi. 2018. "Analisis Gelombang Elektromagnetik (Sinar-X) Dalam Kesehatan Perspektif Al-Qur'an Dan Sains". PROSIDING Seminar Nasional Pendidikan Fisika FITK, UNSIQ ISSN 2615-2789 Vol. 1, No. 1.

[6] Palimbong, E.Y. 2018. "Deteksi Tbc Paru Dari Citra Foto Rontgen Menggunakan Jaringan Syaraf Tiruan Backpropagation". Teknik Elektro Fakultas Teknik Universitas Semarang.

[7] P, D.A., Arista, V., dkk. 2021. "Segementasi Citra Digital Ikan Menggunakan Metode Thresholding Dan K-Means".

[8] Priyawati, D., Soesanti, Indah., & Hidayah, I. 2015. ”Kajian Pustaka Metode Segmentasi Citra Pada Mri Tumor Otak”. Teknik Elektro dan Teknologi Informasi, Fakultas Teknik, Universitas Gadjah Mada.

[9] Atina. 2017. Segmentasi Citra Paru Menggunakan Metode k-Means Clustering. Universitas PGRI Palembang.

[10] Torkis Nasution. 2012. ”Segmentasi Citra Digital Berbasis Clustering Menggunakan Deteksi Tepi Sobel”. Program Studi Teknik Informatika, STMIK-AMIK Riau.