A DEEP LEARNING ALGORITHM TO DIAGNOSE BREAST CANCER AMONG FEMALE

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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DECLARATION

I declare that this report entitled "A Deep Learning Algorithm to Diagnose Breast Cancer Among Female" is the result of my own work except for quotes as cited in the references.

Signature :

Author : SITI SUHAILAH BINTI ABDUL RAHMAN

Date : …19/8/2020……

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature : ……

Supervisor Name : ……

Date : …19/8/2020……

DEDICATION

With this study's success, I am indebted to God for all the blessings in terms of balanced living and well-being. This research is dedicated to my dad and mom, Abdul Rahman Bin Abdul Majeed and Juraidah Binti Sukin. They have supporting me to go through all the difficulties until I was becoming successful in my life. Thank you for raising me with all the support and write to me when I am doing the wrong thing. Besides, I feel so thankful to Dr. Syafeeza Binti Ahmad Radzi as my supervisor, who always guides hands and me out the knowledge to complete the project.

ABSTRACT

Breast cancer is an infection in which cancer is found and develops in the tissue of the breast. Presently, approximately 1 in 30 females in Malaysia has started to have breast cancer in their lifetime. Hence, the early detection of breast cancer by the radiologist can stop these health issues from becoming chronic and may facilitate the patient to treat adequately based on the histopathology image (image of tissues and cells). Breast cancer categorized into two types, which are malignant and benign. A mammogram is one of the essential criteria that could detect abnormality if exist areas of white, high-density tissue depending on the size, shape, and edges of the breast cancer. However, the doctors have a difficult time detecting breast cancer due to the complex structure of mammogram images, and the ability of a digital screening mammogram is limited in the extremely dense breast with 60-70% detection accuracy. With the advent of the Computer-Aided Diagnosis (CAD) system, recent researches have shown that the deep learning techniques applied to classify various cancers based on histopathology images. Besides, the growth of the Convolutional Neural Network (CNN) is helpful in systems for detecting relatively whether the tumor is malignant or benign. The classification result may guide the doctors to develop a more realistic treatment plan that provides an early detection result and intervention besides can aid the patients in obtaining an accurate diagnosis. By using deep learning techniques, it expects to create an algorithm that can classify between benign and malignant factual. This project has proven that CNN architecture has successful obtained higher accuracy which for VGG-19 has accuracy of 91% while for VGG-16 has the accuracy of 94.34%.

ABSTRAK

Kanser payudara adalah jangkitan di mana kanser ditemui dan berkembang dalam tisu payudara. Pada masa ini, kira-kira 1 dalam 30 wanita di Malaysia telah mula mempunyai kanser payudara dalam jangka hayat mereka. Oleh itu, pengesanan awal kanser payudara oleh Radiologi boleh menghentikan masalah kesihatan ini daripada menjadi kronik dan boleh memudahkan pesakit untuk dirawat secukupnya berdasarkan imej histopathologi (imej tisu dan sel). Kanser payudara dikategorikan kepada dua jenis, iaitu malignan dan tidak berbahaya. Mammogram adalah salah satu kriteria penting yang boleh mengesan abnormaliti jika wujud kawasan putih, tisu berkepadatan tinggi bergantung kepada saiz, bentuk, dan tepi kanser payudara. Walau bagaimanapun, doktor mempunyai masa yang sukar untuk mengesan kanser payudara kerana struktur kompleks daripada imej mammogram, dan keupayaan sebuah gergasi yang saringan digital adalah terhad dalam payudara yang sangat padat dengan ketepatan pengesanan 60-70%. Dengan adanya sistem diagnosis bantuan komputer (CAD), penyelidikan terkini telah menunjukkan bahawa teknik pembelajaran mendalam digunakan untuk mengelaskan pelbagai jenis kanser berdasarkan imej histopathologi. Selain itu, pertumbuhan Rangkaian neural Convolutional (CNN) membantu dalam sistem untuk mengesan dengan agak sama ada tumor adalah malignan atau tidak berbahaya. Keputusan pengelasan boleh membimbing doktor untuk membangunkan pelan rawatan yang lebih realistik yang menyediakan hasil pengesanan awal dan intervensi selain dapat membantu pesakit dalam mendapatkan diagnosis yang tepat. Dengan menggunakan

teknik pembelajaran dalam, ia menjangka untuk mencipta satu algoritma yang boleh mengelaskan di antara fakta yang tidak berbahaya dan malignan. Projek ini telah membuktikan bahawa senibina CNN berjaya memperoleh ketepatan yang lebih tinggi yang mana untuk VGG-19 mempunyai ketepatan 91% sementara untuk VGG-16 mempunyai ketepatan 94.34%.

ACKNOWLEDGEMENT

Firstly, I am so grateful to Allah S.W.T, who gives me his blessing and strength to complete this report. I want to take this opportunity to express my sincere appreciation. I thank my dedicated supervisor Dr. Syafeeza Binti Ahmad Radzi, for his guidance, useful time, support, feedback, and motivation to finish my report. It helps me a lot during completing my project.

I want to continue my thanks to my friends who always help me and give me morally during my hard time completing this project. At last, special thanks to the most important people, my parents, for loving and supporting me. They always encourage me not to giving up on achieving something.

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LIST OF ABBEREVATIONS

CNN	:	Convolutional Neural Network
CAD	:	Computer-Aided Diagnostic
FC Layer	:	Fully-Connected Layer
MIAS	:	Mammographic Image Analysis Society
VGG	:	Visual Geometry Group
GUI	:	Graphical User Interface
TP	:	True Positive
TN	:	True Negative
FP	:	False Positive
FN	:	False Negative

LIST OF APPENDICES

CHAPTER 1:

INTRODUCTION

Chapter 1 will include project background and problem statement, objectives, scope of work and project significance.

1.1 Project Background

Breast cancer categorized as one of the most frequently diagnosed among females, which can cause cancer deaths [1]. 47.5 out of ASR (Age-Standardized World) per 100,000 females in Malaysia are having breast cancer, which started in 2018, the International Agency Research on Cancer. However, the number of females that was having breast cancer in Malaysia is not quite high compared to another country. Belgium showed the highest rate of breast cancer in women, which is 113.2 out of ASR(World) per 100,000, and Luxembourg shows the second-highest, which is 109.3 out of ASR(World) per 100,000 stated by World Cancer Research Fund International.

Breast cancer is a condition where cells develop out of control in the breast. Breast cancer may start in various of the breast sections. The breast consists of three major components, namely ducts, lobules, and connective tissue. The tubes that were bringing milk to the nipple are called canals. Lobules function as the milk-producing glands while the connective tissue is consisting of fatty tissues and the fibrous that covers and holds it all together. Breast cancer mostly starts in the ducts and lobules area. Besides, any space that does not look like healthy tissue is a possible cause for concern. There are various types of breast cancer.

Among the kind, invasive lobular carcinoma and invasive ductal carcinoma categorized as the most prevalent type of breast cancer. Cancer cells of invasive ductal carcinoma are developed in other areas of the breast tissue outside the ducts, while cancer cells of invasive lobular carcinoma are growing out of the lobules to the nearby tissues of the breast. The most frequent cancer among females is breast cancer. Breast cancer symptoms consist of a breast lump or thickening, and the skin changes or the

nipple changes. Risk aspects may be genetic, but certain aspects of lifestyle, such as taking alcohol, make cancer more likely to occur.

Table1.1 Stages of Breast Cancer

Type of stages	Description of Stages
Stage 0	-There are abnormal cells in the breast but they have not spread to nearby tissue.
Stage 1	Early Stage -The cancer spreads in a small area to other tissues.
Stage 2	Localized - If there are no lymph nodes, the cancerous tumor may be 50 mm or larger. - The tumor can measure between 20-60 mm when lymph nodes are involved.
Stage 3	Regional Spread - The tumor was larger than 50 mm and the lymph nodes in a wider region. Cancer can spread to the skin or chest wall in cases where there is no tumor.
Stage 4	Distant Spread - Cancer cells in other parts of the body have spread.

Table 1.1 shows the stage of breast cancer used by clinicians to classify the method for them to cure the patient of breast cancer. Five stages of breast cancer start

from stage zero that shows abnormal cells in the breast, but they have not spread to the tissue. The last step, which is stage four, also called distant spread, shows cells of cancer in other parts of the body has spread. Radiologists and Pathologists are responsible for the determination of breast cancer. Radiologists will interpret diagnostic imaging of breast cancer screening mammograms and send the sample tissue to the Pathologists. Pathologists will be responsible for the diagnosis, whether it is a cancerous cell or not based on tumor cells taken under a microscope. The pathological consultation report will also include information on breast cancer staging, such as TNM status.

Mammography is a popular protocol of screening which may assist in differentiate dubious regions from the breast. Mammography is also a biopsy of possibly cancerous areas to decide whether the suspicious part or area is benign or malignant [2], [3]. There are two types of mammograms. Among the kind, screening and diagnostic mammograms commonly used by a doctor to diagnose cancer cells in the breast. The screening mammogram used to test the looks of breast cancer among women without symptoms show. The aim is to catch the disease early if it can treat better. For a diagnostic mammogram, it is usually detecting the specific sign among women. Typically, a diagnostic mammogram requires more breast pictures than a mammogram test. Despite the significant improvement of these technologies for imaging, pathologists will incline to visually examine the ultimate diagnosis of histological samples under the microscope, including grading and staging [4].

However, from mammographic screening, a lot of cancers limited by dense tissue of the breast. Besides, the mammographic selection also can cause the human error because of the less accuracy in detection. The false-positive mammography tests

and unnecessary biopsies are also increased [5]. In the hospital, there are so many image data that need to identify by the doctor to detect whether the patient is benign or malignant of breast cancer. The rate of detection is as low as 60 –70 percent [6].

The advancement of computerized engineering, which is computer-aided diagnostic (CAD) method, has been placed to detect breast cancer using histopathology image in medical institutions. CAD also lead to scientific criteria which to boost productivity and to achieve a correct conclusion. Three elements involved in the CAD system, which are to be segmented, feature extraction and identified and also classifying. But for this case, it needs the professional radiologists and pathologist to classify the correct breast cancer grouping, and it takes a longer time for the medical team to have experienced in detecting the image and classify the precise of the breast cancer cell. In respect to these implications, the CAD technology has developed to a multi-layer of deep-learning.

Recently, several researchers acknowledge that deep learning architecture is an ideal way to predict and treat breast cancer. Among the all listed method in deep learning, Convolutional Neural Network (CNN) is choosing in this research because of CNN potential in classifying the breast cancer accurately. CNN functions as to differentiate the type of breast cancer separately through three central part, which is pre-processing the data, feature extraction image data and segmentation. Through this approach, this project will allow radiologists and pathologists to determine the cancer pattern in the human breast accurately.

1.2 Problem Statement

For these issues, there is a need for processes and procedures that can enhance the detection and specificity the breast cancer most accurate. The known of Computer-aided diagnostic (CAD) systems developed to assist radiologists in interpreting a diagnostic image of breast cancer screening mammograms and send the sample tissue to the Pathologists. It also helps pathologists for diagnosis, whether it is a benign or malignant of the breast based on tumor cells taken under a microscope. Several kinds of research proposed that the CAD model can be integrated [7–9] in the breast screening diagnostic process. This step will improve routine diagnostic quality and quantitative support for clinical decisions. In past studies, these steps addressed to identify the discriminatory characteristics for classifying breast cancer, whether it is benign or malignant. However, these steps involve complicated tasks such as post-processing and pre-processing steps. Besides, these steps rely on an understanding of processing images from critical domain experts. Despite this technique, several CAD systems have generated to solve these problems using multilayer deep-learning architecture.

This research aims to design a deep learning model in detecting benign or malignant breast cancer. The deep learning type used in this proposed research is known explicitly as a Convolutional Neural Network (CNN). CNN has a better performance in biomedical image analysis, such as detecting mitosis cells from microscopic images. The development of the Convolutional Neural Network (CNN) is useful for the identification of cell cancer and categorized it as benign or malignant in pictures of the breast. CNN combines segmentation, feature extraction, and ranking in one single module. The module is a feature extractor, so the designer doesn't have to come

out with an algorithm to extract the features as CNN has taken care of that function. Besides, signal decomposition is not needed as long as we know the classification labels for each data. Practically, the proposed method can implement as a decision support system to help clinicians make decisions and perform actionable intervention strategies for detecting the cancerous or non-cancerous of breast cancer.

1.3 Objectives

They are three objectives that need to be achieved after completing this project which are:

1) To classify the data sample either it is a benign or malignant breast cancer using Convolutional Neural Network (CNN).
2) To analyze VGG-16 and VGG-19 models of Convolutional Neural Network (CNN) to recognize breast cancer classification.
3) To validate the performance of Convolutional Neural Network (CNN) technique in term of accuracy.

Based on the objective stated above, the purpose of this project is to design a deep learning-based system using CNN for image classification breast cancer.

1.4 Research Question

Since this project is intended to help in understanding the significance of breast cancer by implies of a classification method, study questions in this research are:

1) How the data sample can be categorized into its classes?

2) What is the model used to classify the data sample into their classes?

3) What need to be analyzed at the performance of Convolutional Neural Network (CNN)?

1.5 Scope of Work

The project aims to propose a Convolutional Neural Network (CNN) system in detect the cancer and classifying into benign or malignant breast cancer. Table 1.2 show the operating system used in this project, datasets framework, programming language, performance measure, hardware used, method, type of breast cancer and data sample sizes.

Table 1.2 Requirement for Convolutional Neural Network (CNN) of Deep Learning

Datasets Framework	Keras and Tensorflow
Programming language	Python
Performance Measure	Diagnose accuracy and computation complexity
Dataset	BreakHis Mammography
Method	Deep Learning - Convolutional Neural Network (CNN)
Type of Breast Cancer	Benign and Malignant.

1.6 Brief Description of the Methodology

This project methodology has three main part which consists of data collection and pre-processing, design of CNN model and performance evaluation. The data sample for breast cancer are collected from BreakHis dataset and mammography images. Both datasets will include benign and malignant sample of breast cancer. After that, data sample will be going through data processing. By performing data pre-processing, it will reduce some noise detection and it will perform a correct pattern for image sample. Image magnification, resizing and adjusting colour of image are common method for pre-processing. Resizing for all dataset images will follow the pixels size as prescribed. The resize images is then used for pre-training of CNN. The operation of pre-training will be started after the model of CNN was developed.

For data labelling, the samples will be labelled as benign and malignant. After data labelling, 10-fold cross-validation method was performed to identify an optimized architecture for model of CNN. If the system is working correctly, then the data will continue to be analyze for the results of CNN model. If the training system of CNN is unsuccessful, the operation of sample data will redo again until the working system is successful.

For the last part, the performance evaluation will be obtained from CNN model used in this project. The performance of the process will evaluate based on an accuracy of the system. In report writing, the performance of CNN model will be comparing to other architecture of CNN model. Besides, the objective of the project will be point out either it meets the requirement or not.

1.7 Thesis Organization

Five chapter contains in the thesis. For chapter 1, the thesis includes the project background, problem statement, objectives, scope of work, and project methodology with brief description.

In chapter 2, the thesis contains literature review of breast cancer, introduces of deep learning and Convolutional Neural Network (CNN) architecture.

For chapter 3, the thesis embraces about detail description in methodology. Flowchart for this project include data pre-processing, data labelling, model training of CNN and classification of data obtained.

In chapter 4, the thesis will explain the result obtained after from CNN model. The performance of CNN model will evaluate and then analyze the better classification for benign and malignant.

In last chapter which is chapter 5, the project will be conclude with the project's contributions. Besides, the improvement of the object will be described for future project.

CHAPTER 2:

BACKGROUND STUDY

Chapter 2 will discuss on background study which include an introduction, female breast, breast cancer, malignant and benign, deep learning and Convolutional Neural Network (CNN). Two type of breast cancer are being in this project for classification which are benign and malignant. The medical image use are histological images which are collected from BreakHis datasets and mammography image. Convolutional Neural Network (CNN) is the technique used for the project system. Besides, this chapter will include various of article about breast cancer, deep learning and CNN architecture.

2.1 Introduction

This chapter will be discussing breast cancer and deep learning architecture techniques. By using computer-aided diagnosis, this research aims to develop a state-of-the-art deep learning model in detecting benign or malignant breast cancer. The type of deep learning used in this proposed research is known explicitly as a Convolutional Neural Network (CNN). The development of the Convolutional Neural Network (CNN) is useful for the identify and classify of benign or malignant cells in images of the breast. The training dataset used for automatic classification in breast cancer is histology images collected from the BreaKHis dataset and mammography images.

2.2 Female Breast

Breast is one of the main parts of the human body. The human body consists of two breasts, and the anatomy of the female breast include skin, lobules, ducts, nipple, areola lymph nodes, and fibrous tissue, all on the chest wall [10]. Lobules also are known as milk glands that function as production and supply of milk. Then, lobules send the liquid to the nipple through a special duct. For the female person, they consist 12-20 lobes each of breast, and each of the nodes contains about 20-40 of the lobules [11]. The tubes that start from smaller ducts are combining jointly into the increasing of more giant cells that are attached to the breast lobules. Each breast consists of ten duct systems, and each tube of its own has open to the nipple.

Besides, the pigmented layer of pink or brown colour around the nipple known as areola and the nipples that involve muscle tissues can react to stimulation and also breastfeeding by letting them become straight. Muscle tissue also functions to assist in pressing milk into the breast ducts that the lobules surround it. Areola has the glands

which the skin that contains the darken circle that all over the nipple. During breastfeeding, the liver produces a little volume of fluid to lubricate the breast nipple [12]. Apart from that, the breast also consists of the stroma, which includes adipose(fatty) tissues and ligaments enclose to lobules and ducts, lymphatic and blood vessels.

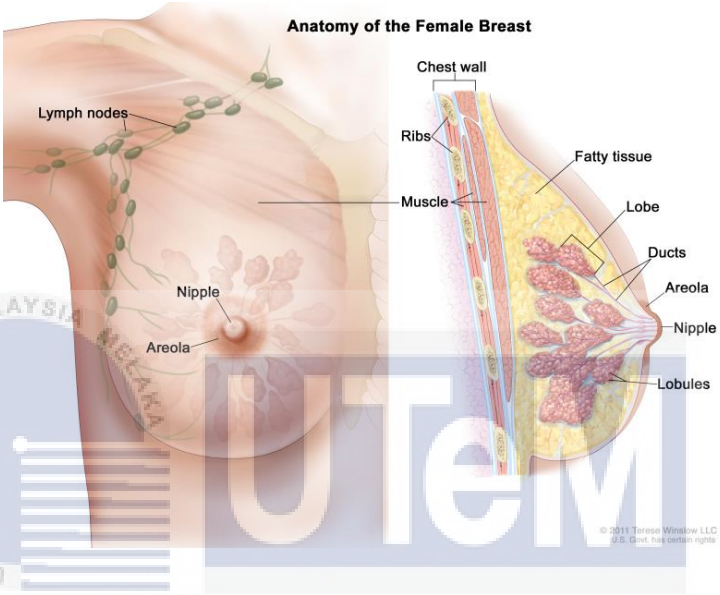


Figure 2.1 diagram of the Anatomy of the Female Breast

https://nbcf.org.au/about-breast-cancer/diagnosis/breast-cancer-anatomy/

[Source: 'National Breast Cancer Foundation']

Gain a piece of knowledge on breast anatomy essential for imaging of study. The specialist can avoid mistakes in treats the patient and not harm the patient. They also can identify the spot in the breast abnormality with the breast anatomy structure and lead them to diagnose the anomaly in the breast [13]. Besides, it helps the clinician to describe the identity in benign or malignant breast and assist them in managing the abnormalities of the breast [14].

2.3 Breast Cancer

Breast cancer is the particular diseases caused by cell growth and its spread into different parts of the body [15]. There are several symptoms of breast cancers in the human body, especially for females. Early warning signs of breast cancer can assist the patient by detecting the abnormality of their breasts such as visible lump, changes in the nipple, the colour or texture change, dimpled(depressed) skin and bloody discharge in nipple of the chest. The patient may notice early breast cancer if they see the difference of their breast, such as a remarkable piece contains swelling or lump in the breast, whether in the same area or around the nipple [16]. The cause of visible lump includes trauma, infection and cyst. The visible lump of the breast might spread in males and females, but visible pieces mostly happen in females.

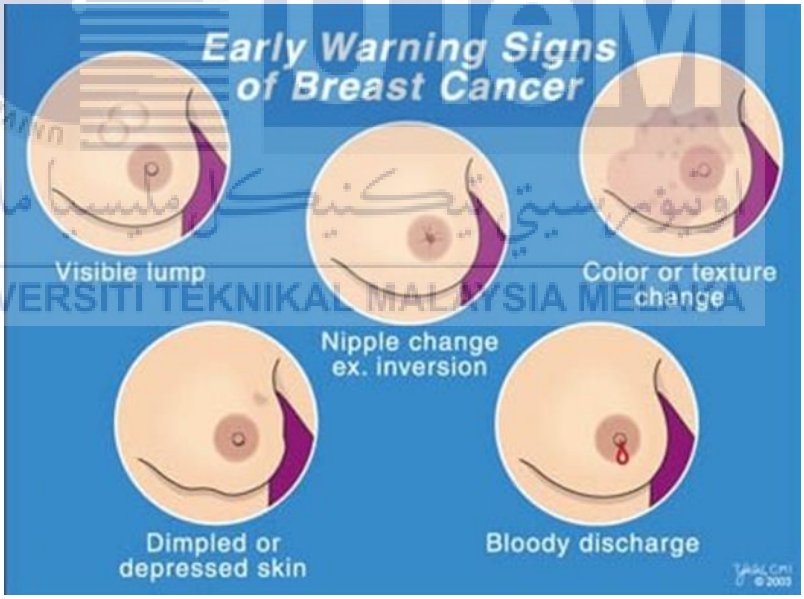


Figure 2.2 an Early Warning Signs of Breast Cancer

https://albieaware.org/five-things-friday-breast-cancer-symptoms/

[Source: 'Albie Aware Breast Cancer Foundation']

Besides, a human might detect the bloody discharge of nipple by the colour range from white to pale colour, then turn to yellow or green or red colour. For breastfeeding women, it is usual to have a discharge of nipple in milky colour. The bloody discharge of nipple other than breastfeeding is suggested to see a specialist to treat their sickness [17]. Bloody discharge usually is non-cancerous, but it can be a sign of breast cancer to some human. The reasons for the bloody discharge of nipple are infections of breast and a pill for birth control or picking some medication that has a side effect on the health of humans.

Colour or texture change in the breast are led to breast cancer because the cell of skin got swelling and colour changes in the nipple. Rough skin around the areola or nipple like the skin got inflamed, moles or extremely sharp are one of the examples for the modifications of texture [18]. Other than that, texture changes when some parts in the skin chest that have become thick and rashes can cause breast cancer. Skin infection and rashes that not becoming better within a few days can be a symptom of breast cancer. The texture changes can cause irritated among some people that can relate to breast cancer even though the case is not ordinary.

In nipple changes, the size, shape or colour of the nipple include in early signs of breast cancer by observing the difference of the nipple. Other than that, nipples that are retracted or inverted are a part of the sign-in breast cancer [19]. It happens when the nipples unexpectedly press in the direction of your body alternately showing out. When the nipple looks like an itchy rash, and it turns to red or purple colour, it shows the nipple has a sign of cancer. Breast cancer also happens when liquid other than breast milk that flows out of the nipples on its own. The liquid colour includes white, milky or some time it is blood colour [20].

To prevent this thing from occurs, the woman is responsible for taking care of their breast health. Breast cancer can be prevented if an early step has taken. Breast is a specialized part of the female body because it functions to produce milk for child and baby feeding. Table 2.1 shows the three Primary Steps Detection for Breast Cancer that should be noticed by a woman out there.

Table 2.1 Three Primary Steps Detection for Breast Cancer

STEPS	DESCRIPTION
1) Breast Self-Consciousness	• Recognize how commonly your breast feels and reacts such as lumps, size and shape changes, skin dimpling or puckering, discharge, etc. • If you spot a lump, nominate a doctor, but don't worry, most of the lumps are often not cancer.
2) Woman's Analysis	• Every year, women advised visiting their family doctor for a woman's Analysis. • Use the time to answer any questions or worries you have about your breast wellbeing with the doctor.
3) Mammogram	• When you are 40 years and older, a mammogram has recommended every year. Breast x-ray is healthy, fast and reasonably painless. • It is impossible to prevent breast cancer, but early detection offers the excellent capability of accurate diagnosis.

2.4 Benign and Malignant

Breast cancer consists of two kinds of variables, which are benign and malignant diseases. Benign is the condition where the breast is non-cancerous. Abnormality or changes happen in the chest sometimes is classify ad benign, which is not cancerous [21]. Harmless breast symptom was occasionally familiar with the breast cancer condition, which causes the patient to be scary with mild symptoms. The doctor may require further treatment for a patient who has a change in nipple or feel a lump in their breast even though the sign is just a benign breast condition. Any changes in the chest or the abnormality happen in the human breast must be looked over by a doctor. But the anomaly occurs in the breast become to be a benign symptom. Benign breast is quite popular in real life, and even it is more popular rather than breast cancer.

Malignant condition is referring to the term of breast cancer that the tumour has spread from cells in the breast. Malignant neoplasm starts in lobules cells, where the ducts from the lobules passing the drained milk to the nipple. Besides, it can begin in the tissue of stroma, which consists of fatty muscles and connective tissues of fibrous in the breast. The color of the breast cancer tumor is light brown, and its area surrounded by bright yellow color [22]. Cancer cells can occupy the breast tissue in good health by entering the lymph nodes. The lymph nodes function as filters out an external medium in the body. A cancer cell can spread into another part of the human breast or entity if they can depart into lymph nodes.

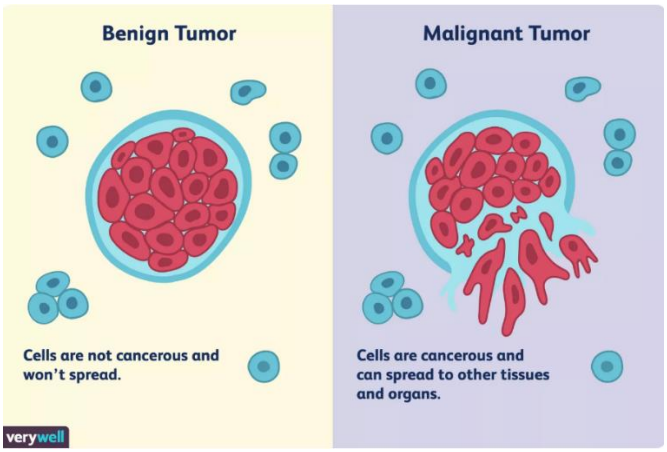


Figure 2.3 the Benign and Malignant Tumor

https://www.verywellhealth.com/what-does-malignant-and-benign-mean-514240

[Source: 'Very well Health, Joshua Seong']

2.5 Deep Learning

Deep learning has been introduced to assist the clinician in diagnosing breast cancer so that the patient can go for further treatment. Deep learning is a new tool that useful in detecting various kinds of the dataset, especially in medical image processing [23]. Deep learning defines a class of machine learning techniques in which information is processed in hierarchical layers to comprehend representations and data characteristics in growing complexity concentrations [24].

Besides, Computer-Aided Diagnosis is useful in identifying breast cancer. It is an algorithmic technique that can be helpful during routine screening so that human error in breast cancer screening is decreasing. Computer-Aided diagnosis is a cost-effective, non-invasive tool for reducing medical errors in the diagnostic process [25]. However, CAD has taken various needed such it requires complex processes that include post-

processing and pre-processing steps. Besides, these steps based on an interpretation of images collected by crucial field experts. Thus, deep learning has found a new method that can use in classify breast cancer which is Convolutional Neural Network (CNN).

2.6 Convolutional Neural Network (CNN)

Convolutional Neural Network (CNN) has several applications that give a better performance in human life. Several applications that use Convolutional Neural Network (CNN) include classification of image data, detection in a human cell, and wave net. Convolutional Neural Network (CNN) development helps the clinician to detect and classify malignant cells in images of breast cytology [26]. It is because CNN is a unique neural network considered for data processing.

CNN has three basic features, which include convolution, pooling, and fully connected layer that may reduce a neural network's number of parameters. CNN has sparse connections across layers, as in the traditional feed-forward neural network linked with each neuron in one layer. This refers to many variables the system needs to learn, which can trigger many issues in effect. CNN architecture could limit the number of parameters by indirect connections where neuron and substrate called. CNN produces a massive amount of data per trained object classification. Feature extractor reused to discern pixel-level characteristics in microscopic objects [27].

2.6.1 Convolutional Layer CNN

The convolutional layer is including one of the layers in CNN. The convolutional layer has several filters or kernels that perform a convolutional operation. It shows that CNN has conclusively demonstrated very accurate in the processing and classification of images. The convolutional layer made up of a variety of filters or kernels convolution, and these kernels are correlating with a specific region. The

specific region is known as the field of reception. It divides the image into tiny blocks and transforms it into a specific range of weights.

For convolutional layer, three parameters regulate the size of the feature diagram, which are depth, stride and padding. Depth is known as the number of filters used to process the convolution. For stride, it functions as several pixels through which the matrices pass over the input matrix. For the padding parameter, padding function as the input matrix with boundary zeroes, matrix. Then, the total error calculation on the output layer is a summation of all classes.

2.6.2 Pooling Layer CNN

The primary objective of the pooling process is to extract the representative features of the statement to use a feature that analyzes the output between each filter [36]. A pooling layer is including a standard downsampling process. The process is, which decreases with an in-plane complexity of the function maps to add a translation invariance to minor shifts and transformations [37]. Then, it will reduce the number of corresponding convolutional layers.

The outcome of a pooling layer and the creation of sampled or pooled function maps is the summary of the features found in the image. They are beneficial because minor differences in location of the feature in the input detected by the convolutional layer lead to a pooled feature map with the feature at a particular specific place. Besides, in deep learning, over-fitting is often managed by the implementation of pooling layers [38].

2.6.3 Fully Connected Layer CNN

Fully connected layer or FC layer is an essential element of CNNs that have been demonstrably effective in the identification and classification of deep learning images. For a typical deep learning model, the FC layers contain much of the network's parameters [39]. Consequently, VGGNet has an amount of 135 million parameters, 128 million of which come from FC layers [40]. For the FC layer, data obtained from the previous layer was compiling, and then the performance of all previous layers is carefully analyzed.

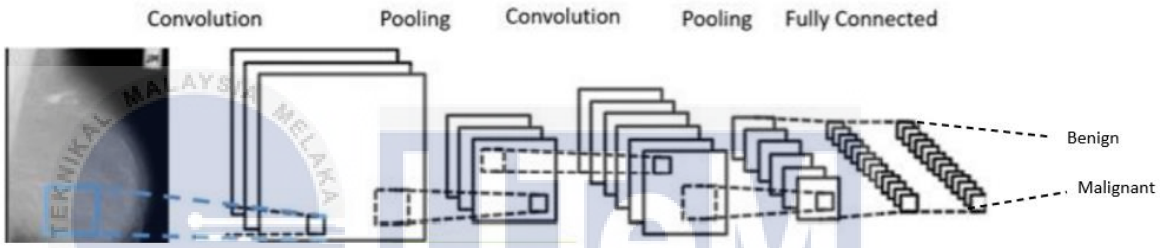


Figure 2.4 Breast Cancer Classification using Convolutional Neural Network (CNN) [40]

2.7 Summary of Literature Review

In this chapter, the classification of breast cancer among female will analyze. The progress in breast cancer classification perceives through the use of histopathological and mammogram image features. Radiologists and pathologist will face a difficulty to identify cancer call of the breast without precise instructions and experience. By applying the model from CNN, the evaluation can be made with accurate findings expertly. It will also decide whether the breast cancer is malignant or benign accurately. Thus, it can reduce the time taken to achieve results.

CHAPTER 3:

METHODOLOGY

For methodology, the chapter will cover on dataset from previous study and process of the flowchart. Flowchart for this project include data collection, pre-processing, data labelling, training process of CNN architecture and classification of images. Besides, there are three parameters used in chapter 3 for performance of CNN models which are recall, precision and percentages accuracy of data sample. To develop an optimum CNN architecture, it has three part which are data collection and pre-processing, design of CNN model and performance evaluation.

3.1 Dataset previous studies

Table 3.1 will show research about breast cancer classification from previous studies. The Table 3.1 will include reference, approaches, strength and weakness. The approach will attain with method and dataset used to classify image.

Table 3.1 Breast Cancer Classification

REFERENCES	APPROACHES	STRENGTH	WEAKNESS
Richard Ha, MD., et al., 2018 [28]	METHOD: Pixel-wise heat maps of CNN model DATASET: mammographic dataset	The accuracy in detecting cancer has increase to 72% by pixel-wise heat maps	Pixel-wise heat maps only use small dataset. Increase image of dataset cause over fitting.
Fei Gao, Teresa Wu., et al., 2018 [29]	METHOD: Shallow-Deep CNN model DATASET: CEDM image	The model achieves improve the breast cancer diagnose with better accuracy to 84%.	Limited access of CEDM image -only 49 CEDM cases have been collected.
Yangqin Feng, Lei Zhang et al., 2018 [30]	METHOD: DNN model DATASET: Breakhis dataset	The Deep Neural Network (DNN) successfully separate between malignant and benign data from applying model	Number of image patches is not enough to fit the larger parameter. Thus, it less accuracy in recognition
Li Shen 1, Laurie., et al., 2019 [31]	METHOD: Resnet-50 CNN model DATASET: Mammogram dataset	Mammogram image feature created by Resnet has better the performance of the system	Mammogram image need to be downsized to fit the GPU
Yashwant Kurmi, MTech., 2019 [32]	METHOD: Handcrafted features and BoW (Bag of Visual Word)	Multilayer Perception (MLP) classifier provides highest accuracy with 95% and Support Vector	Only used 10 images from each benign and malignant to analyse result of

	DATASET: Bisque and BreakHis dataset	Machine (SVM) classifier have the accuracy of 90%	400X magnification
Zichao Guo, Hong Liu., 2019 [33]	METHOD: DCNN models DATASET: Camelyon16 dataset.	Bigger training patch contain more related information; thus, it gives the best in performance of segmentation	Computational resources and parameters selection detail is limited - GTX 1080Ti GPU
Abhinav Kumar a, Sanjay Kumar Singh., 2019 [34]	METHOD: VGGNet-16 pre-trained CNN model DATASET: BreakHis dataset	Testing accuracies for BreakHis dataset differential identification ranged from 86% to 90%,	Less accuracy for 400X magnification due to VGGNET-16 not support the higher magnification
Alyssa T. Watanabe., 2019 [35]	METHOD: Artificial Intelligence-based Computer-Aided Detection (AI-CAD) DATASET: Mammographic dataset	AI-CAD help radiologists in earlier cancer detection and decrease in false-negative mammograms The false-positive decrease to 6.25%	Since this was an enhanced analysis of data primarily consists of cancer cases, the researchers were unable to accurately assess the specificity
Neslihan Bayromoghu., et al., 2016 [43]	METHOD: Own CNN architecture DATASET: Breakhis	Designing own CNN architecture for image classification	Accuracy achieve for benign is below 75% and malignant is below 85%
Shweta Saxena., et al., 2019 [44]	METHOD: Machine Learning Dataset: Breakhis	Improve in image quality and can identify local entities.	Class imbalanced effect the performance in term of accuracy between benign and malignant.

Through the Table 3.1, Abhinav Kumar a, Sanjay Kumar Singh research will be the point of view because of the performance of accuracy achieved by the CNN model. Besides, the models chosen is because it is more relatable architecture for breast cancer classification with higher testing accuracy achieved.

3.2 Flow chart of Methodology

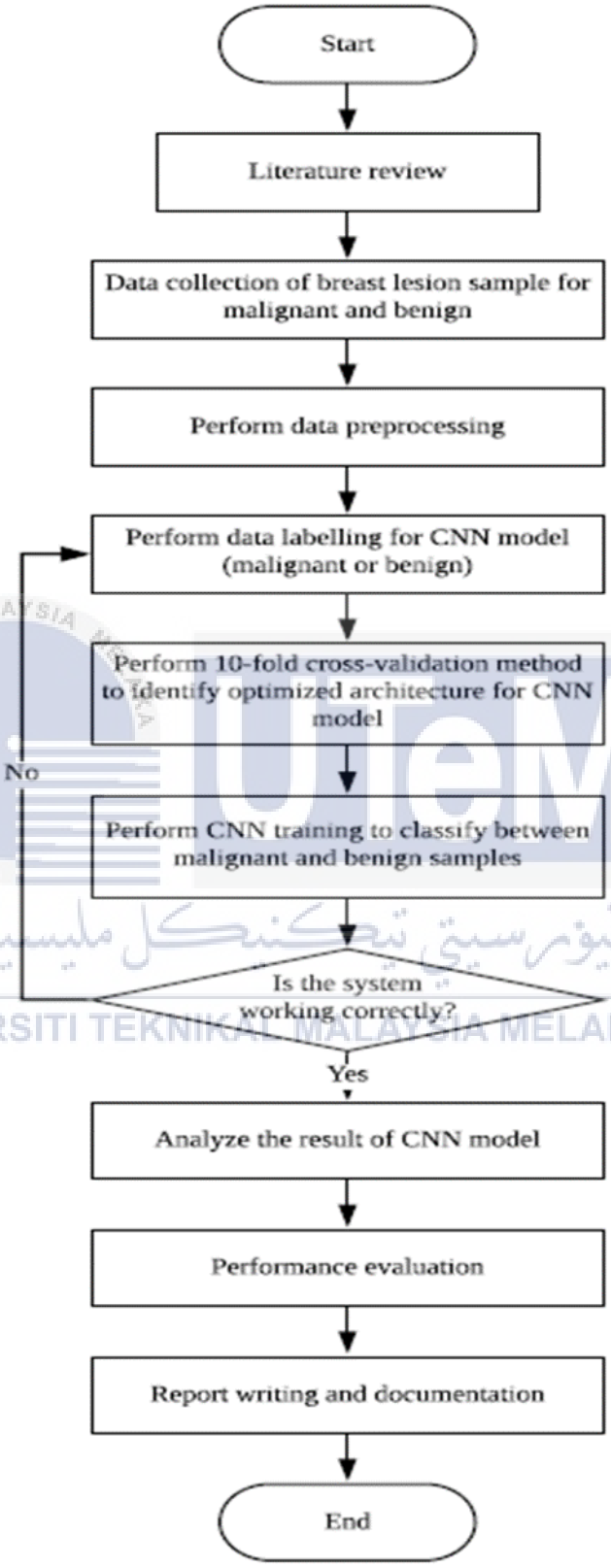


Figure 3.1 Flow chart process of Methodology

3.3 Flow chart process of Convolutional Neural Netwrok (CNN) architecture.

For this research, the histopathological image will used to classify image with performance of accuracy achieved from the CNN model. it will cover six primary processes, which are data selection, pre-processing, data labelling, model design, training and classification of the image breast cancer, there are. The data gathering is signifying for BreakHis data collection from a breast cancer patient. The data sample, categorized into two, which are benign and malignant. The raw data collected will undergo a pre-processing method to decrease some noise and improve the data sample quality.

The data sample will experience in segmentation, feature extraction, and classification of the data by using the CNN model. Segmentation will create the wanted region from the more significant histopathological component. Then, feature extraction is when the image is extracting the full amount of detail image from the histopathological dataset to create a useful solution. Lastly, the image sample classifies according to its type, such as benign or malignant — the CNN model designed for identifying the image sample, whether between harmless and deadly cancer with performance of accuracy achieved.

3.4 Data collection

The first thing is the process of data collection. The sample data are taking from the female that had breast cancer only. The female patient will match cancerous or non-cancerous of breast cancer. In this project, BreakHis dataset and the mammographic Image will be added and apply during the training process of the CNN. Then, the

histopathological images will have two folders which are for training and testing image folders, and each folder will be renamed as benign and malignant.

3.4.1 BreakHis Dataset

The BreakHis dataset had taken from an online source, which is Robotics Vision and Image Laboratory, Research Laboratory linked to the Computer Science Department. The histopathological image is comprising of 9109 microscope images. This image is taken from 82 patients with breast cancer symptoms and several magnification factors of the image, which are 40X,100X,200X and 400X. The dataset has made up with two folders which consists of 2,480 benign and 5,429 malignant cancer cell of image samples. The BreakHis dataset has 700X460 pixels with 3-channel RGB. The format for images sample are in PNG with 8-bit depth in each channel.

Table 3.2 Type of BreakHis Dataset

Classes	Subtypes	Magnification Factors				Total
		40×	100×	200×	400×	
Benign (B)	Adenosis (A)	114	113	111	106	444
	Fibroadenoma (F)	253	260	264	237	1,014
	Tubular Adenoma (TA)	109	121	108	115	453
	Phyllodes Tumor (PT)	149	150	140	130	569
Malignant (M)	Ductal Carcinoma (DC)	864	903	896	788	3,451
	Lobular Carcinoma (LC)	156	170	163	137	626
	Mucinous Carcinoma (MC)	205	222	196	169	792
	Papillary Carcinoma (PC)	145	142	135	138	560
Total		1,995	2,081	2,013	1,820	7,909

In the latest edition, samples present in the dataset, including partial breast augmentation or excisional biopsy, were obtained by the SOB procedure. Similar to any needle biopsy, this type of procedure extracts the larger tissue sample and is performed in a general anaesthetic hospital.

3.4.2 The Mammographic Image

The mammography image is obtaining from the Mammographic Image Analysis Society (MIAS) database. MIAS is a scientific agency of the UK involved in mammograms interpretation and has developed a public mammogram database. The UK National Breast Screening Program digitised mammographic films to a 50-micron pixel edge. The film is with a Joyce-Loebl scanning microdensitometer which is the system linear in the 0-3.2 range of optical intensity and reflecting every 8-bit term for each pixel. The films image has 1024x1024 resolutions. The database will include 322 digitized films on a 2.3 GB 8 mm (ExaByte) tape. This also contains the "fact" marks of the radiologist on the spots of suspected differences.

Mammography image have several criteria to get a clear and accurate films. The level of image quality obtained for mammography screening is extremely important. Table 3.3 will discuss the quality criteria of mammography image.

Table 3.3 Quality Criteria for Mammography

Criteria	Description
Positioning	The proper orientation of the oblique mediolateral (MLO) vision may be determined with the rear nipple line (PNL), which is a line drawn by the nipple at an upward angle perpendicular to its tip.
Compression	Compression allows more explicit pictures by closer breast to film and regenerates the breast to avoid movement.
Exposure	Before adequate exposure can be assessed, the material selection process must be in place, which include low ambient room light,

	sufficient visual box luminance and masking the illuminated area of the outlook box outside the film.
Contrast	High contrast is of extreme significance in mammography. The breast tissue has a relatively small array of x-ray impedance so that contrast is more significant to allow its variability.
Sharpness	If the images are accurate, microcalcifications, mass margins, and little speculation cannot be visualized.
Noise	The statistical fluctuation of photons absorbed by various areas of the intensification screen (quantum mottling) is mainly due to noise.

3.5 Pre-processing

The raw data are collecting and the data will undergo a pre-processing method to improve the sample data quality and reduce unwanted noise. The data will pass through the low pass filter and band-limited of the BreakHis dataset. The Figure 3.2 had shown pre-processing method.

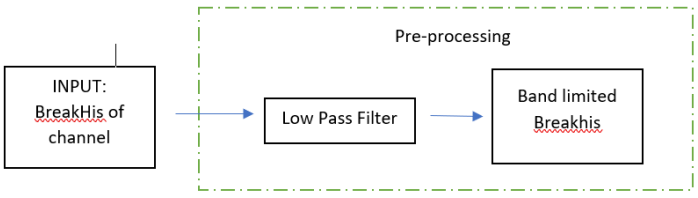


Figure 3.2 Pre-processing method

3.6 Data labelling

Data labelling is the sample data that is transferring into supervised training. The data labelling will categorize into their type of breast cancer. A data labelling must be implemented before training with a CNN model to show breast cancer in two categories, malignant and benign. Unmarked data sometimes doesn't disturb the operation for the validation process subsequently due to the data labelling carried out in the training session. In contrast, precise data labelling provides an effective CNN model image classification method.

3.7 Perform 10-fold cross-validation method

In this phase, the data sample for the CNN model will split into two, which 80% for train and 20%. The training and the cross-training will go through with 1020 of image sample. The 10-fold cross-validation method is when the number of folds is ten that happen by splitting between dataset given.

Each fold will use for model testing where the other fold is undergoing model training. This process is about to discover the correct data sample of layers number and its group characteristics of CNN architectures. In Python, Scikit-learn library divided the labelled training data into ten folds and then organized to adjust the folds in every class.

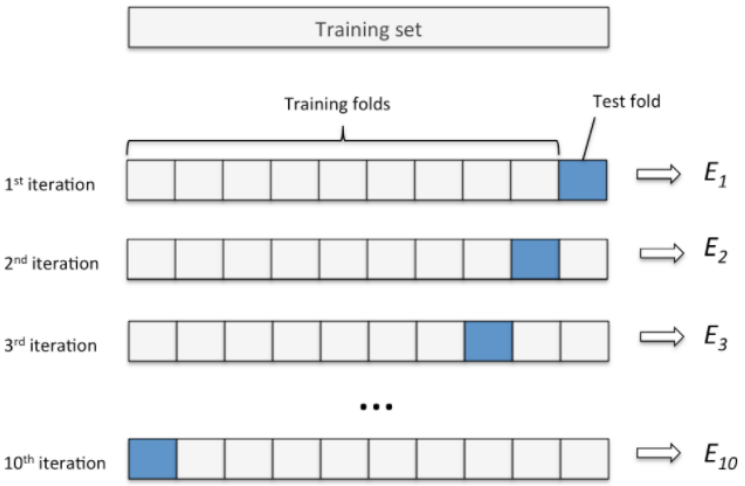


Figure 3.3 Example of 10-fold cross validation

http://karlrosaen.com/ml/learning-log/2016-06-20/

[Source: 'Karl Rosaen']

3.8 Convolutional Neural Network Architecture

The CNN is an algorithm for interpretation and efficiency of the segmentation of the images, image recognition and recognition algorithms. Convolutional neural networks can retrieve image information, thereby removing the need for conventional manual image processing techniques. It shows that CNNs is genuinely suitable and precision computer vision applications like object detection and image recognition that are extracted from the feature.

The CNN consists of two central part of layers which are convolution layer and FC layer. For convolution layers, it divides all of the features of an image for further testing, which provides a feature map to recognize the class by a few pixels at a time. For a fully connected layer or FC layers, it is used in order of prediction the most

useful features and description by applying weights above the previous convolutional layer output.

Besides, for CNN to be a fully working learning system, many other layers must be combined, such as a pooling layer, a fully connected input and output layer. For pooling layer, its purpose is to slowly reduce the spatial representation size to minimize the number of parameters and computation throughout the network. The pooling layer works separately on each feature map. Apart from the fully connected input layer, the current layer output is inserting flattened into one single vector such that an entry for the next layer can be used. Eventually, the fully connected output layer provided the ultimate image classification depending on its category.

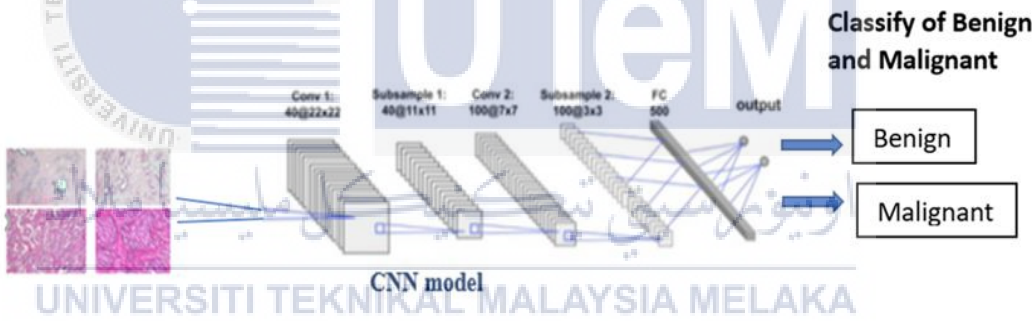


Figure 3.4 Example of CNN Model

3.8.1 VGG-19 Architecture of CNN

In this project, two VGG is used to classify breast cancer. VGG comes from word Visual Geometry Group at Oxford's. VGG-19 models are one of VGG architecture which has 19-layer deep of CNN. VGG-19 is very useful in image classification because it can distinguish items into 1000 types of objects, including thing and

animals. A trained version of the computer system can be loaded from the ImageNet database for over one million images. The network has therefore acquired a variety of function representations for a large variety of images with the image input size of the network is 224-by-224.

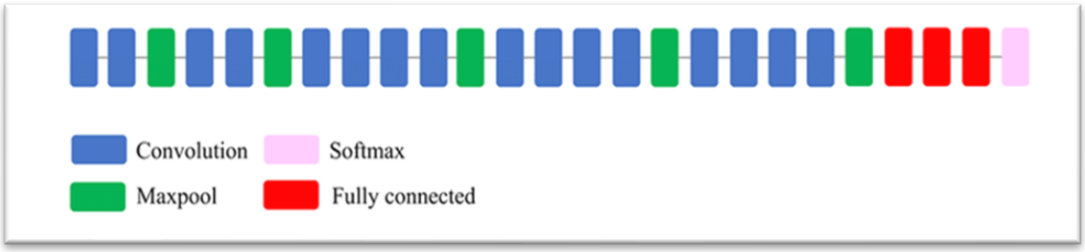


Figure 3.5 Schematic diagram of VGG-19 [41]

3.8.2 VGG-16 Architecture of CNN

VGG16 is a CNN architecture has used for the ILSVR (Imagenet) competition. These were known as one of the best model architectures until now. Simonyan and Zisserman have developed VGG-16 network architecture that represents Very Deep Convolutional Networks for Long Scale Image Recognition. VGG-16 has about 16 layers deep based on its structures. VGG-16 can concentrate on making 3 x 3 filter layers with 1 stage in convolution and often use the same padding and max pool 2 x 2 strand two filter layers instead of a wide range of hyper-parameters. It continually tracks this arrangement of convolution and maximum pool layers throughout the entire architecture.

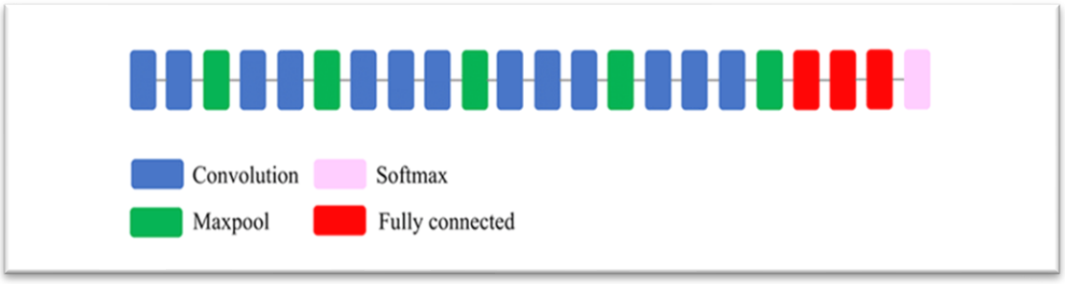


Figure 3.6 Schematic diagram of VGG-16 [41]

3.9 Training process of CNN

For the process of training, the dataset that has collected is training with the CNN model. The histopathological image will put into two folders which name as train and test folders. The benign and malignant folder will put for each folder of test and train. Train folder will contain 400 benign images and 600 malignant images. For the training process, the dataset used is to analyze the accuracy obtained from the result. Then, the result obtained for the training process will save to further used.

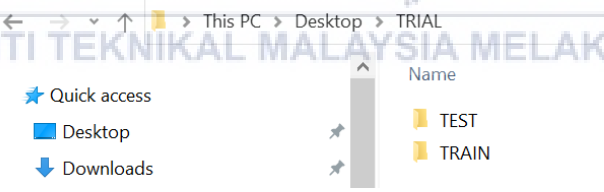


Figure 3.7 Train and Test Folder Files

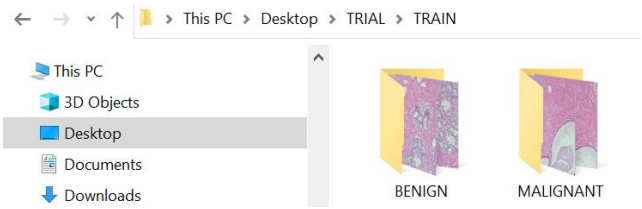


Figure 3.8 Benign and Malignant Folder Files

3.10 Classification process of CNN

A GUI (Graphical User Interface) is an interactive computer visual component system. It is the user interface with graphical components, including icons, window frames. It demonstrates A GUI is considering to be easier to use than a command-line interface based on text. A GUI is designing to produce a graphical method in this classification process. It is easier for the user to classify image by click button without the need to write programming codes. By using the CNN model in the Interface, the user can load the CNN model and the test image to track the outcome of the breast cancer can be graded based on a previously experienced educated CNN program. The image of breast cancer is either malignant or benign by comparing the test image charts and qualified CNN systems. Classification. Breast cancer can be graded based on a previously experienced, educated CNN program. The image of breast cancer is either malignant or benign by comparing the test image charts and qualified CNN systems.

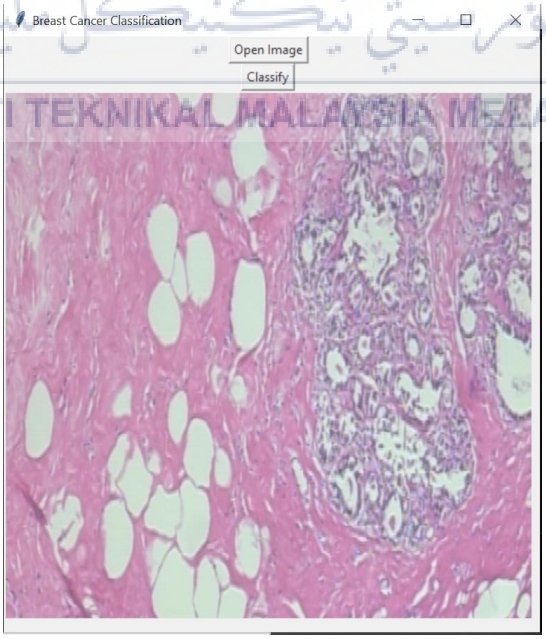


Figure 3.9 Example of Graphical User Interface (GUI)

3.11 Perform Evaluation CNN model

This phase consists of the CNN design to identify the benign or malignant presence in the system. The data samples will experience the training process that is collecting from the BreakHis and mammography dataset. After the training process, the data sample will be examining. The test sample, is used to figure out the performance of the CNN model. The confusion matrix that get from the CNN model is used to for explaining the output of classification result. The performance is obtained by following parameter which are the calculation of recall, precision and percentages of accuracy.

Table 3.4 Parameters of CNN models

PRECISION	RECALL	ACCURACY
$P = \frac{TP}{TP + FP} \times 100\%$	$R = \frac{TP}{TP + FN} \times 100\%$	$A = \frac{TN + TP}{TN + FN + TP + TN} \times 100\%$
TP = True Positive TN = True Negative FN = False Negative FP = False Positive		

Table 3.5 Table for Confusion Matrix

Predicted/ True Label	Benign	Malignant
Benign	True Positive	False Positive
Malignant	False Negative	True Negative

CHAPTER 4:

RESULTS AND DISCUSSION

This chapter will show the results obtained based on GUI to classify between benign and malignant and accuracy using two model of CNN. The layer of coding used is Convolutional Neural Network (CNN) layer. In this CNN model, VGG-16 and VGG-19 will be used to compare the accuracy between this both models. The results will show the classification and accuracy of breast image dataset. The image dataset used in this coding is 1000 images from a training folder and 20 images that are from the test folder. The result will include training image that create accuracy and loss graph, model on CNN used and GUI as final result in classifying breast cancer type with an accuracy achieved by using VGG-16 and VGG-19 of CNN models.

4.1 Introduction

In this chapter, the result will show based on the performance of method apply with an analysis on the project. The CNN model used as the pre-processing technique and followed by GUI as the classification process. VGG-16 and VGG-19 are chosen to be performed for the classification process to compare the best accuracy among these two models. To get an excellent classification of image, the performance of matrix which include precision, recall and accuracy between the model will be analysis.

4.2 Pre-Processing

The dataset used in this project include Breakhis and mammography image and most datasets comprise with RGB images of different shapes. For the pre-processing, the techniques will include normalization of color that need to eliminate staining differences, spatial filtering process to highlight the image structure and de-noise to supress noise of dataset image. Besides, enhancement process will happen to improve contract between point of interest and context that used in histopathological image. The following Figure 4.1 shows the image of pre-processing

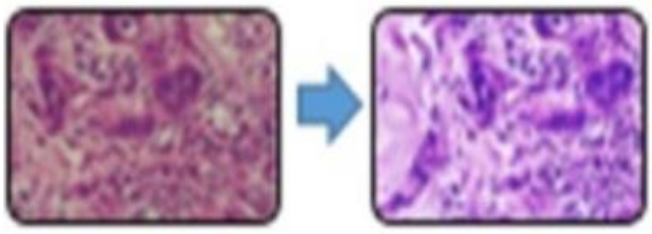


Figure 4.1 Region of Interest Detection

4.3 Process of Training and Testing

The CNN models' architectures are trained with 1020 samples image from breast cancer dataset. Then, the models will undergo training and testing(validation) process to obtained the accuracy and loss graph that apply matplotlib function. After the models have be trained, the weight of both models' system will be saves .h5 files format for further use of the graphical user interface (GUI).

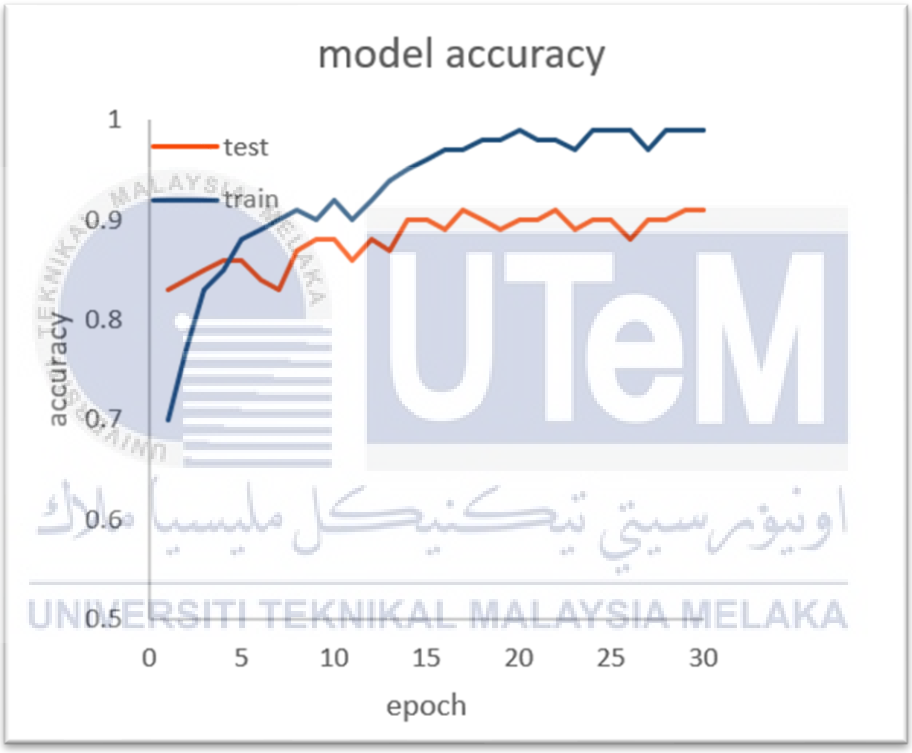


Figure 4.2 Graph of Training and Testing (Validation) Accuracy for VGG-19

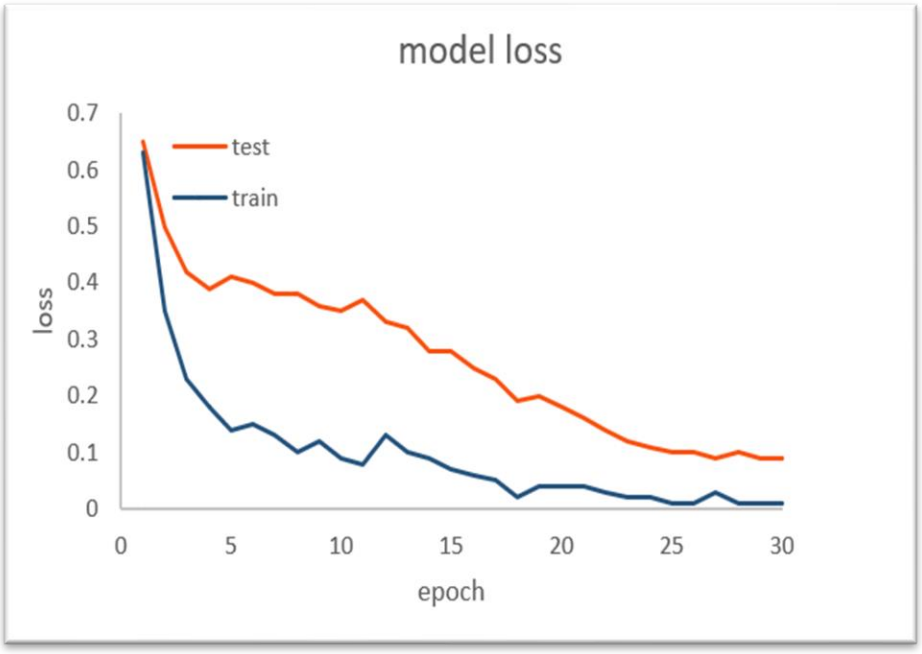


Figure 4.3 Graph of Training and Testing (Validation) Loss for VGG-19

Based on the graph in Figure 4.2 above, VGG-19 model rises from 70% to 98.9% on the train accuracy graph. Still and all, there seems to be a slight decrease in training process such as from epoch 10 to 12 and epoch 20 to 23. In testing accuracy, it shows that at epoch 1 until epoch 5, the test accuracy shows an increase pattern but when at epoch 7, the accuarcy drop and then rising up when at epoch 10. The process of testing graph shows the sew-saw pattern because of images are uniformly labeled.

For the loss graph in Figure 4.3, VGG-19 model indicates the fall off pattern start from 0.63 and end with 0.01 for the train loss. The testing(vaidation) loss also show the fall off pattern same with the train loss but the different is the train loss decrease drastically from epoch 1 until epoch 8 while the validation loss show decrease from epoch 1 to epoch 4.

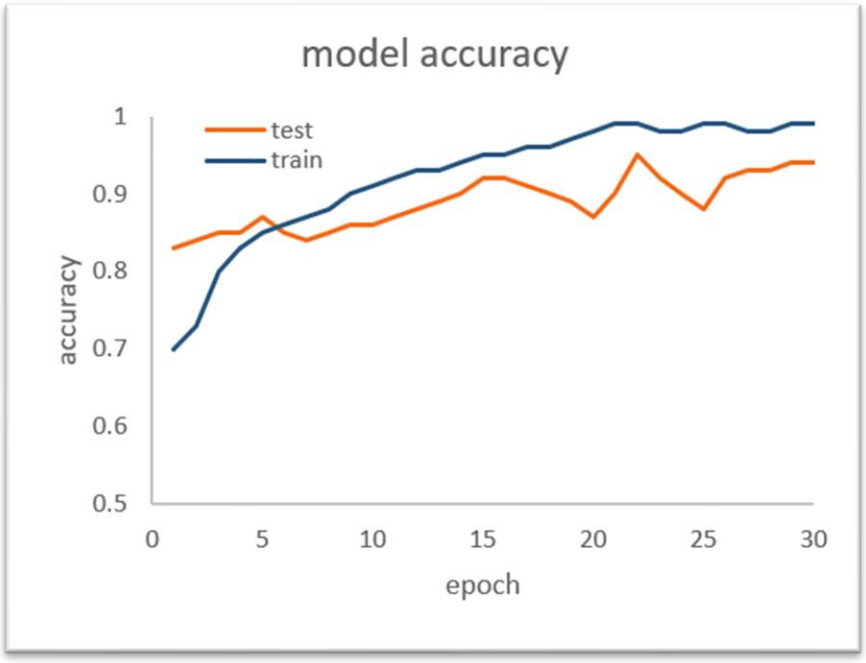


Figure 4.4 Graph of Training and Testing (Validation) Acuracy for VGG-16

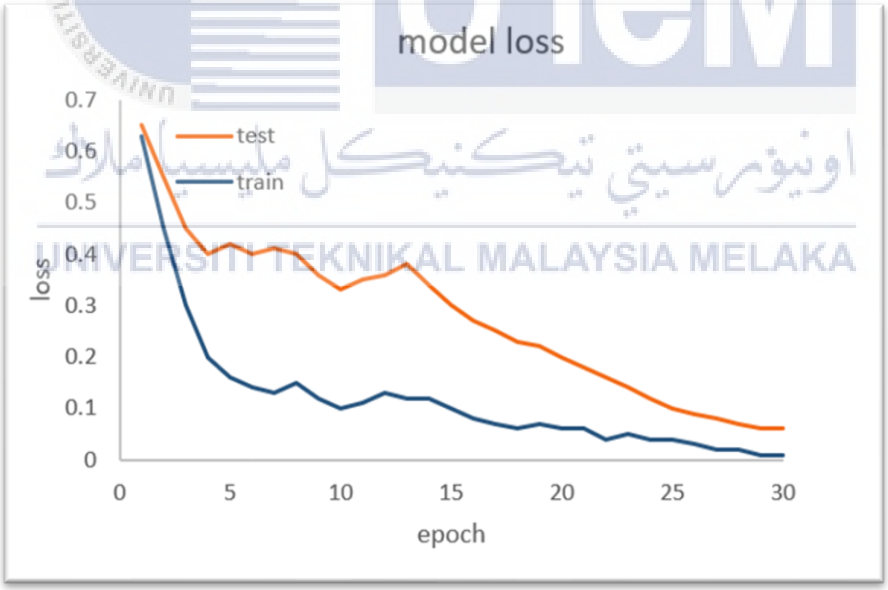


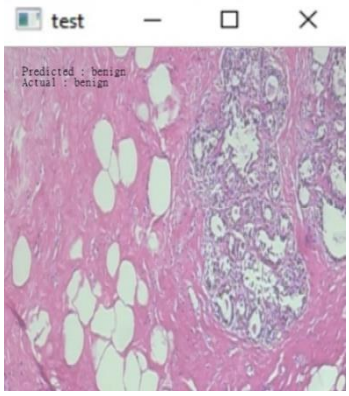
Figure 4.5 Graph of Training and Testing (Validation) Loss for VGG-16

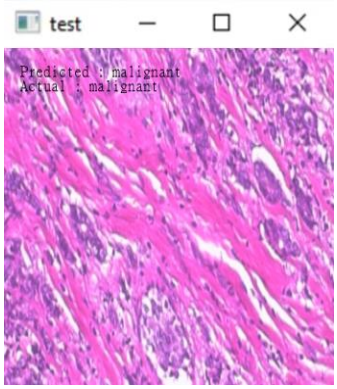
Based on Figure 4.4, its shows that the pattern of test accuracy for VGG-16 model increase slightly from epoch 1 until epoch 5. The accuracy then dropped at epoch 7 before rising moderately to epoch 16. The graph end with 94% of accuracy at epoch 30. As for train accuracy, the accuracy increases significantly from epoch 1 until epoch 8. The train accuracy continues to rising gradually until epoch 21 before its start to fluctuate until the end.

Figure 4.5 shows the losses for Vgg16 model. The number of test loss for Vgg16 was decreased sharply at epoch 5 before shows fluctuate pattern until epoch 13. Then the value of loss decreases steadily until end. For the test loss, its value of loss decreases rapidly from epoch 1 until epoch 7. Then the value of loss started to decrease slowly until the end.

4.4 Process of Classification

Process of classification focus on breast cancer image to classify even if image is benign or image is malignant. VGG-16 and VGG-19 of CNN model are implemented in the classification session of this project.





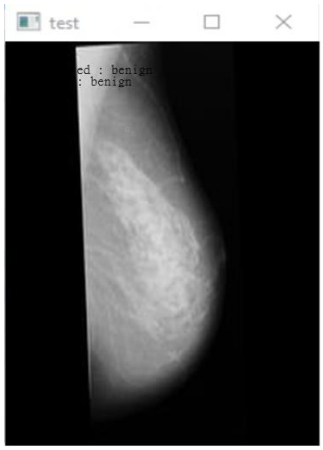


Figure 4.6: Process of Classification between Benign and malignant.

4.4.1 VGG-19 CNN Model

VGG-19 is a Convolutional Neural Network that composed of 19 layers and VGG-19 can categorise images almost 1000 classes of object such as thing and animals. Thus, VGG-19 has discovered a wide range of complex image. The Figure 4.7 will show the confusion matrix of VGG-19 model obtained from testing (validation process) that consists two label which are predicted and true labels. Then, the performance of VGG-19 model will present in the Table 4.1.

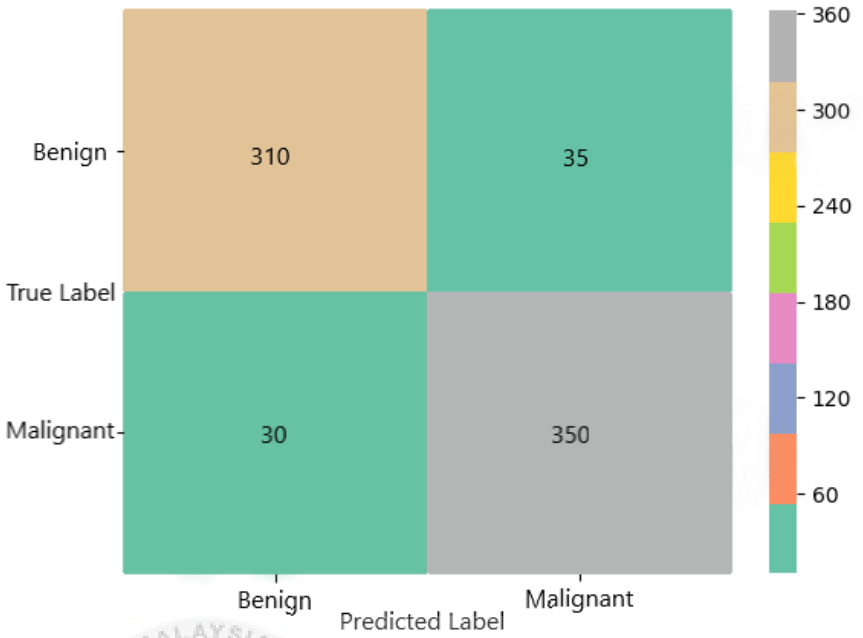


Figure 4.7: Confusion Matrix for VGG-19 of CNN Model

Table 4.1: Performance of VGG-19 CNN Model

PRECISION	RECALL	ACCURACY
$P = \frac{310}{310+35} \times 100\%$ $P = 89.86\%$	$R = \frac{310}{310+30} \times 100\%$ $R = 91.18\%$	$A = \frac{310+350}{310+35+350+30} X100\%$ $A = 91.03\%$

4.4.2 VGG-16 CNN Model

VGG-16 is a Convolutional Neural Network that composed of 16 layers, frequently combined with other 3x3 convolutional layers and 2x2 pooling layers. VGG-16 has an impressive capability to extract features that can have a positive impact on image recognition. The Figure 4.8 shows the confusion matrix of VGG-166 model achieved from testing (validation process) that have two label which are predicted and true labels. Then, the performance of this model will display on the Table 4.2.

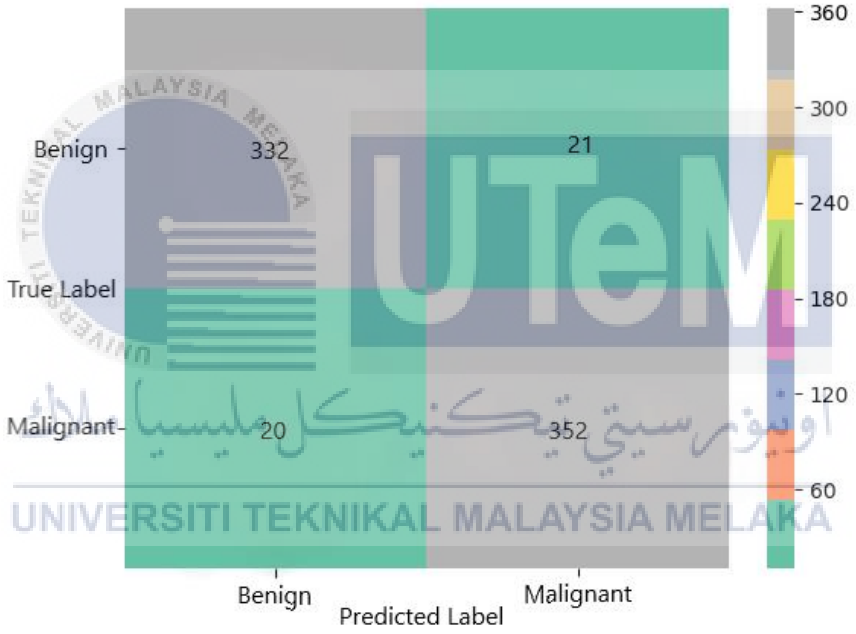


Figure 4.8: Confusion Matrix for VGG-16 of CNN Model

Table 4.2: Performance of VGG-16 CNN Model

PRECISION	RECALL	ACCURACY
$P = \frac{332}{332 + 21} \times 100\%$ $P = 94.05\%$	$R = \frac{332}{332 + 20} \times 100\%$ $R = 94.32\%$	$A = \frac{332 + 352}{332 + 21 + 352 + 20} X100\%$ $A = 94.34\%$

Based on the Table 4.2, it shows that VGG-16 model architecture gives a better performance in term of the classification image for breast cancer image with 94% accuracy. Besides, VGG-19 can classify the image well as the accuracy of VGG-19 is above 90%

4.5 Classification by using GUI

The GUI is developed in this project so that the system become more user-friendly as the user can easily select the image and classify the classes of image. The GUI is developed for carry out classification process which user load the breast cancer image for obtain the test result. If the 'Classify' button is pressed, the expected class of the picture will be shown on the screen with the accuracy achieved.

Figure 4.9 Example of classification using CNN model

After the CNN model is load into the GUI, both models will classify between benign and malignant cancer cell with the accuracy achieved. For VGG-19, the

accuracy obtained is 87.45% with benign classification and for the VGG-16, the accuracy achieved is 94% with benign classification. From the performance of GUI above, it proves that VGG-16 has a better achievement rather than VGG-19 in term of the accuracy.

4.6 Comparison between VGG-16 and VGG-19

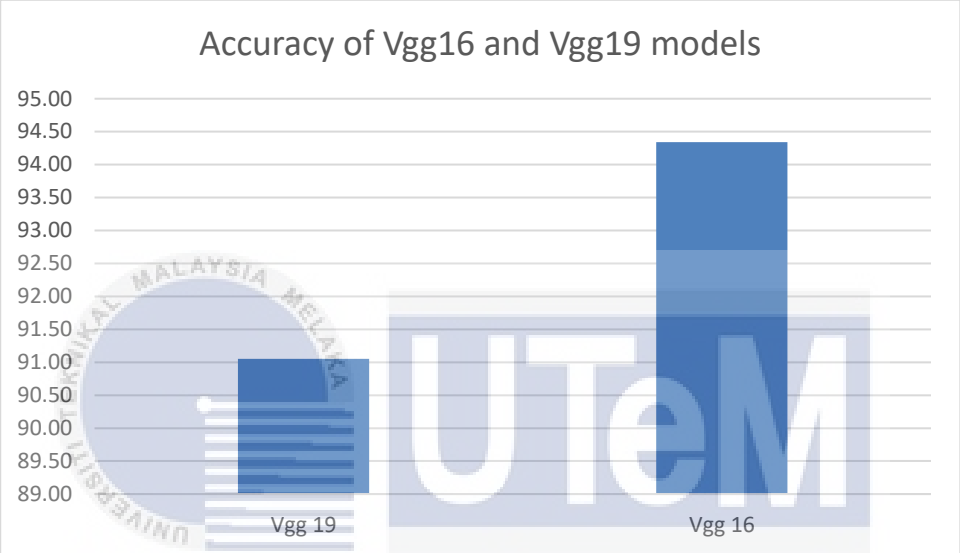


Figure 4.10 Accuracy Graph for VGG-19 and VGG-16 CNN model

According to the Figure 4.10, VGG-19 model attained the accuracy of 91% while VGG-16 model achieved the greater accuracy which is 94.34%. The accuracy obtained between these two models is slightly difference which is 3.34%. The difference might be due to set size of image used in this project and the weight of the model. VGG-16 model is suitable for BreakHis and mammography image.

4.7 Summary

As outcome of this project, the primary objective is obtained based on the classification of breast cancer using CNN model with performance of the accuracy achieved. The TensorFlow architecture, along with Keras, is chosen to carry out this project rather than MATLAB. MATLAB is not chosen because of the performance of speed training in MATLAB is quite slow rather than Tensorflow and Keras. Besides, python is used because of the languages is simple to follow and easy to understand.

CHAPTER 5:

CONCLUSION AND RECOMMENDATION FUTURE WORK

This chapter will dispute about the conclusion of the project. The conclusion will include the breast cancer classification and CNN models accuracy. Besides, future work also will be added as to upgrade the classification and accuracy of the project involved.

5.1 Conclusion

Breast cancer is a condition in which cancer cells are spreading out of control in the breast. Early possible signs and symptoms of breast cancer may allow the patient to detect abnormalities in their breasts such as visible lumps, abnormalities in nipples, color or shape changes, dimpled (depressed) skin, and bloody discharge in the nipple of the chest.

A medical team responsible in the classification process of breast cancer. To get a precise result, radiologists and pathologists are necessary for the provision of breast cancer. Radiologists will analyse the breast cancer symptoms and send sample tissue to pathologists. Then, pathologists will be responsible for diagnosing the classification of breast cancer obtained under light microscopy. But this technique could cause them to misclassification of the cancer cell. Besides, patients need to wait for the long term to get an accurate result.

Therefore, deep learning is an effective way to classifying breast cancer with higher accuracy. Convolutional Neural Network (CNN) is a suggested procedure for this classification project. For this project, the following are the three main steps that need to be taken: pre-processing image, training CNN model, and classification between benign and malignant. For CNN models, VGG-16 and VGG-19 are applying in the training process and classification system.

The classification system will be run by the file obtained from the testing file, which implements the system's accuracy for the CNN model. Then, GUI is created for the user as they can classify by clicking the button only without the need to write programming code to get the result. Users can choose any image from the file, and

then the image will be loaded, and the user needs to click the button to get the outcome from the GUI. The result will show the classes of breast cancer with accuracy achieved.

Besides, few parameters are identified for VGG-16 and VGG-19 to assess the breast cancer type's effectiveness and precision. The setting is including recall, precision, and accuracy. This parameter will be attained from the confusion matrix of both models during the training session.

The parameters included are the recall, precision, and accuracy of the system, based on the matrix of confusion displayed during the training process. The number of layers and set sizes of sample data can manage to get a high accuracy level. Overfitting can be happening when training accuracy is high, but when testing accuracy got a problem, the value will drop. To conclude the final result, VGG-16 is a better CNN model in the classification of breast cancer than VGG-19, in which the accuracy achieved is 94.34%.

5.2 Recommendation for future work

Based on the findings of this study, several suggestions have been made to strengthen the classification framework. This research was used primarily for the diagnosis of breast cancer. In further research, this classification will be integrated into a single structure for another disorder, such as skin cancer classification, malaria identification, etc. Besides, this project just used two models of CNN as the training process.

Other CNN models can be included, such as Resnet50, Alexnet, and so on, to get higher accuracy of the image and best training time in this project. Besides, more comparisons can be made to choose the best model performance for CNN architectures. As a consequence of that, it would allow the medical team to diagnose the illness more efficiently and precisely. Furthermore, the dataset used is in this project is limited due to the laptop software used in this project. More datasets can be combined in this project to increase accuracy. In the future, the laptop specification must have high performance, and more set sizes of data sample will give the best efficiency and classes.

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APPENDICES

APPENDIX A : Classification of Mammography Image Using CNN Models

APPENDIX B: Classification of Breakhis Image Using CNN Models