

# Faculty of Electrical and Electronic Engineering Technology



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

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# DEVELOPMENT OF COMPUTED TOMOGRAPHY LUNG CANCER ANALYSIS USING IMAGE PROCESSING

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## DECLARATION

I declare that this project report entitled "Development Of Computed Tomography Lung Cancer Analysis Using Image Processing" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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# APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours.

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# DEDICATION

Special dedication to my beloved dad, mom, brothers and sisters for their endless support, their constant love and inspiration. To my supervisor, Encik Khairul Azha Bin A. Aziz for his knowledge, motivation and guidance that has been poured tirelessly throughout completion of this project as well as to my fellow friends for their support an encouragement on me.



#### ABSTRACT

Image processing as it is known is a very sophisticated and widespread as well as rapidly used technology that been used nowadays, which can be used in various fields. It is also widely used especially in medical fields because it is extremely useful and very important in identifying various type of diseases that are difficult to see in the human body especially cancer which is a type of node growth in the body and was a dangerous disease that needs to be identified at an early stage so that it can be detected and get an early treatment which indirectly minimized the cases of death due to cancer. So by using an image processing technique, it can indirectly detect whether the tumor is present or not in the body and also to show that, at what stage the growth of the cancer nodes is in the lungs. Mostly this method is call as a Computed tomography or in short CT-scan. Therefore, in this paper, it focuses on all its main objective which is to designing and creating a Graphical User Interface (GUI) which can detect cancer node as well as the stage of the nodule cancer using App Designer in MATLAB software as well as analyzing the type of cancer stage by using a Computed Tomography (CT). Other than that, this project would use an Edge Detection method to determine the boundaries for each objects within the images. Besides that, this project also focus on using a Fuzzy C-Mean clustering method for the lung cancer segmentation and edge extraction. With regards to the Fuzzy C-Mean clustering approach, the outcome is not fixed to a single image iteration because it is dependent on the cluster that has been established. Thus, the more clusters applied to the image, the more varied the output of iteration. At the end, this project is capable to achieve the final result which is able to analyze and read the image as well as able to measure the size of cancer nodule by using GUI that been created in App Designer through MATLAB.

#### ABSTRAK

Pemprosesan gambar seperti yang diketahui adalah satu teknologi yang sangat canggih dan luas serta pesat digunakan pada masa kini, yang dapat digunakan di dalam pelbagai bidang. Ia juga digunakan secara meluas terutama dalam bidang perubatan kerana ianya sangat berguna serta penting dalam mengenal pasti pelbagai jenis penyakit yang sukar dilihat di dalam tubuh manusia terutama barah yang mana merupakan satu jenis pertumbuhan di dalam badan yang sangat berbahaya yang perlu dikenal pasti pada peringkat awal supaya ia dapat dikesan dan mendapat rawatan awal yang mana secara tidak langsung meminimumkan kes kematian disebabkan barah. Jadi dengan menggunakan kaedah pemprosesan gambar, ia secara tidak langsung dapat mengesan sama ada tumor itu ada atau tidak di dalam badan dan juga menunjukkan pada tahap mana pertumbuhan barah tersebut berada di dalam paru-paru. Kaedah ini selalunya dipanggil sebagai "Computed tomography" atau Pengimbas CT. Oleh itu, dalam laporan ini, ia akan memfokuskan pada semua objektif utamanya iaitu merancang dan membuat Antaramuka Pengguna Grafik (GUI) yang dapat mengesan pertumbuhan nod barah di paru-paru serta menganalisis jenis tahap kanser dengan menggunakan kaedah Computed tomography (CT) di dalam GUI tersebut. Selain daripada itu, projek ini menggunakan kaedah Pengesanan Pinggir untuk menentukan sempadan bagi setiap objek di dalam imej Pada waktu yang sama, projek ini juga akan menumpukan pada penggunaan metode pengelompokan Fuzzy C-Mean untuk segmentasi barah paru-paru dan pengekstrakan. Pada akhir projek ini, projek ini mampu mencapai hasilyang diharapkan iaitu dapat menganalisis dan membaca gambar serta dapat mengukur ukuran nodul barah dengan menggunakan GUI yang telah dibuat di App Designer melalui MATLAB.

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# LIST OF SYMBOLS

# None - None

- -
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# LIST OF ABBREVIATIONS

Magnetic Resonance Imaging MRI \_ Computed Axial Tomography CAT \_ Computed Tomography СТ \_ Position Emission Tomography PET \_ Digital Imaging and Communication in Medicine DCM -Hounsfield Scale HU \_ Fuzzy C-Mean FCM \_





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### **CHAPTER 1**

## **INTRODUCTION**

Nowadays, cancer has become a major burden of disease worldwide. Each year, more than a million of people are diagnosed with cancer around the globe, and more than half of that amount eventually die from it. In many countries, cancer have been ranked the second most common cause of death just behind the cardiovascular diseases. As all know, the cancer occurs when the cellular reproduction process in our body goes out of control. In other words, cancer is a disease characterized by uncontrolled, uncoordinated and undesirable cell division. Unlike normal cells, cancer cells continue to grow and divide for their whole lives, replicating into more and more harmful cells. To reduce this cancer disease percentage and to save a lot of life, diagnosing cancer at its earliest stages must be done so that the chance to cure the cancer become higher. There are varies of way to diagnosis a cancer such asa physical exam, laboratory test, Imaging test or biopsy. In this paper will be focus on MALAYSIA MELA EKNIKAL diagnosing using a imaging test, which is by using computed tomography (CT) scan and also discuss about a systems developed for cancer detection based on CT scan images of lungs to spot any type of cancer stage as well as the detail of the patients. The background, problem statement, objective and project scope are included in this chapter.

## 1.1 Background

Lung cancer has been a major cause of death among types of cancers in the world. It is estimated by the World Health Organization (WHO) that in 2020 only, about 19.3 million new cancer cases has been detected and recorded throughout 2020 with nearly 10.0 million from it leading to death. It been stated by World Health Organization (WHO) that about 2.26 million cases was about a breast cancer. Follow by 2.21 million cases for lung cancer then a colon and rectum cancer (1.93 million), prostate cancer (1.41 million), skin cancer (1.20 million) and stomach cancer (1.09 million). This show that the lung cancer is the second most common cause of death just behind the breast cancer which is the most major cancer cases in worldwide. Usually, this lung cancer happens because of changes of normal cells into a tumour cells which mostly caused by interaction between a person's genetic factors with a chemicals and hazardous substances such as ultraviolet, ionizing radiation, components of tobacco and etc. But mostly, lung cancer cases happen was causes by smoking which is clearly the strongest risk factor for most people not just for the smoker but also for the non-smoker. This happens because of the exposition of radon and asbestos for the smoker and second-hand smoke and air pollution for the non-smoker. So, because of these reasons, this project has been conducted which is to help to detect the early stage of lung cancer and to avoid it from becoming worse by using a medical imaging technique which has been prove useful nowadays to detect any types of cancer that happen in the body as well as give a clear result of the lung cancer nodules compare to other techniques and processes.

## **1.2 Problem Statement**

Lung cancer has become the most common cancer among people in worldwide especially in Malaysia. It not just causes a lot of death among the smoker but also to the nonsmoker both men and women. In 2020, It is estimate that nearly 50, 000 people in the Malaysia face a new lung cancer cases with more than half (29, 530) leading to death. Although various method has been used such as the Cancer or Tumour segmentation method which is a process of separating tumour from normal tissue which is a good method because it provides a useful information of the cancer for diagnosis and treatment planning. However, it is still a challenging task due to the irregular and confusing shape of the cancer as well as lack of knowledge about the cancer. These has led many researchers all around the world to continue doing their research to find a better way on how to detect and cure this disease to decrease this lung cancer cases which has cause million and thousand death every year.

One of the better ways to doing this is by using CAT scan or usually been call as CT scan which has an able to access, collect and shows a detailed image (data) of any part of the body by emits a series of narrow beams through the whole body which been used to take an image of different angle of body as it moves through an arc which create a cross-sectional image of the body parts. These show that CT scan is more detail in collecting and show a data compared to normal x-ray scan.

Besides that, with the advanced technology that keep improving in medical field year by year which from this, introduce a new technique such as image pre-processing, image enhancement and segmentation will help to improve the quality of the image so that it become more clear without having any noise in the image.

## **1.3 Project Objective**

The main aim of this project is to develop or design a lung cancer detector system for medical purpose by using image processing method. So this system analyze each of the image data which is in DCM format and detect a cancer nodule that exist in the data. Specifically, the objectives are as follows:

- a) To develop a Computed Tomography Lung Cancer Analysis Using Image
   Processing in App Designer through MATLAB software.
- b) To design and create a Graphical User Interface (GUI) which can detect cancer node using App Designer in MATLAB software.
- c) To proposed to use a Fuzzy C-Mean clustering method for the lung cancer segmentation and edge extraction.
- d) To analyse and measure the size of cancer nodule output by using GUI that been created in App Designer through MATLAB.

## **1.4 Scope of Project**

The main purpose of this project is to create a system that can analysis the data and display it in the App Designer. The system was created by using a Graphical User Interface (GUI) and also using DICOM image files from The Cancer Imaging Archive (TCIA) dataset that been provided as a data for the GUI. The DICOM image from the TCIA dataset come in various type of nodule which is suitable for testing the created GUI. By using a Computerized Tomography (CT) scan method which is the most suitable method to diagnose and detect the cancer or lung nodule as well as an image processing technique such as image pre-processing, image enhancement and segmentation which help to improve the quality of the data image so that it become clearer without having any noise in the image.

## **CHAPTER 2**

## LITERATURE REVIEW

## 2.1 Introduction

The study is about a research on a cancer and how to detect it in early stage. This research been conducted by using an imaging test method which is, a computed tomography (CT) scan or simply, CT-Scan. This method used powerful X-rays, a form of radiation, to create detailed pictures of the inside of your body in a shape of cross-sectional image or "slices" image which been call "tomographic images" and contain more detailed information than a conventional x-rays but with a more radiation exposure effect compare to other imaging test such as MRI and PET scan. But with advanced technologies that keep improving year after year, decreasing CT radiation dose without affecting image quality is a hot direction for research of medical imaging nowadays. So basically, the goal in this section is to educate people on the basics of cancer and cancer treatment. Possessing this knowledge will, I hope, help people to better understand what cancer is, how it occurs, and how to make informed choices about cancer care options.

# 2.2 Related Work

# 2.2.1 Implementation of Image Processing Technique For Identifying Different Stage of Lung Cancer

Based on journal "Implementation of Image Processing Techniques for Identifying Different Stages of Lung Cancer" by Anjali Sevani, Hardik Modi, Sagar Patel and Himanshu Patel say that Lung cancer or Lung carcinoma is an uncontrolled cell growth tumour in the tissue of the lungs. This Lung cancer can be categories into two types which is Small Cell Lung Cancer (SCLC) and Non-Small Cell Lung Cancer (NSLC).

## 2.2.1.1 Stage of Lung Cancers

There is total four stages of the lung cancer as below:

Stages	Descriptions
	The cells of cancer are present only in the lungs and have not spread to any
Stage I	lymph nodes. The size of tumor is $< 3$ cm.
Stage II	The cells of cancer are presents in the lung and nearby lymph nodes. The size
	of tumor in this stage is between 3 cm to 7 cm.
	In this stage, cancer cells are occurred in the lung and in the lymph nodes in
Stage III	the middle of the chest. In this stage, the size of tumor is $> 7$ cm.
F	This stage of cancer is very dangerous and impossible to recover. In this
Stage IV	stage, cancer cells are spread into both lungs or to another part of the body,
	such as the liver or other organs

Table 2.0 : Stage of Lung Cancer

Through this, it can be assumed that if the tumor is in the first or in the second stage, it can UNIVERSITITEKNIKAL MALAYSIA MELAKA

be recovered. If the tumor is in the third stage of the cancer, it will be a bit difficult to recover. But when tumor is in dangerous stage which is fourth stage, in which there will be no more chances to remove the lung tumor because the cells of the cancer are spread through all the part of the body which is very difficult to recover. As a treatment of the lung cancer, several image processing techniques especially CT (Computed tomography)-scan must be used to detect whether tumor is present or not and also to shows that, in which stage the cancer is present in nodes of the lungs through CT- scan (Computed tomography) image.

#### 2.2.1.2 Image Processing Techniques

There are a few processes of lung cancer detection which mainly use to detect cancer by using image processing techniques.



Figure 2.0 :Image Processing Technique

#### a) Image Pre-processing

For the first step which is Image Pre-processing, the image needs to be resized first as well as improve the quality of the image by removing unnecessary parts and the image noise. This is because the image sources that been obtained from various sources may possible different in terms of size and quality. So, to get a better image and result in our case, to specify the stages of the cancer in image processing, image resizing is the most important factor. After resizing the image, the image will be converted into the grayscale image. In grey scale image, the value of each pixel is single sample, which carries only intensity information of the pixel. This type of images is the result of measuring the intensity of light at each pixel in a single band of the light spectrum such as infrared, ultraviolet, and visible light. So, by converting image to grayscale, it will make the detection of an intensity object (cancer) from the background easier. [1]

### b) Image Enhancement

Secondly to improve the quality of the image, Image enhancement will be used. This is because by using Image Enhancement, it will make the image look better as well as improving the quality of the image. Besides that, in Image Enhancement, it can also increase or decrease the brightness of the image based on application needed. Basically, this technique can be performed in both domains which is Spatial Domain and Frequency Domain.

- 1. Spatial Domain method.
  - A method which operates or based on direct manipulation of pixels in an images
- 2. Frequency Domain method
  - A method which operates or based on modifying the Fourier transform of an image first before back into the Spatial Domain for improvement of the image.

## c) Median Filter

Before going to the next steps, there are a technique that should be used to the image which is call Medium Filter. This technique is a useful and effective technique not only to remove a noise in the image but also to detect the edges of an images. The

process is that, firstly the noise should be removed in image. After done it, the edge remover will then be is performed. But usually, this technique main been used only to remove a noise without changing or remove an images' edge. So, the main idea of this median filter is to run image and replacing each entry with the median of neighboring pixels intensity entries which is this pattern of neighbors is call as "window". Basically, this median filtering technique has commonly been used in window sizing. [4]

For example:

18	65	80
75	88	55
110	158	230
3 after rearrange	in ascending series	1
3 after rearrange	in ascending series	65
x3 after rearrange 18 75	in ascending series 55 80	65 88

Table 2.1 :Example of Median Filter Technique

#### d) Binary image processing

This step is about processing a Binary Images which involves some binary operations. For that, the morphology operations must use. Morphology is basically used to find the shape and size or structure of the object by using the concept of structuring element. The structuring element is a window which is placed in original image to find desired output and basically smaller in size compared to the original image. The basic morphological operations are [5][6]:

• Dilation

In this operation, the image will be expanded from its original shape by adding extra pixels to the boundaries of object in an image which will makes objects more visible and fills in small holes in objects. The number of pixels added to the object boundaries or the binary image is depending on the size and shape of structing element. It is similar to the convolution process, and it reflected and shifted from top to bottom and left to right. • Erosion

Opposite to Dilation operation, this operation will shrink the area of the foreground pixels on the boundaries of the object from its original shape and sizebut at the same time make the holes within that pixel area become larger. Basically, Erosion remove a foreground pixels which is not completely surrounded by other white pixels in an image.

• Opening

Opening is based on Dilation and Erosion. It is defined as Erosion followed by Dilation operation. It removes small objects such as foreground (white) pixels from the edges of the foreground pixels of an image while preserves the shape and size of larger objects in the image. In general, it is less destructive than erosion. Somewhat it is similar to erosion.

Opposite to Opening operation but still based on Dilation & Erosion. Closing is defined as Dilation followed by the Erosion operation. It shrinks and removes small holes and fills the holes in background region as well as enlarges the boundaries of the foreground (white) pixels in the image while preserves the same shape and size of larger objects in the image. It is less destructive of the original boundary shape. Closing is somewhat similar to dilation.

Closing



Figure 2.1 : Four Basic Morphology Operation

#### e) Feature extraction

As for the last step which is Feature Extraction, it represents the desired part of the image and a part of the dimensionality reduction process, in which, an initial set of ALAYSI, the imagedata at a desired part will be divided and reduced to more manageable groups so that can easy be view and process. So, basically this step just reduces the number of resources needed for processing without losing important or relevant information in the specific extracted region. Usually, a feature of the image that can be extracted like colours, textures, shape, position, edges and the regions etc. So, in our case which is to detect cancer, this feature extraction will help by show the Extracted tumor cancer, Boundary detection, Circularity of the tumor cancer and the Diameter of the cancer. For extraction of tumor cancer, it can be done by use a Region of interest (ROI) method. Basically, the ROI is the samples within dataset and be used to detect the area. By using ROI, it can define the boundaries of the object and can know the area of the object meanwhile for boundary detection, it can draw each boundary over the object and fill it with different colours in object using a software such as MATLAB. Hence, it can make us easy to define the cancer and the stages of the lung cancer through this step. [7][8]

### 2.2.1.3 Summary of Journal

Based on this journal, it stated that a lung cancer is a dangerous disease which not only cost a lot of life but also the treatments are very costly, lengthy and painful. So this journal was make as an attempt to help solve this disease by detect the lung cancer using image processing techniques such as Median filter to sharp and remove a noise in image, binary image processing (morphology method) to expand and shrink the image according to the appropriate and desired criteria as well as a feature extraction to show an extracted tumor, diameter of tumor and stage of tumor cancer.

# 2.2.2 Lung Cancer Detection on CT scan Images: A Review on the Analysis Techniques

Based on journal "Lung Cancer Detection On CT Scan Images: A Review On The Analysis Techniques" by H. Mahersia, M. Zaroug and L. Gabralla from Albaha University and University of Science & Technology Khartoum say that Lung cancer is caused by uncontrollable irregular growth of cells in lung tissue which often been called as Lung nodules with a Pulmonary nodules as a characterization for early stage of lung cancer. It is usually small in shape which is about 5 to 30 millimetres in size.

# 2.2.2.1 Type of Cancer

This Lung cancer can be categories into four groups which is:

- Juxta-vascular
- Well-circumscribed
- Pleural tail
- Juxta-pleural



Figure 2.2 : Nodule's Classification

# 2.2.2.2 Method of Image Processing

In this journal, the authors proposed several methods for detection of Pulmonary nodules with all these methods involved a four step to detect the nodules such as pre- processing, segmentation, extraction of nodule, reduction of false positive and classification.



Figure 2.3 : Methods For Detection of Pulmonary Nodules

#### a) Pre-processing

In here, it stated that pre-processing method is a first method which aim to reduce a noise in the images. The reasons of the noise mostly because the image quality that been reduce during Computed Tomography (CT) scan. As been say, the Computed Tomographyis a method that uses x-rays scan to obtain structural and functional information about the human body and considered as one of the best methods to diagnose a cancer nodule but this method also will harm the human body because of the significant amount of radiation dose that been used to get a clear quality of image. So to prevent the human body from all kind of risk and harm, it is obliged to reduce the radiation dose which will also affects the quality of image as well as increase amount of noises in the images. To remove this noise, there are many filtering techniques that can be used such as Median filtering [9], Wiener filtering [10],Gaussian filtering [11], Bilateral filtering [12] and a High pass filter [13].

# اونيونر سيتي تيڪنيڪل مليسيا ملاك b) Segmentation SITI TEKNIKAL MALAYSIA MELAKA

For second method is a Segmentation of the lung image region which is referring to a process of partitioning the pre-processed Computed Tomography (CT) image into multiple regions to separate the pixels or voxels corresponding to lung tissue from the surrounding anatomy structure. There are various approaches that have been used from this method and these approaches can be classified in two, 2D approaches and 3D approaches.

## 2D Approaches

 For these approaches, there are several numbers of segmentation method which will be classify into few groups such as Thresholding-based, Stochastic, Region- based, Contour-based, Learning-based, Edge-based etc.

**3D** Approaches

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• For these approaches, there are several numbers of segmentation method which will be classify into few groups such as Thresholding, Mathematical morphology, Region growing, deformable model and dynamic programming

But mostly only 2D approaches which is Thresholding-based, Region-based and Edge-based that been used.

1. Thresholding-based method [14]

It is a segmentation technique which change or convert an image from colour or grayscale into a binary image in other word, black and white image by setting all pixel whose intensity values are above a threshold to a foreground and all the remaining pixels to the background.

- 2. Region-based method [15]
  - It is a segmentation technique that focus generally on the homogeneity of the image for determining object boundaries. It will divide the entire image into sub regions depending on the rules which is all the pixels in one region must have the same grey level and will rely on common patterns in intensity values within a cluster of neighbouring pixels.

- 3. Edge-based method [16]
  - It is a segmentation technique which transform original image into edge image benefits from the changes of grey tones in the image. It generally used for finding or detecting an edge in an image based on a discontinuities in the grey level images

#### c) Nodules extraction and classification

For last method is a Nodules extraction and classification or shortly Nodules classification method is a method of lung nodule detection which is to identify the location of the nodules that exist. Usually for this method, the best approach is detection by using Classification and Clustering which are a technique used in data mining to analyses collected data. As for Classification, it is used to label data, while Clustering is used to group similar data instances together. There are various approaches for this classification and clustering which can be classified into four categories such as Fuzzy and neural network, K-nearest neighbour (KNN), Support vector machine (SVM) and linear discriminant analysis (LDA).[17]

#### 2.2.2.3 Summary of Journal

Based on this journal, it shows a review of an overview of all the detection technique that available for CT image which this journal stated will and may help all the researcher to choose a suitable method or as a guide to solve an issue that been faced suchas develop a new and better technique of contrast enhancement.

# 2.3 Digital Imaging and Communication in Medicine (DICOM)

A Digital Imaging and Communication in Medicine or also known as DICOM is a worldwide standard protocol for storage and transmission of medical imaging. It also specifies a non-proprietary data interchange protocol which mean this DICOM allow a digital or normal medical images, file structure for biomedical images and images-related information to be exchanged between imaging equipment from different computer, hospital or any healthcare facilities. [21]

Basically, this DICOM uses a structured representation of image and a communication mechanism which allows the hospital or healthcare facilities to easily acquire images from multiple sources and store them directly into the online patient record. So, from this, it shows that this DICOM purpose is to ensure the interoperability of the systems used to store, share, send and retrieve any medical images and manage related workflows. This DICOM address five general application areas which is:

- 1) Network Image Management
- 2) Network Image Interpretation Management
- 3) Network Print Management
- 4) Imaging Procedure Management
- 5) Off-line Storage Media Management

### 2.3.1 DICOM Standard

This DICOM has become the de-facto standard in medical imaging nowadays, which vast majority of digital medical imaging systems of all major vendors including acquisition devices, diagnostic workstation, archives, servers, medical printers etc. support and comply with portions of the DICOM standard by depending on the services they implement. This show that DICOM has been widely useful and accepted as well as adopted by many sectors especially a medical institutions. Besides that, it also show that how to format and exchange the medical images and related information inside and also output of the medical fields. Stated below is the DICOM interface that available for any combination of following categorize of digital imagery equipment [20]:

- Image Acquisition Equipment
- Image Archives
- Image Processing Devices and Image Display Workstation
- Hard-copy Output Devices

Below here is table 2.2 which show a variable as assign value from DICOM file.

From DICOM header file	Value
Height	512
Width	512
Rows	512
Columns	512
BitDepth	16
Modality	'CT'
Instance Number	12
Slice Thickness	5
Pixel Spacing	0.8301
Rescale Intercept	-1024
Rescale Slope	1

Table 2.2 : A Variable as Assign Value from DICOM File

# 2.3.2 DICOM Structure

As for the structure, DICOM files contain a header file portion, Data set portion, singleData set, and a Data Elements as can be seen in Table 2.3 below.





- The file header contains 128-byte file preamble, and 4-byte DICOM prefix

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Bytes type	Description
Preamble	- Used to access the images and other data in DICOM file to provide a compatibility with a common used image file format
Prefix	- Contains the string "DICM" as uppercase character

### 2) Data Sets

- Data sets is a representation of the real-world data information with each file will contain a single data set which represent SOP instance and SOP class with related IOD (Initial Object Descriptor).

- 3) Data Elements
- Data element is a uniquely identified by a Data Element Tag and consist of the DataElement Tag itself, value length and value of the Data Element. This Data Elements in the Data Set will be ordered by increasing Data Element Tag value or number and shall occur once in every Data Set.

#### 2.4 Hounsfield Unit (HU)

Hounsfield unit or short, HU is a system that been used in computed tomography (CT) to represent CT numbers in a standardized format of the resultant image. Hounsfield units by definition mean a density measurement tool utilized to differentiate between different tissues on the CT scan. It makes up the grayscale in medical CT imaging and scale from black to white of 4096 values (12 bit) and ranges from -1024 HU (black) to 3071 HU (white) including zero value.

As can been see in the Figure 2.4 & Table 2.4, -1000 HU represent an air, -900 to -600 HU for lungs, -50 HU is for a fat, 0 HU represent a water and 200 (Trabecular/spongeous bone) to 2000 HU (cortical bone) for bone. L MALAYSIA MELAKA



Figure 2.4 : The HU Value in Brain
Substance/ Matter	Hounsfield Unit (HU) value
Air	-1000
Lung	-500
Fat	-100 to -50
Water	0
Blood	+30 to +45
Bone	+700 (Cancellous bone) to +3000 (dense bone)
Soft Tissue	+100 to +300
Kidney	30
Muscle	+10 to +40
Liver	+40 to +60

## Table 2.4 : The HU Value for Other Substance

## 2.5 Clustering

Clustering is the process of dividing a population or set of data points into a number of groups so that data points belonging to the same group are more comparable to one another than to data points belonging to other groups. In simple terms, the purpose and objective of clustering is to classify segments or groups based on shared characteristics and assign them to clusters. So, clustering is divided into two subgroup:

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# 1. Hard Clustering SITI TEKNIKAL MALAYSIA MELAKA

In hard clustering, each data points that exist is clustered or organized into single cluster and each data point might be wholly or partially associated with a cluster. For this clustering, there are only one that used this type of algorithm which is K-Mean Clustering because as a hard clustering, it also clusters or divides the data points into k-cluster. As illustrated in Figure 2.5 is the example of hard clustering which the data points are separated into three clusters, with each point belonging to one of the clusters.



Figure 2.5 : Hard Clustering

2. Soft Clustering

In soft clustering instead of assigning each data point to a distinct cluster as the hard clustering, it assigns a likelihood or probability for each data point to be or belonging in a cluster. Easy to understand is that in soft clustering, each data point can belong or assigned to numerous clusters along with its probability score or likelihood. As for this clustering, the Fuzzy C-Mean is the only one known to use this algorithm. As show in Figure 2.6 is the example of soft clustering which is the probability or likelihood of each data points to belong to multiple clusters is assigned.



Figure 2.6 : Soft Clustering

## 2.5.1 K-Mean Clustering

The K-Means algorithm is a hard clustering technique that splits the unlabeled dataset into k distinct clusters in such a way that each dataset belongs only one group with comparable / similar qualities or properties. Here K is define as the number of pre-defined clusters that need to be created. For example in process, if k = 2, then there will have 2 clusters and if there are 3 clusters, it means that k = 3 in process. Besides that, K-Means algorithm also a clustering data based on centroid positions. So it means that centroid point would be used to represent each cluster in the k-means clustering technique.

# 2.5.2 Fuzzy C-Mean Clustering

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Fuzzy C-Means clustering is a type of soft clustering in which each data point is allocated a probability or score indicating whether it belongs to that cluster. This show that a data point located near the cluster's centre shall have a high degree of membership or group in the cluster, whereas a data point located far from the cluster centre will have low degree of membership or group. Besides that, there are a step-wise that need to follow to approach the Fuzzy C-Mean clustering algorithm such as fix the value of c (number of cluster), and select a value of m before initialize partition matrix U. Finally, the cluster centers (centroid) must be calculated before updating the Partition Matrix.

## 2.6 Summary of Literature Review

Based on this literature review, it can be said that the best medical imaging technique for this project which is to detect a lung cancer is by using a CT-scan. Although this technique is quite risky due to the use of x-rays which is a kind of dangerous radiation but in general this technique gives very encouraging results in terms of clear picture quality and can detect various types of diseases that are deep in the body and it's also be considered as the best method since the image allows a physician to confirms the presence of a cancer tumor, measure its size, identify its precise location and determine the extent of its involvement with other nearby tissue. Besides that in the clustering process, based on comparison of fuzzy c-mean to the k-Means algorithm, fuzzy c-means clustering can be considered a superior algorithm. Unlike the k-Means algorithm assigns each data point to multiple clusters with a probability. Fuzzy c-means clustering produces significantly better results when data sets are overlapped.

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## **CHAPTER 3**

#### METHODOLOGY

# 3.1 Introduction

In this chapter, it about explaining the detail of the project process and concept that have been done as well as the description and justification of the component that been created. As a result, the flow chart of the process also had been shown to have a clear and better explanations about the project. Additionally, material used and procedural information on how the system connection established in the project also has been provided. The development of MATLAB software had examined to develop the algorithm and Graphical User Interface the system.

# 3.2 Project Workflow

For our workflow project, it will be divided into 6 step which is Planning, Research, Algorithm, Design, Implement and Analysis. The reason for these categories is to make sure that our workflow project will always in the correct direction as been planned so that the project will get a positive result at the end of the project output. As can been see here in Figure 3.0 is our project workflow.



Figure 3.0 : Project Workflow

# 3.2.1 Planning

The objective of the planning methodology process was to determine the early state for detection of lung nodules and the classification of lung cancer. As for planning process, it starts with the pre-processing technique by using a segmentation method which is the Fuzzy C Means for the lung cancer segmentation and extraction. Then, a few guideline and task are being planned as a guide so that our project meet the objectives that been set. As can been seen in Figure 3.1 is the Flow Chart of the project that has been planned so that the task could be complete based on the schedule as shown.



#### 3.2.2 Research

The research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic, object or data. In a research paper, the methodology section allows the reader to critically evaluate a study's overall validity and reliability of the data. So this part of process will identify the DICOM data that been provided and process as well as analysis the data first before display or process to next process.

## 3.2.3 Algorithm



Shown here is the Figure 3.2 which is about the flowchart of Algorithm.

#### 3.2.4 Design

Shown here is the Figure 3.3 & 3.4 which is about the design of block diagram as well as the application design.



Figure 3.3 : Project Block Diagram



Figure 3.4 : MATLAB Application Design Using App Designer

# 3.2.5 Implement

The implement process is a process in which to identify how a project is implemented in a field. Usually, this process will be needed to solve any problem regarding a step or method that been used. By doing this process, a clear picture of the research or project task can be seen and understand easily to reach the goal of the project research. So, this process is to identify all the available method and technique that usually been used in medical imaging especially related to lung cancer with the data that received from the database and choose the best technique or method to implement in the project.

## 3.2.6 Analysis

The analysis process focused on identifying the main problems factor contributing to the software issues. As stated above, the types of medical imaging that used in this project is CT scan which mostly been used in medical field to detect a disease. Besides that, there are also various types of techniques and methods for lung segmentation that have been researched and comparison to figure out the most suitable method to be introduced for the project. At the end after comparison all the method, finally this project will focus on one of the image segment which is Fuzzy C Means.

# 3.3 Data Collection

For the data collection, the primary reference and source for data collection will be the Cancer Imaging Archive (TCIA) which is a database of medical images (DICOM) for cancer. The reason of using this source because it is available for free to public with thousands of medical images of cancer which is useable for testing the project. Besides that, other source that can be used to obtain data as well as knowledge would be by reading through other research journals or book related to CT-Scan or Lung Cancer which is quite important to understand more about knowledge about this project.



Figure 3.5 : The Cancer Imaging Archive (TCIA) Webpage

# 3.4 Software Setup

# 3.4.1 MATLAB & APP DESIGNER

The main software that will be used in this project is MATLAB which is a highperformance language for computing programming. It is a combination of computation, visualisation and programming in an easy-to-use environment where issue and complication as well as a solutions are expressed in usual mathematical notation. As for the project GUI, App Designer which already included in the MATLAB will be used to create and design the project GUI.

# 3.5 Software Flow

# 3.5.1 Open Data in MATLAB Application

MATLAB is a main software that will be used in this project. MATLAB as all known is an interactive system whose basic data element is an array that does not require dimensioning. Furthermore, MATLAB is a latest and modern programming language environment because it has sophisticated data structure which contains built-in-editing and debugging tools and support object-oriented programming. As can been see below is Figure 3.6 which show the basic window for MATLAB software.

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Nome - Volue	<ul> <li>∧</li> <li>↔</li> </ul>

In the MATLAB window, it will have 4 type of windows which is the "Workspace" window which contain or keep every variable that been created or import into the MATLAB from data files and this "Workspace" window can allow the user to view as well as edit the content in it. Stated below is the figure 3.7.1 which is the example of "Workspace" window.

Workspace	
Name 🔺	Value
⊞ c	650x600x3 uint8
•	4

Figure 3.7.1 : The "Workspace" Window

The second window is "Command Windows prompt" which is a most important part in MATLAB because it is a place where the user enter an individual statements at the command line for a program and view the generated result of the statement. Figure 3.7.2 is the example of "Command Windows".

Command Window										
>> f <u>x</u> >>	Picture									

Figure 3.7.2 : The "Command Windows"

The third window is "Current Folder" where it is a window which been the reference location for the MATLAB to find data or files. In other word, it is the place where all the data and file been store and save. This folder also sometime been call as current directory or current working folder. Example of the "Current Folder" can be seen in figure 3.7.3 below.



Figure 3.7.3: The "Current Folder"

The last window is "Editor" as can be seen in figure 3.7.4. The "Editor" window is a normal text editor where the user can write, load, edit and save a program or script which is call as an m-file. Besides that, this window also has a menu command (Run) that allows applying the program to the command window.



# **3.5.2** Open Data in APP DESIGNER in MATLAB Application

As for App Designer which is part of MATLAB software is an interactive development environment that been used as a tool to design and create a simple application or simple graphical user interface (GUI). This App Designer is suitable for a new startup developer which want to learn on how to design a simple app layout and also program the behavior of the app layout. In this App Designer, it provide a lot of function such as a large set of interactive UI components as well as offers a grid layout manager to organize the shape of app layout. As show below is the basic window for App Designer in the MATLAB.

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Figure 3.7.5 : Basic Window for App Designer

In the App Designer window, there are two option which is "Design view" and "Code View". As for Design View, there are two type of window which is "Component Library" and "Component Browser" as can be see in figure 3.7.6 below: AL C 

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A	a b c List Box	©ª ⊙b Radio Button Group	Knob Lamp Linear Gauge	
1 2 Slider	0 v Spinner	डानाः State Button	Rocker Switch Semicircular Switch Gauge	

Figure 3.7.6 : The Component Library (Left, Center) and Component Browser (right)

As can be see, the "Component Library" is a window which provide the tool or components that needed to create a app layout or GUI. It is consist of various category of components such as "Common", "Container", "Figure Tools" and "Instrumentation" meanwhile the "Component Browser" is a window in which displaying all the component that been used to create the layout and also to setup the components. As for the second window which is "Code View", it have a "Component Browser" window as well as "Code Browser". The function of the "Code Browser" window is to list all the function, callback and properties that been used in program the behaviour of the app layout or GUI. Stated below in figure 3.7.7 is the "Code Browser" and "App Layout"

LungCancerDetector.mlapp $\times$			
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FuzzyCMeanButtonPushed		Edge Delection	> 0.5 > 0.5
DetectedTumorButtonPushed		Tumor Alone	
EdgeDetectionButtonPushed		Futty C Mean	FUZZY C MEAN IMAGE
ResetButtonPushed		Patient Name	0.5
		Turrour Size (mm) 0	

Figure 3.7.7 : The Code View Window (Upper), Code Browser (Left) and App Layout (Right)

## 3.5.3 Segmentation of MATLAB

## **3.5.3.1 DICOM Image Segmentation**

When talk about Image Segmentation in MATLAB, firstly the software will need to have a DICOM image which can be obtained from Lung Image Database Consortium (LIDC) or Cancer Imaging Archive (TCIA) which is a database of medical images (DICOM) for cancer. Then, the DICOM image will be entered into the software through coding which can be built using the MATLAB code or by using Image Processing Toolbox so that the MATLAB can read the DICOM file. This will produce an image of the DICOM file in the MATLAB by mapping quantitative results as a grey scale image. However, the image does not indicate a significant difference with the original image (DCM) because the MATLAB is just used to read and generate an image same as the original image and not edit the image yet. As can be see here in Figure 3.8 is an image of a patient from TCIA datasets which have been used in the App Designer through MATLAB. The method that been used is to convert manually the DICOM file named "1-145.dcm" or any dcm image to JPG format. Then to display it in the App Designer, a coding same as in Appendix A will be used to display the image.



Figure 3.8 : Image of Patient 1-145 From TCIA

## 3.5.3.2 Edge Detection Using Kirsch Algorithms

The image processing technique that will be used in this project is an Edge Detection using Kirsch Algorithms method. Edge detection is a technique of image processing that been used to identify points in a digital image that has a discontinuities because of the sharp changes in the image brightness. So, these discontinuities where the image brightness varies sharply is known as edge (boundaries) of image. In Image Processing, the edge is the boundary between the lesion and the background. Therefore, the edges of this image precisely identified, all objects can be located and their properties, suchas area, perimeter and shape had been calculated. So, this edge detections' process will firstly locating the edge of lesion pixels. Then the edge enhancements increase the contrast betweenthe edges and the background so that the lesions become more visible as can see at Figure 3.8.1 which is the example of Edge Detection image that been created using a coding in App Designer (refer Appendix B).



Figure 3.8.1 : Edge Detection Image Created in MATLAB

## 3.5.3.3 Fuzzy C-Means (FCM)

The segmentation method that will be used in this project is Fuzzy C-Means (FCM). Fuzzy C-mean is a clustering method which make and allow each data point or one piece of data belong to more than one clusters and each of the data point must has a degree of membership or probability of belonging to each cluster. For example, a data point that lies near to the center of the cluster will have the higher degree of membership in that cluster while data point that lies far from the center of the cluster will have the low degree of membership in that cluster. The level in fuzzy clustering is close to the pixel probability of a mixture modelling assumption. The results at Figure 3.8.2 is an example of "1-145.dcm" image which show that to achieve an exact boundary of the domains, the lesion in the image is calculated by Fuzzy C Means Clustering segmentation and the output result will be as shown in the figure.



Figure 3.8.2: Image of Fuzzy C Means Clustering Segmentation

Stated here in Figure 3.8.3 is a flowchart of fuzzy c-means clustering algorithm method. In this figure will shows the flow process of fuzzy c-means from how the number of clusters is randomly chosen, the degree of membership for each data point to every cluster is calculated and the data point is added to that cluster to which membership matrix is less than criterion for convergence ( $\mathcal{E}$ ) else move the data point to next cluster (if membership matrix greater  $\mathcal{E}$ ). The process will be repeat until the cluster's center doesn't change or move.



Figure 3.8.3 : Flowchart of Fuzzy C-means Clustering Algorithm Method





Figure 3.8.4 : Flowchart of Fuzzy C Means Segmentation Process in MATLAB

## **3.6 Equivalent Diameter for Lung Image**

## 3.6.1 Diameter Measure in MATLAB & APP DESIGNER

As can be seen in Figure 3.9 is the image from App Designer. It shows the corresponding segmented CT image of "1-145.dcm" that was first converted to a jpeg file before being used in App Designer. So, to measure the cancer/tumour nodule, a coding as shown in Appendix C will be used. It will automatically detect the cancer/tumour when the "Detected Tumor" button is pressed which will create a yellow circle region around the cancer/tumour area as well as measure the size of the yellow cicle region to get the exact size of the cancer/tumour before display the size at the edit field "Tumor Size (mm)" in the App Designer through MATLAB software.



Figure 3.9 : Shape of Cancer Nodule with the Size in Milimetre

# 3.6.2 Diameter Measure in Dataset

As shown in Table 3.0 is the size or diameter of cancer/tumour nodule that can be obtained from the valid medical dataset provided by the project supervisor via Microsoft Excel. In the excel, it is already stated eight number of patient which mean eight dicom image with different shape of cancer/tumour that exist in the image as well as the size of the cancer/tumour in milimetre.

Patient	Slice	Size (mm)
A173	172	25.78
A181	145	31.25
A194	203	18.75
A197	86	26.4
A230	90' -	32.81
44 44		S. 09.9
A234		SIA MELAKA
A263	235	25
A265	222	37.5

Table 3.0 : Size of Cancer Nodule from Dataset

#### 3.6.3 Comparison Both Diameter

From the result that has been done previously in App Designer through MATLAB which is to get the diameter for the "1-145.dcm" image, there are a bit of different in value when been compared to valid medical dataset that been provided by the project supervisor via Microsoft Excel which is the diameter of cancer nodule that been measured in App Designer is 31 mm meanwhile the diameter of lesion that been stated from the dataset for this image is 31.25 mm as shown in Table 3.1.



Table 3.1 : Comparison Diameter of Cancer Nodule

From this, it shows that the value is a bit difference but still in 31 mm. The reason for this difference is due to inaccuracies in detecting the shape of the nodule cancer as well as the difficulty in testing the DICOM image using two different data with different method. Based on this, it can be say that both software is measure the same size and the cancer nodule size is 31 mm.

# 3.7 Gantt chart

The Gantt chart is a guideline for the project and should be followed so that the project progress flow will easy to understand and always on a track as well as a easy way to update any improvement that be done every day. So, in this Gantt chart will show every progress and works that be conduct and done throughout this semester. As can been see below is the Gantt chart for this project that been planned. The yellow colour represent the Matlab/App Designer/GUI work that have to be done in the whole week meanwhile the green and blue colour represent report work that have to be done and date of submission of logbook and final report.

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Ш.		PROJE	CT FIN/	AL YE		ROGI	RESS	PSM 2	2 (20)	21/20	22)							
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Introduction & Project Background	Ine																	
Design GUI In App Designer																		
Abstract & Problem statement			. 1	<	_	. *	<	_	10	-					1			
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Objective & Project Scope										1.0					_			
Submission Logbook Week 6	ERS	ITI '	TEK	N	KA	L	M/	4L	4Y	SI/	A N	1E	LA	K	λ.			
Learn & create a coding to circle and detect a cancer nodule																		
Literature Review																		
Learn & create a coding to detect and display the size of cancer nodule																		
Methodology																		
Preliminary & Expected Results																		
Submission Logbook Week 12																		
Conclusion & Reference																		
BDP Presentation																		
Submission Final Report																		

### **CHAPTER 4**

#### **RESULTS AND DISCUSSIONS**

# 4.1 Introduction

As already mentioned in chapter 3 that this project is about build a GUI (Graphical User Interface) for Lung Cancer System Detector by using App Designer in MATLAB software. So, this project will use a DICOM data image that can be obtained through a Lung Image Database Consortium (LIDC) or Cancer Imaging Archive (TCIA) which is the database source of medical images (DICOM) for the project and process and at the same time analyze the image to detect the cancer nodule in the image. So in this chapter 4 is about discussing the possible and final result that will be obtained at the end of the project process as well as the step flow of this project in obtaining the size of the cancer nodule image.

# 4.2 Results

By using the application that was told in the previous chapter which is App Designer through MATLAB for designing and creating the Graphical User Interface (GUI) as well as the coding that been created throughout this semester for the GUI application, this indirectly will help in obtaining results for each process in the project. The results are presented and discussed with reference to the objective of the project which is to understand first the basic principle of CT–scan and how it operates to create an image in DICOM file. After that, it will relate to the two other objective which is to design and create a Graphical User Interface (GUI) which can detect cancer nodule and also the size of the cancer nodule by using App designer in MATLAB software as well as to develop a system which can improve a quality of image data and at the same time reduce any noise that exist in the image. As been stated before, this project will also focus in using an image segmentation method of Fuzzy C-Mean (FCM) that have been proposed earlier to obtain each of the result.

# 4.2.1 Project Result Flow

Stated here is the project flow that been proposed and done throughtout this semester which is the main function is to detect a cancer in the Dicom image and measure the size of the cancer nodule. The project flow is as shown below from the first step until achieve the results.



Figure 4.0 : The Layout Design of GUI

To start this project, a layout will be create first as can see in figure above is the design of the GUI that been create for this project by using App Designer. Next, a coding need to be create first as a brain to the project GUI. So listed below is the coding that already create for this projec:

<pre>% Callback function: PatientNameEditField, % PatientNameEditField, SelectImageButton function ButtonPushed(app, event)</pre>	
<pre>global a; [filename, pathname] = uigetfile('*.*', 'Pick an Image'); fullname=strcat(pathname,filename); a=uint8(imread(fullname)); app.Image.ImageSource = fullname; app.PatientNameEditField.Value=filename;</pre>	
end	

Figure 4.1 : The Coding for Displaying Original DICOM Image



Figure 4.1.1: The Coding for Button "Tumor Alone" And Function of Circle the Area of Tumor

% Button pushed function: FuzzyCMeanButton	
<pre>function FuzzyCMeanButtonPushed(app, event)</pre>	
global maskedImage;	
global b;	
<pre>b = im2double(maskedImage);</pre>	
<pre>b = imadjust(b);</pre>	
data = b(:);	
% Number of clusters	
num_clust = 2;	
% Fuzzy C-means classification with 3 classes	
[~.U.~] = fcm(data.num clust):	
[,,,,](	
% Finding the pixels for each class	
maxU = max(U);	
<pre>fcmImage(1:length(data))=0;</pre>	
for n c= 1:num clust	
$index1\{n c\} = find(U(n c.:) == maxU):$	
end	

% Assigning pikel to each class by giving them a specific value fcmImage(index1{1,1}) = 0.9; fcmImage(index1{1,2}) = 0.5; [M,N] = size(b); % Reshapeing the array to a image b = reshape(fcmImage,M,N); %figure;imshow(b,[]); imshow(b,'Parent',app.UIAxes8);

end

Figure 4.1.2: The Coding for Button "Fuzzy C-Mean" And Display A Converted FCM Image



Figure 4.1.3 : The Coding for Detect A Tumor and Display the Size of Tumor



Figure 4.1.4 : The Coding to Display Converted Edge Detection Image Using Sobel Method



Figure 4.1.5 : The Coding to Reset Back the App Designer GUI

Next to run the GUI, the "Run" button will need to be pressed which will pop up a "MATLAB APP" window as show below:

MATLAB Ann			1 0 0		- 0 X
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		0	0.5 1 X	0 0.5 0 0.5 X	5 1
Select Image	)	1	SHAPE OF TUMOR		TUMOR
Edge Detection	)	≻ 0.5		≻ 0.5	
Tumor Alone Detected Tumor	J	0	0.5 1 X	0 0.9 X	5 1
Fuzzy C Mean	)	1 1	UZZY C MEAN IMAGE		
Patient Name		≻ 0.5			
Tumour Size (mm) 0		0	0.5 1 X		
Reset	J				

Figure 4.1.6 : The Display Window of GUI

Then, press the "Select Image" button to call or search any jpg file of DICOM image from computer. For example, the data that been pick is "1-145.jpg" as show below.



Besides that when select an image, it also will display the patient name in the EditField. The example is as below which it displaying Patient Name "1-145.jpg":

	A 100			1		1				
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							IMAGE	TYPE		
	DICOM IMAGE	RSI	TI	TEKN	IKAL	IMAGE WITH TUN	IORA	MELA	EDGE DETE	CTION
					≻ 0.5			≻ 0.5		
					0	0.5	1	0	0.5	1
						Х			Х	
	Select Image				1	SHAPE OF TUMO	DR	1 1	DETECTED T	UMOR
	Edge Detection	)			≻ 0.5			≻ 0.5		
	Tumor Alone	)			ol	0.5		٥,	0.5	
	Detected Tumor	)			0	X		0	X	
		J				FUZZY C MEAN IM	AGE			
	Fuzzy C Mean	)			1					
Patient	Name 1-145.jpg	9			≻ 0.5					
Tumour Size	(mm) 0				0	0.5	1			
	Reset	)				Х				

Figure 4.1.8 : The DICOM Image of Patient 1-1.45 with Patient File Name

After display the DICOM image (Original image), click "Edge Detection" button to display the processed edge detection image to identify points in a DICOM image that has a discontinuities because of the sharp changes in the image brightness. The result is as below:



Figure 4.1.9 : The Edge Detection Image Using Sobel Method

After that to find the tumor as well as its size, first of all the tumor needs to be detected using the "Regionprop" function. However, because there are many objects in the DICOM image that make it difficult for the app designer to detect, another function has been used which is "Circle" function to limit the parts that have tumors only. By pressing "Tumor Alone" button, a new window with original DICOM image will pop up asking to circle the potential area of tumor. The result is as below:





MATLAB App			
	IMAGE TYPE		
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Edge Detection	× 2. 1	≻ 0.5	
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Detected Tumor	Х	x	
Fuzzy C Mean	FUZZY C MEAN IMAGE		
Patient Name 1-145.jpg	≻ 0.5		
Tumour Size (mm) 0	0 0.5 1		
Reset	X		

Figure 4.2 : The Image Before Circle (upper left) and After Image Circled (upper right) as well as Image with Circle and Circled Image Displayed in GUI (below)

As can see in figure above when the tumor is circled, it will display the circled image and image with a circle in the GUI. After that, press the "Detected Tumor" button to region the area of tumor that exist in the circled image as well as to measure the size of tumor.

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матьав арр	1	
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Detected Termon	Х	Х
Fuzzy C Mean	FUZZY C MEAN IMAGE	
Patient Name 1-145.jpg	] ≻ 0.5	
Tumour Size (mm) 31	0 0.5 1	
Reset	X	

Figure 4.2.1 : The Shape Region of the Tumor with the Size of Tumor

Lastly, click "Fuzzy C Mean" button to display the processed Fuzzy C Mean Clustering segmentation image in App designer GUI. The "Fuzzy C Mean" button can be press manytime to get different iteration. The result is as show below:



As can been seen here is the final result that be obtained for this project. So, figure 4.3 is the image data of patient which is based on dataset at The Cancer Imaging Archive (TCIA) and figure 4.3 is the result from using an Edge Detection method while figure 4.4 is a result that been obtained after segmenting the image using Fuzzy C-mean method through code by using App Designer software (Refer Appendix D).



Figure 4.4 : DICOM Image Using Fuzzy C-mean Image Segmentation with 2 Cluster

## 4.2.3 Output Results

Stated here in Figure 4.5 is the overall output result of "Lung Cancer Detector" application for this project that been obtained by using data patient 1-145.dcm. In this figure, it contain the original DICOM image, Edge Detection image, the circle image of tumor (red), the region detect tumor (yellow) and Fuzzy C-mean (FCM) image. To reset the GUI, press the "Reset" button (Refer Appendix E for the coding)



Figure 4.5 : The "Lung Cancer Detector" Application

# 4.3 Analysis Result Size between App Designer and Dataset

Finally, the results from the previous subtopic on tumor size must be analyzed and compared to the valid medical dataset provided by the project supervisor via Microsoft Excel. The purpose of this analysis and comparison is to ensure that the result obtained in the App Designer is identical to or a bit same to the size of tumor in dataset. Below in Table 4.0 is three example of image from TCIA dataset which been used to analysis and compare the size of tumor between both value.

Number of Patient Name	DICOM Image with Size of tumor in App Designer (mm)	Size of tumor in Dataset (mm)	Percentage of Difference
A181 (1-145)		31.25	$100 - \left(\frac{31.25 - 31}{31.25}\right)$ = 99.992%
5	Patient Name Tumour Size (mm)	ۇىرسىتى تې	اوني
UN A197 (1-086)	IVERS Patient Name Tumour Size (mm) 1-086.jpg 24.68	26.4	$\frac{4 \times 4}{100 - \left(\frac{26.4 - 24.68}{26.4}\right)} = 99.935\%$
A230 (1-041)	Patient Name 1-041.jpg Tumour Size (mm) 32.54	32.81	$100 - \left(\frac{32.81 - 32.54}{32.81}\right)$ $= 99.992\%$

Table 4.0 : Analysis And Comparison of Size Tumor
#### 4.4 Discussion

At the end of this chapter, it can be say that the project "Development Of Computed Tomography Lung Cancer Analysis Using Image Processing" was succesfully developed after a lot of research and trial been done as well as a lot of obstacle and error that happen all the way to complete this project. This thesis require an App Designer as the main GUI for this project which is through MATLAB software. In this project as mention before, it's using a Fuzzy C-Mean clustering method which is the main method of this project to detect the tumor and also the main reason of this project goal. But to achieve the target goal, the GUI need to be design first by using App Designer which at the end of this project must contain the original DICOM image, Edge Detection image, the circle image of tumor, the region detect tumor and Fuzzy C-mean (FCM) image. To do this, certain coding need to be wrote and create in the App Designer with a few reference and help from various source in the Internet. However, certain modifications must be performed on the coding to meet the criteria and objectives that have been planned before as well as to ensure that the coding is suitable and adaptable with the project. Besides the code for images, there are also other code that need to devolop which is code for display patient name and also the most important thing, display the measured size of tumor. All this code requires a lot of effort to create because "App Designer" is the latest version of "Guide" software in MATLAB so there are not a lot of example in internet to refer as a reference and because of this reason, the possibility to create a functional coding is low and always come to a error and failed code. Lastly when all the code for each of the method and function is successfully created, the App Designer can now run. By pressing each of the button in the GUI sequentially, it will display all the image as well as the size of tumor and patient name same as show in 4.2.3, Output Result. To set the App Designer GUI back to initial, press the reset button and the GUI is ready for another input dataset.

#### **CHAPTER 5**

#### **CONCLUSION AND RECOMMENDATIONS**

#### 5.1 Conclusion

At the end of this semester, this project is able to completed and successfully achieve its goal where all the objectives that have been planned in the beginning are expected to completed. In addition, the data that been collected and obtained from the TCIA and LIDC portal will be used to observed and studied first using theoretical method as well as experimental method throughout completing this project period which is very useful in developing our lung cancer system project. With all the research and the data that has been successfully obtained and studied, it is hoped that it will only lead to the achievement of completing all the objective that been stated in the report and project but also helps in resolving all the difficulties in the completing this project. As a result, this project able to proceed further in progress to develop a Computed Tomography Lung Cancer System by using this Fuzzy C Means method. So, the first objective of this project is to understand the basic fundamentals of CT-scan and develop a computed tomography lung cancer analysis using image processing through application in MATLAB software. These are the key basic knowledge that need to be known to ensure that this project works as desired and always on the right track. Besides that, the objective also focus on designing and creating a Graphical User Interface (GUI) which can detect cancer node as well as the stage of the node cancer using a MATLAB software. This is to ensure that the GUI operated as requested which can read and analyse each of the data given along with all the detail regarding the data. Finally, the objective of this project is also aimed to propose to use a Fuzzy C-Means clustering method for lung cancer segmentation and edge extraction and to analyse the output image of the cancer as well as measure the diameter size of cancer node that obtained from the output by using GUI that been created in App Designer through MATLAB. Finally, the diameter size of cancer nodes obtained through the App Designer shall be compared to the valid medical dataset provided by the project supervisor in order to analyse and observe the difference between both value of size tumor.

#### 5.2 Future Works & Recommendation

Computed tomography (CT) has made enormous technical advances since its introduction into the world especially in medical use. Now days, CT still one of the useful method in diagnosis and detecting diseases and injuries which normally can not be seen by human eye. But even with this accomplishment, CT still have some problem especially in accuracy and precision in medical image segmentation to detect a cancer tumor. This happen because of interference of image noise which happen in the image as well as the problem detecting the edge region of the exact value of cancer which occur during segmentation process. So an improvements in image segmentation in medical field need to be done in the future to ensure the accuracy and precision of tumor cancer region for the safety of human health. For future improvements, accuracy and precision of tumor results could be enhanced as follows:

- By using and testing various type of segmentation method (eg: Region-based Segmentation or Edge Detection Segmentation) to identify Region of Interest that exist in the image as well as to get a better region edge probability during segmented the image.
- ii) By using clustering technique method (e.g: Fuzzy C-Mean or Thresholding) to identify two or more group of classes (colour) in an image dataset which will help to arrange the pixel exist in image and also to locate the region of tumor.

#### 5.3 **Project Potential**

As for the project potential, image processing as all know is a advanced technology which be used to improve the quality of an image, or to help extract useful information from it. It's useful in fields like medical imaging in diagnose to seek diseases related to inner structure of human body. For example in medical field, scientists study the inner structure and tissues of organisms through CT- scan image dataset in order to help identify anomalies faster. As for clinical or hospital fields, image processing used in medical imaging can help produce a high-quality, clear images for scientific and medical reseach, ultimately helping doctors diagnose diseases. From this, it can be say that image processing is helping to solve any problem related to image in medical fields nowadays. So the potential of the project undertaken through this thesis is to help provide important diagnostic information that medical researchers are looking all this time as well as for research purposes and possibly to treat any problem that occur in medical field. In addition, this project is also been create as a tool to facilitate the work in detecting diseases such as tumour growth in the body more easier without going through many procedure just for detecting single tumour. So this project is an example of simple medical graphical user interface (GUI) for detection of tumour and suitable for public user especially medical expect such as clinic or hospital doctors.

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#### APPENDICES

#### Appendix A : Code for Read DICOM Image In App Designer

#### **CODING**



## **IMAGE CODING FROM APP DESIGNER**

📣 A	App Designer - C:\Users\Acer\LungCancerDetector.mlapp							
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PP LAYOUT	34 · 35 · 36 · 37 ·			a=uint8 app.Ima app.Pat	ie=strcat() 3(imread(fi age.ImageScientNameEc	patnname,Fil ullname)); ource = full ditField.Val	lename); lname; lue=filename;	
A	38 -	-		end				

#### **Appendix B : Code for Segmented Edge Detection In App Designer**

#### **CODING**

% Button pushed function: EdgeDetectionButton function EdgeDetectionButtonPushed(app, event) global a; bw=edge(a,'sobel','nothinning'); imshow(bw,'Parent',app.UIAxes10); end

### **IMAGE CODING FROM APP DESIGNER**



## Appendix C : Code for Circle Area Tumor And Detect Automatically The Circled Cancer & Measure Size of Cancer Tumor

## CODING (CIRCLE AREA OF POTENTIAL CANCER TUMOR)



```
% Show circle over image.
subplot(2, 2, 1);
imshow(a);
axis('on', 'image');
hold on;
plot(x, y, 'r-', 'LineWidth', 2);
title('Image with Tumor');
% Display image with Tumor
imshow(a,'Parent',app.UIAxes6);
hold(app.UIAxes6,"on");
axis('on', 'image');
hold on;
             AALAYSIA
plot(app.UIAxes6, x, y, 'r-', 'LineWidth', 2);
hold(app.UIAxes6,"off");
% Get a mask of the circle
mask = poly2mask(x, y, rows, columns);
subplot(2, 2, 2);
imshow(mask);
axis('on', 'image'); SITI TEKNIKAL MALAYSIA MELAKA
title('Tumor Alone');
% Mask the image with the circle.
if numberOfColorChannels == 1
     maskedImage = a;
     maskedImage(~mask) = 0;
else
      maskedImage = bsxfun(@times, a, cast(mask, class(a)));
end
```

#### % Crop the image to the bounding box.

props = regionprops(mask, 'BoundingBox');

maskedImage = imcrop(maskedImage, props.BoundingBox);

imshow(maskedImage,'Parent',app.UIAxes7);

end

## CODING (DETECT CANCER TUMOR & MEASURE SIZE)

```
% Callback function: DetectedTumorButton,
% TumourSizemmEditField
function DetectedTumorButtonPushed(app, event)
    global maskedImage;
    bw=im2bw(maskedImage,0.3);
    label=bwlabel(bw);
    stats=regionprops(label,'Solidity','Area');
    density=[stats.Solidity];
    area=[stats.Area];
    high_dense_area=density>0.1;
   max_area=max(area(high_dense_area)); MALAYSIA MELAKA
    tumor_label=find(area==max_area);
    tumor=ismember(label,tumor label);
    se=strel('square',5);
    tumor=imdilate(tumor,se);
    imshow(tumor,'parent', app.UIAxes9);
    B=bwboundaries(tumor,'noholes');
    imshow(maskedImage);
    hold on
      for i=1:length(B)
        plot(B{i}(:,2),B{i}(:,1), 'y', 'linewidth',1.45);
```

end hold off;

#### % Display image with Tumor

imshow(maskedImage,'Parent',app.UIAxes7);

hold(app.UIAxes7,"on");

axis('on', 'image');

hold on;

plot(app.UIAxes7, B{i}(:,2),B{i}(:,1),'y', 'linewidth', 1.45);

hold(app.UIAxes7,"off");

title('Shape of Tumor');

#### % Measure size Tumor

measurements = regionprops(tumor, 'area');

area= measurements.Area;

area=sqrt(2\*area/pi);

ģ.

app.TumourSizemmEditField.Value=area;

end

#### IMAGE CODING FROM APP DESIGNER (CIRCLE AREA OF POTENTIAL CANCER TUMOR)

13.9

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	Q	ą	ę	9	斜 Go To 🔻	Comment % %	Enable and coding alerts	?			
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FILE		II	NSERT		NAVIGATE	EDIT	VIEW	RESOURCES	RUN		
Lung	CancerDetect	or.mlapp ×									
VSER	55										
BROV	40	% Button pushed function: TumorAloneButton function TumorAloneDetectedButtonPushed(app, event)									
42 - global a; global maskedImage;											
5	44 - 45 -	<pre>[rows, columns, numberOfColorChannels] = size(a); imshow(a);</pre>									
8	46 -	axis('on', 'image');									
2	47 -	g = gcf;									
APF	48 - 49		g.Windo	wState = '	maximized;						
	50		% Ask u	ser to dra	w a circle:						
	51 -		uiwait(	helpdlg('P	lease click	and draw out a c	<pre>ircle.'));</pre>				
	52 -		h.Radiu	s = 0;							
	53		while h	.Radius ==	0		4) -				
	54 -		n =	b Padius -	= 0	κ, FaceAlpha ,0.	4);				
	56 -		11	uiwait(he	lndlg('You )	double-clicked	You need to single cli	ck then (	irag then single c	lick again ')).	
	57 -		end	aznaz c(ne		addie erreneu.	The field to bingle cli	ency enter t	n og, enen singre e	1100 ugu100 //),	
	58		end								

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ER		
MC	60	% Get coordinates of the circle
BR	61 -	angles = linspace(0, 2*pi, 10000);
В	62 -	x = cos(angles) * h.Radius + h.Center(1):
00	63 -	y = sin(angles) * h.Radius + h.Center(2);
	64	
5	65	% Show circle over image.
2	66 -	<pre>subplot(2, 2, 1);</pre>
A.	67 -	imshow(a);
PP	68 -	<pre>axis('on', 'image');</pre>
_	69 -	hold on;
	70 -	<pre>plot(x, y, 'r-', 'LineWidth', 2);</pre>
	71 -	title('Image with Tumor');
	72	
	73	% Display image with lumor
	74 -	Imsnow(a, Parent, app.utAxeso);
	75 -	avid (apt. i lagard);
	70 -	hold on ; Image );
	78	nortann UTAxes6 x y 'r-' 'lineWidth' 2).
	79 -	hold(app.UIAxes6."off"):
	80	
	81	% Get a mask of the circle
	82 -	<pre>mask = poly2mask(x, y, rows, columns);</pre>
	83 -	<pre>subplot(2, 2, 2);</pre>
	84 -	<pre>imshow(mask);</pre>
	85 -	axis('on', 'image');
	86 -	<pre>title('Tumor Alone');</pre>



# IMAGE CODING FROM APP DESIGNER (DETECT CANCER TUMOR & MEASURE SIZE)

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SEP			
≥ 136	% Callback function: DetectedTumorButton,		
· Handler 137	% TumourSizemmEditField		
出 138	function DetectedTumorButtonPushed(app, event)		
8 139 -	global maskedImage;		
140 -	bw=im2bw(maskedImage,0.3);		
⊨ 141 -	label=bwlabel(bw);		
<b>5</b> 142			
₹ 143 -	<pre>stats=regionprops(label,'Solidity','Area');</pre>		
<u>a</u> 144			
₹ 145 -	density=[stats.Solidity];		
146 -	area=[stats.Area];		
147			
148 -	high_dense_area=density>0.1;		
149 -	<pre>max_area=max(area(high_dense_area));</pre>		
150 -	<pre>tumor_label=find(area==max_area);</pre>		
151 -	<pre>tumor=ismember(label,tumor_label);</pre>		

-	🚯 App Designer - C/\Users\Acer\LungCancerDetector.mlapp						
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E							
SM	152						
1 2 2	153 -	<pre>se=strel('square',5);</pre>					
μ	154 -	<pre>tumor=imdilate(tumor,se);</pre>					
	155 -	<pre>imshow(tumor, 'parent', app.UIAxes9);</pre>					
0	156						
_	157 -	B=bwboundaries(tumor, 'noholes');					
15	158 -	<pre>imshow(maskedImage);</pre>					
₩.	159 -	hold on					
	160 - 😑	<pre>for i=1:length(B)</pre>					
AP	161 -	plot(B{i}(:,2),B{i}(:,1), 'y' ,'linewidth',1.45);					
-	162	end					
	163 -	hold off;					
	164						
	165	% Display image with Tumor					
	166 -	<pre>imshow(maskedImage,'Parent',app.UIAxes7);</pre>					
	167 -	hold(app.UIAxes7,"on");					
	168 -	axis('on', 'image');					
	169 -	hold on;					
	170 -	plot(app.UIAxes7, B{i}(:,2),B{i}(:,1),'y', 'linewidth', 1.45);					
	171 -	hold(app.UIAxes7,"off");					
	172 -	title('Shape of Tumor');					
	173						
	174	% Measure size Tumor					
	175 -	<pre>measurements = regionprops(tumor, 'area');</pre>					
	176 -	area= measurements.Area;					
	177 -	area=sqrt(2*area/pi);					
	178 -	app.TumourSizemmEditField.Value=area;					
	179	end					



#### Appendix D: Code for Method Fuzzy C-Mean (FCM) In App Designer

#### **CODING**

```
% Button pushed function: FuzzyCMeanButton
function FuzzyCMeanButtonPushed(app, event)
    global maskedImage;
    global b;
    b = im2double(maskedImage);
    b = imadjust(b);
    data = b(:);
    % Number of clusters
    num_clust = 3;
    % Fuzzy C-means classification with 3 classes
    [~,U,~] = fcm(data,num clust);
    % Finding the pixels for each class
    maxU = max(U);
                                (NIKAL MALAYSIA MELAKA
    fcmImage(1:length(data))=0;
    for n_c= 1:num_clust
      index1{n c} = find(U(n c,:) == maxU);
    end
    % Assigning pixel to each class by giving them a specific value
    fcmImage(index1{1,1})= 0.9;
    fcmImage(index1{1,2})=0.5;
    fcmImage(index1{1,3})=0.3;
    [M,N] = size(b);
```

## % Reshapeing the array to a image b = reshape(fcmImage,M,N); %figure;imshow(b,[]); imshow(b,'Parent',app.UIAxes8); end

## **IMAGE CODING FROM APP DESIGNER**

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E S	
No 101 ₩ 102 ₩ 103 □	% Button pushed function: FuzzyCMeanButton <pre>function FuzzyCMeanButtonPushed(app, event)</pre>
8 104 -	global maskedImage;
105	global b;
5 106 -	<pre>b = im/double(maskedimage); b = im/dist(b):</pre>
¥ 108 -	data = b(:);
L 109	
₹ 110	% Number of clusters
111 -	num_clust = 3;
112	
113	% Fuzzy C-means classification with 3 classes
114 -	[~,v,v,~] = tcm(data,num_clust);
115	% Finding the pixels for each class
117 -	maxU = max(U):
118 -	<pre>fcmImage(1:length(data))=0;</pre>
119 - 🖨	for n c= 1:num_clust
120 -	<pre>index1{n_c} = find(U(n_c,:) == maxU);</pre>
121	end end
122	webber of a state of the state
123	A Assigning pixel to each class by giving them a specific value
124 -	formane (index[1]) = 0.9,
125 -	fcmirage(index[ $\{1,3\}\}$ ) = 0.3:
127 -	[M,N] = size(b);
128	
129	% Reshapeing the array to a image CALLER ALLER ALLER ALC ALC ALC A
130 -	b = reshape(fcmImage,M,N);
131	
132	<pre>%rigurejumsnow(0,[]); imcharchildenandi.acm UTAxac9);</pre>
133 -	and (a) farenc ,app.oiAxes8);
154	enu

#### **CODING**



### **IMAGE CODING FROM APP DESIGNER**

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SER		
Ň	187	
BR	188	% Button pushed function: ResetButton
E H	189 🗎	function ResetButtonPushed(app, event)
10	190 -	global a;
_	191 -	global maskedImage;
5	192 -	global b;
õ	193 -	global tumor;
A	194 -	global bw;
d d	195 -	app.UlAxes6.cla;
A	196 -	
	197 -	app.ulaxes/.cla;
	198 -	maskedimage= ;
	199 -	app.utaxess.cia;
	200 -	
	201 -	turen "
	202 -	ann Ultiver10 slav
	203 -	app.olaxesio.cla,
	204 -	00-, 200 Image ImageSource-"".
	205 -	and
	200	end
	207	CIN