Feature Extraction and Classification of Tissue Mammograms Based on Grayscale and Gray Level Co-occurrence Matrix

Publisher: IEEE

Wiwien Herwanto ; Ali Khumaidi ; Harjono Padmono Putro All Authors

Abstract: Breast cancer is a major cause of death for women in the world. Breast cancer can be diagnosed by various means of examination, including mammography examination, which i... **View more**

Metadata

Abstract:

Breast cancer is a major cause of death for women in the world. Breast cancer can be diagnosed by various means of examination, including mammography examination, which indicates abnormalities in the breast. Doctors need other information, such as a biopsy to detect breast cancer further. However removal of some tissue can cause bleeding, hematoma formation, and infection. A pattern recognition system is needed using mammogram images for breast cancer detection to avoid unnecessary biopsies. According to research conducted by experts from Kaiser Permanente in Oakland, California, breast tissue density can be one of the factors that determine whether a woman is at risk for breast cancer or not. Breast tissue density is always associated with cancer risk. The denser the breast, the more vulnerable it is to be attacked by cancer. This paper proposes a technique classification of breast tissue density into Glandular, Dense Glandular, or Fatty Glandular groups. The features used are mean, kurtosis, skewness, contrast, correlation, energy, and homogeneity. The proposed system consists of two main stages, namely (a) Performing feature extraction using Grayscale and Gray Level Co-occurrence Matrix (GLCM), (b) Compile transaction data and build a classification model. The evaluation results using the Tree and Random Forest algorithms are the accuracy rate is 92% (Tree), 95% (Random Forest).

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Publisher: IEEE

Conference Location: Jakarta, Indonesia

Contents

Breast cancer is a chronic disease, and a total cure is still very doubtful and requires a long treatment period and high costs. There are many ways to diagnose Breast cancer, including mammography, X-ray examination technique for soft tissue, which has proven effective indicating abnormalities of the breast [1]. Understanding of mammogram images to arrive at a diagnosis is a complicated thing because there are many steps that must be done, such as image processing, pattern recognition, segmentation, classification, and conclusions [2]. This process requires comprehensive knowledge in many fields, so it is interesting to study, primarily to obtain relevant features to breast cancer. A specialist can identify breast abnormalities visually by looking at the features seen on a mammogram. From the characteristics of the visually visible mammography image, expert doctors can classify breast tumors into two groups, namely benign tumors or malignant tumors [3]. Breast tissue density can be one of the factors that determine whether a woman is at risk for breast cancer or not [4]. Breast tissue density is always associated with cancer risk. The denser the breast, the more vulnerable it is to be attacked by cancer. The purpose of this study proposes a technique to classify breast tissue density into Glandular (G), Fatty Glandular (F), or Dense Glandular (D) groups [5] using texture feature extraction based on Gray Level Co-occurrence Matrix (GLCM). Figure 1. shows some types of breast tissue.

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Ali Khumaidi <alikhumaidi@unkris.ac.id>

[2021 ISMODE] Your paper #1570783251 ('Feature Extraction and Classification of Tissue Mammograms Based on Grayscale and Gray Level Co-occurrence Matrix')

1 message

2021 ISMODE (ismode@unkris.ac.id) <ismode=unkris.ac.id@edas.info> Tue, Jan 18, 2022 at 4:01 PM
Reply-To: 2021 ISMODE <ismode@unkris.ac.id>
To: Ali Khumaidi <alikhumaidi@unkris.ac.id>, Herwanto Herwanto <herwanto@unkris.ac.id>

Dear Mr. Ali Khumaidi:

Congratulations - your paper #1570783251 ('Feature Extraction and Classification of Tissue Mammograms Based on Grayscale and Gray Level Co-occurrence Matrix') for 2021 ISMODE has been **accepted** to be presented and published in The 2021 International Seminar on Machine Learning, Optimization, and Data Science (ISMODE) - 2021 ISMODE which will be held in Virtual (Jakarta, Indonesia) during 29th January 2022.

The double-blind review process has already been taken from three reviewers and the results are attached to this email. You have to revise your paper aligned with the review results.

The reviews are below or can be found at 1570783251.

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6. Since the global pandemic, the 2021 ISMODE will be conducted as a VIRTUAL conference (online)

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Review 1

Technical content and scientific rigour: Is the paper interesting to the expected audience of this conference? Rate the technical content of the paper. (e.g. completeness of the analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.

Excellent (5)

Novelty and originality: Does the paper discuss novel topics, new technology or a new approach to established technology? Rate the novelty and originality of the ideas or results presented in the paper.

Excellent (5)

Quality of presentation: Is the technical content accurate? Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.

Good (4)

Relevance and timeliness: Will the work have a significant impact on the field or just be an incremental step? Rate the importance and timeliness of the topic addressed in the paper within its area of research.

Excellent (5)

Recommendation: How do you rate your recommendation? You are to score the manuscript.

(Based on this and other indicators, the TPC and publication chair will make the final judgment.)

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Indicators: The following indicators will help the final judgement of accept/reject.

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Is the writing clear enough to convey the meaning?
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Please contact TPC immediately if the grammar issues hinder the prompt review. (TPC may contact the authors to ask for re-submission of the paper after a quick grammar-only fix if the content seems worthwhile. Of course, if the content does not seem to warrant such handling, we may simply reject the paper.)

The english quality is good

Points to stress: Assuming that the paper is ACCEPTED, please list two (2) points (or more if you would like) that are covered in the draft and you would like the presenter to explain in detail.

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The authors apply machine learning in classifying tissue mammograms into three categories. The precision and recall values are higher with the Tree algorithm.

1. There is no discussion why there are performance difference between Tree algorithm and Random Forest algorithm.

2. More details about how to do preprocess, and its impact on the final performance should be given.

Check list: Optional Check List to help the reviewer

Check list: You may want to use the following checklist during review to come up with the indicator values above and your final judgment.

This checklist was prepared for FULL paper review, but maybe useful for quick judgment of SHORT paper/extended abstract, too.

This is optional, and you don't have to check all of the list items.

Check List of issues for review

[] Identify and note the type of manuscript (research, tutorial, survey, or case study).

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- **- a survey,**
- **- a tutorial,**
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Does the submission contain technically sound and accurate content?
Correct errors and misconceptions.
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Is the topic discussed appropriate for ISMODE conference?
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Is the main idea presented clear and well?
Are concepts understandable or defined adequately? Is the discussion easy to follow?
Suggest improvements if possible.

[] Does this work contain new topics that are not found in the existing works?
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This may not be that important if the manuscript is a survey.
If the manuscript is a Work-in-Progress report, the point is moot at best.

[] Overall structure
Pay attention to organization and technical content by commenting on the technical significance and accuracy of the work.
Is the overall structure of the presentation good?
Balance: Does the manuscript lack some elements? Are some topics discussed in too much detail while others are not discussed well enough?
Provide tips that will help the author to organize the material to help the readers to understand the issues presented.

[] Is the title appropriate?

[] Does the abstract capture the essence of the submission?

[] Figures/Tables
Are the captions clear and do they describe the essence of the figures and tables?

[] References
Does the References section list appropriate papers?
Does the References section list too many papers?
A couple of dozens should suffice usually unless the submission is a survey paper.
In "principle", most references should be from refereed periodicals instead of conference proceedings papers with little peer reviews. (But, of course, this is "principle.")

[] Text and mathematical formulas
Is text clear and simple?
Are math formulas clear and understandable?

[] Conclusion/Summary
Is the Summary/Conclusion section of the paper a good summary of what is presented?

Thank you again for your time.

7th

Review 2

Technical content and scientific rigour: Is the paper interesting to the expected audience of this conference? Rate the technical content of the paper. (e.g. completeness of the analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.

Good (4)

Novelty and originality: Does the paper discuss novel topics, new technology or a new approach to established technology? Rate the novelty and originality of the ideas or results presented in the paper.

Good (4)

Quality of presentation: Is the technical content accurate? Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.

Good (4)

Relevance and timeliness: Will the work have a significant impact on the field or just be an incremental step? Rate the importance and timeliness of the topic addressed in the paper within its area of research.

Good (4)

Recommendation: How do you rate your recommendation? You are to score the manuscript.

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Manuscript is of appropriate size and contents are arranged well

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NO major language issue noted

Points to stress: Assuming that the paper is ACCEPTED, please list two (2) points (or more if you would like) that are covered in the draft and you would like the presenter to explain in detail.

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Authors have performed a machine learning approach to classify the mammograms(Images) in to three categories: Glandular, Fatty Glandular, and Dense Glandular. The content of the manuscript is interesting and the manuscript is written well. Before acceptance,authors could incorporating the following comments.

1. Authors are advised to mention the other common biomedical imaging approaches such as optical coherence tomography (OCT) that is used as complementary scheme with mammograms to provide high resolution images of the breast tissue[1-2]. Authors may use the following best reference to introduce and mention about OCT technology for the readers .
   https://doi.org/10.1088/0031-9155/61/21/7652 https://doi.org/10.1117/12.2190530

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[] Text and mathematical formulas
Is text clear and simple?
Are math formulas clear and understandable?

[] Conclusion/Summary
Is the Summary/Conclusion section of the paper a good summary of what is presented?

Thank you again for your time.

2nd

Review 3

Technical content and scientific rigour: Is the paper interesting to the expected audience of this conference? Rate the technical content of the paper. (e.g. completeness of the analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.

Average (3)

Novelty and originality: Does the paper discuss novel topics, new technology or a new approach to established technology? Rate the novelty and originality of the ideas or results presented in the paper.

Average (3)

Quality of presentation: Is the technical content accurate? Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.

Average (3)

Relevance and timeliness: Will the work have a significant impact on the field or just be an incremental step? Rate the importance and timeliness of the topic addressed in the paper within its area of research.

Average (3)

Recommendation: How do you rate your recommendation? You are to score the manuscript.

(Based on this and other indicators, the TPC and publication chair will make the final judgment.)

Accept. (3)

Indicators: The following indicators will help the final judgement of accept/reject.

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Length of this article is appropriate.

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The writing is clear enough to convey the meaning to researchers in this field.

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This article can be accept in this conference where writer required to:

1. Insert subtopic for Literature Review/Related Work.
2. Is good if the subtopic Result and Discussion can be more elaborate by writer.

Check list: Optional Check List to help the reviewer

Check list: You may want to use the following checklist during review to come up with the indicator values above and your final judgment.

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[] Text and mathematical formulas
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[] Conclusion/Summary
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Thank you again for your time.

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Regards,

ISMODE Admin
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ISMODE 2021

#99 (1570783251): Feature Extraction and Classification of Tissue Mammograms Based on Grayscale and Gray Level Co-occurrence Matrix

DATE: **29-30 January 2022**

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Title	Only the chairs (2021ismode-chairs@edas.info) can edit	*Feature Extraction and Classification of Tissue Mammograms Based on Grayscale and Gray Level Co-occurrence Matri*
Abstract	Only the chairs (2021ismode-chairs@edas.info) can edit	Breast cancer is a major cause of death for women in the world. Breast cancer can be diagnosed by various means of examination, including mammography examination, which indicates abnormalities in the breast. According to research conducted by experts from Kaiser Permanente in Oakland, California, breast tissue density can be one of the factors that determine whether a woman is at risk for breast cancer or not. Breast tissue density is always associated with cancer risk. The denser the breast, the more vulnerable it is to be attacked by cancer. This paper proposes a technique classification of breast tissue density into Glandular, Dense Glandular, or Fatty Glandular groups. The features used are mean, kurtosis, skewness, contrast, correlation, energy, and homogeneity. The proposed system consists of two main stages, namely (a) Performing feature extraction using Grayscale and Gray Level Co-occurrence Matrix (GLCM); (b) Compile transaction data and build a classification model. The evaluation results using the Tree and Random Forest algorithms are the accuracy rate is 92% (Tree), 95% (Random Forest).
Keywords	Only the chairs (2021ismode-chairs@edas.info) can edit	Breast cancer; GLCM; Region of Interest; Tree; Random Forest
Topics		Big Data and Machine Learning Applications and Experiences; Machine Learning
Presenter(s)		Herwanto Herwanto and Ali Khumaidi (bio)
Registration		Ali Khumaidi has registered and paid for Batch 3:S-ieee
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Personal notes

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Reviews

3 Reviews

Review 1

Technical content and scientific rigour	Novelty and originality	Quality of presentation	Relevance and timeliness	Recommendation	Check list
Excellent (5)	Excellent (5)	Good (4)	Excellent (5)	Definite Accept. (4)	7th

Length of pages (Is the draft over the allotted maximum of 6 pages in the IEEE template? (or is it below the required minimum of 4 pages for extended abstract?)
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the paper after a quick grammar-only fix if the content seems worthwhile. Of course, if the content does not seem to warrant such handling, we may simply reject the paper.))

The english quality is good

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The authors apply machine learning in classifying tissue mammograms into three categories. The precision and recall values are higher with the Tree algorithm.

1. There is no discussion why there are performance difference between Tree algorithm and Random Forest algorithm.

2. More details about how to do preprocess, and its impact on the final performance should be given.

Review 2

Technical content and scientific rigour	Novelty and originality	Quality of presentation	Relevance and timeliness	Recommendation	Check list
Good (4)	Good (4)	Good (4)	Good (4)	Accept. (3)	2nd

Length of pages (Is the draft over the allotted maximum of 6 pages in the IEEE template? (or is it below the required minimum of 4 pages for extended abstract?)
Is the length appropriate?
Could be shorter.
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Please Identify specific areas that can be removed.)

Manuscript is of appropriate size and contents are arranged well

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Authors have performed a machine learning approach to classify the mammograms(Images) in to three categories: Glandular, Fatty Glandular, and Dense Glandular. The content of the manuscript is interesting and the manuscript is written well. Before acceptance,authors could incorporating the following comments.

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Technical content and scientific rigour	Novelty and originality	Quality of presentation	Relevance and timeliness	Recommendation	Check list
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Feature Extraction and Classification of Tissue Mammograms Based on Grayscale and Gray Level Co-occurrence Matrix

[1st] Herwanto
Faculty of Engineering
Universitas Krisnadwipayana
Jakarta, Indonesia
herwanto@unkris.ac.id

[2nd] Ali Khumaidi
Faculty of Engineering
Universitas Krisnadwipayana
Jakarta, Indonesia
alikhumaidi@unkris.ac.id

[3rd] Harjono Padmono Putro
Faculty of Engineering
Universitas Krisnadwipayana
Jakarta, Indonesia
harjonopputro@unkris.ac.id

Abstract— Breast cancer is a major cause of death for women in the world. Breast cancer can be diagnosed by various means of examination, including mammography examination, which indicates abnormalities in the breast. Doctors need other information, such as a biopsy to detect breast cancer further. However removal of some tissue can cause bleeding, hematoma formation, and infection. A pattern recognition system is needed using mammogram images for breast cancer detection to avoid unnecessary biopsies. According to research conducted by experts from Kaiser Permanente in Oakland, California, breast tissue density can be one of the factors that determine whether a woman is at risk for breast cancer or not. Breast tissue density is always associated with cancer risk. The denser the breast, the more vulnerable it is to be attacked by cancer. This paper proposes a technique classification of breast tissue density into Glandular, Dense Glandular, or Fatty Glandular groups. The features used are mean, kurtosis, skewness, contrast, correlation, energy, and homogeneity. The proposed system consists of two main stages, namely (a) Performing feature extraction using Grayscale and Gray Level Co-occurrence Matrix (GLCM); (b) Compile transaction data and build a classification model. The evaluation results using the Tree and Random Forest algorithms are the accuracy rate is 92% (Tree), 95% (Random Forest).

Keywords— Breast cancer, GLCM, Region of Interest, Tree, Random Forest

I. INTRODUCTION

Breast cancer is a chronic disease, and a total cure is still very doubtful and requires a long treatment period and high costs. There are many ways to diagnose Breast cancer, including mammography, X-ray examination technique for soft tissue, which has proven effective indicating abnormalities of the breast [1]. Understanding of mammogram images to arrive at a diagnosis is a complicated thing because there are many steps that must be done, such as image processing, pattern recognition, segmentation, classification, and conclusions [2]. This process requires comprehensive knowledge in many fields, so it is interesting to study, primarily to obtain relevant features to breast cancer. A specialist can identify breast abnormalities visually by looking at the features seen on a mammogram. From the characteristics of the visually visible mammography image, expert doctors can classify breast tumors into two groups, namely benign tumors or malignant tumors [3]. Breast tissue density can be one of the factors that determine whether a woman is at risk for breast cancer or not [4]. Breast tissue density is always associated with cancer risk. The denser the breast, the more vulnerable it is to be attacked by cancer. The purpose of this study proposes a technique to classify breast tissue density into Glandular (G), Fatty Glandular (F), or Dense Glandular (D) groups [5] using texture feature extraction based on Gray Level Co-occurrence Matrix (GLCM). Figure 1. shows some types of breast tissue.

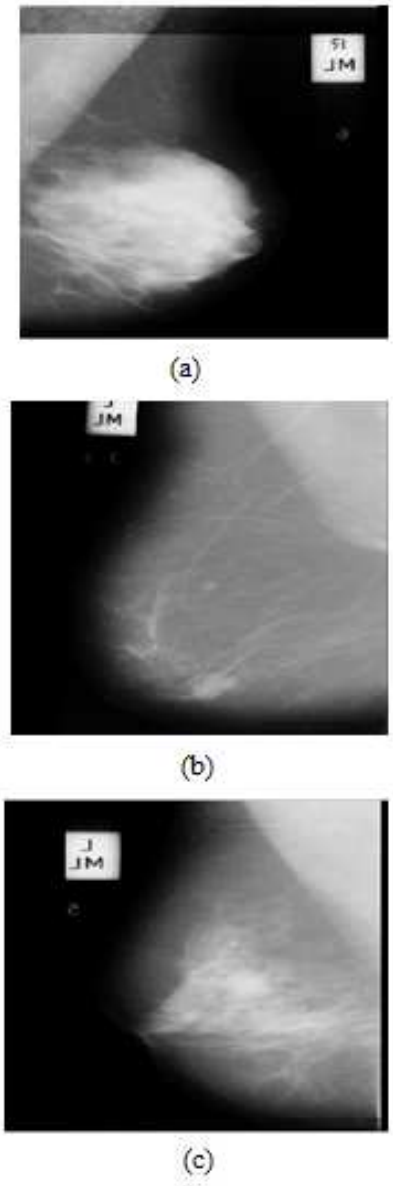

Fig 1. Types of breast tissue: (a) Grandular, (b) Fatty, (c) Dense

Several previous studies have discussed mammogram analysis using algorithms. The algorithm is able to extract features from the image for the desired region and is able to classify the malignancy from the mammogram. GLCM is capable of extracting features on mammograms [6][7][8]. Mammogram image research using the GLCM method to extract features, features with GLCM using 4 directions (0° ,45° ,90° ,135°) and distance = 1 can be used to distinguish between cystic mass and non-cystic mass including myoma images and solid tumor images on ultrasound images. The methods compared are histogram intensity, GLCM, and intensity based on features. From these results, feature extraction using GLCM is the best extraction method [9].

Several studies have examined the classification in 2 classes. In this study will classify into 3 classes. The preprocessing stage carried out is the conversion of the original image to grayscale, interpolation for resample images, prices cropping, image enhancement and adaptive thresholding. GLCM methods and statistical analysis are used to get the value of the features used as parameters. The classification stage uses the Tree and Random Forest algorithms because it is able to classify very well and explore data and be able to find hidden relationships.

II. Material and Method

The data used in this study were 322 images containing position information, individual mass size and microcalcifications, abnormal class types, and tissue type mammograms obtained from the Mammogram Image Analysis Society database.

Figure 2 is a classification stage which includes preprocessing, feature extraction using gray scale and GLCM, building classifier and evaluation model.

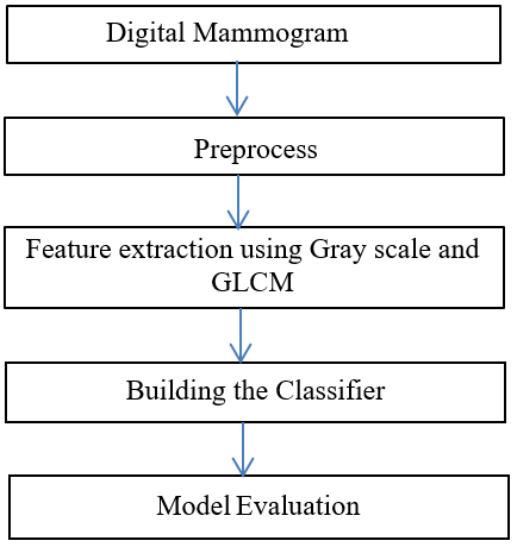

Fig. 2. Tissue Classification Method

A. Preprocess

Preprocess is the initial stage in breast cancer detection, this process is more about improving the quality of the mammogram image by increasing the intensity of the image between the image area and the object through highlighting features and reducing the effects of being too dark and light [10]. In addition, cropping, histogram equalization, median filter method are also options [11]. In this preprocessing, prices cropping, image enhancement and adaptive thresholding are carried out. The purpose of this preprocessing is to obtain more accurate segmentation results. At this stage it does not generate the type of tissue.

TABLE I. Sample Database

Tissue	Mean	Kurtosis	Skewness	Contrast	Correlation	Energy	Homogeneity
G	188.42	4.76	0.94	0.16	0.95	0.15	0.91
F	129.07	51.42	1.20	0.34	0.74	0.23	0.83
F	163.68	2.51	0.09	0.20	0.88	0.27	0.89
F	133.22	2.57	-0.51	0.14	0.95	0.17	0.92
G	197.59	4.33	-0.77	0.19	0.92	0.17	0.90
G	162.86	2.75	-0.01	0.26	0.91	0.12	0.86
G	179.92	4.66	-0.97	0.21	0.95	0.11	0.89
F	123.65	3.45	0.28	0.32	0.88	0.12	0.84
G	196.60	2.64	-0.58	0.23	0.93	0.15	0.88
G	193.75	2.84	0.008	0.33	0.86	0.13	0.83
D	181.18	6.54	-0.77	0.11	0.96	0.18	0.94
F	135.04	5.80	-0.13	0.23	0.90	0.15	0.88

B. Feature extraction

This study uses a second-order texture analysis that applies second-order statistical feature extraction using a co-occurrence matrix, which is an intermediate matrix that represents the neighboring relationship between pixels in the image in various orientations and spatial distances. In GLCM for the second order statistic to determine the texture, entity contrast, correlation, energy, homogeneity is used [11], while in the first order the mean, skewness and kurtosis are used [12]. In addition, the average of the seven orientations is also used as an additional feature. Figure 3 explains of the seven features calculated in the 256 x 256 region of interest then the feature extraction results are stored in a transactional database which can be seen in Table 1. Table 2 shows average value every features. Figure 4 shows GLCM Feature Extraction.

The following is the calculation for the GLCM feature[13]:

Contrast is a measure of the gray level of pixels, calculated by the formula:

$$\sum_{i,j} |i-j|^2 p(i,j)$$

Correlation is a measure of the dependence of the gray level on pixels, calculated by the formula:

$$\sum_{i,j} \frac{(i-\mu i)(j-\mu j)p(i,j)}{\sigma_i \sigma_j}$$

Energy is a measure that expresses the distribution of pixel intensity over the range of gray levels, calculated by the formula:

$$\sum_{i,j} p(i,j)^2$$

Homogeneity is used to measure homogeneity, calculated by the formula:

$$\sum_{i,j} \frac{p(i,j)}{1+|i-j|}$$

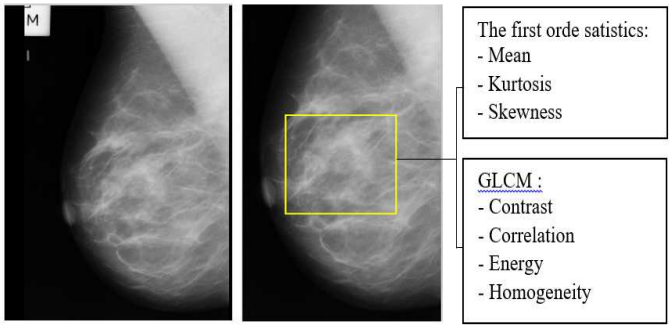

Fig 3. Feature extraction phase

C. Building Classifier

The basis of a decision tree is to make a decision rule from a data set. Decision trees are able to break down complex decision-making processes into simple ones, making it easier to interpret solutions. Tree is able to explore data and find hidden relationships between a number of variables. Tree combines data modeling and exploration makes for a great first step [14]. This decision tree can overlap, especially when the class and criteria used are very large, of course it can increase the decision-making time according to the amount of memory needed. In terms of accumulation, decision trees also often experience error problems, especially in large numbers. In addition, there are also difficulties in designing an optimal decision tree. Moreover, considering that the quality of decisions obtained from the decision tree method is very dependent on how the tree is designed [15]. So we need a Random Forest to overcome the overlap above.

Random forest is a classification consisting of several decision trees. Each decision tree is constructed using random vectors. The basis of a random forest is to create a random collection of trees from an attribute, with the aim of making tree creation and analysis faster. Thus the tree that is created will only have a few attributes. The accuracy of random forest will logically improve from Tree, this is because the classification results are generated from several trees and do not depend on only one tree [16]. A random collection of trees is generated by a random forest in a tree-like manner. Then in the determination using a voting model selected from all trees [17]. Random forest is a combination of each good tree which is then combined into one model. Random Forest depends on a random vector value with the same distribution in all trees where each decision tree has a maximum depth. A random forest is a classifier consisting of a classifier in the form of a tree {h(x, k), k = 1, . . .} where k is an independently distributed random vector and each tree in a unit will choose the most popular class on input x. Following are the characteristics of accuracy in random forest: Focusing on random forest, Strength and Correlation, Random Forest using random input selection, Random Forest using a linear combination of inputs.

TABLE II. AVERAGE VALUE EVERY FEATURES

Feature	Fatty (F)	Dense (D)	Grandular (G)
Mean	147,753	169,617	161,293
Kurtosis	12,121	6,725	7,073
Skewness	0,374	0,101	0,053
Contrast	0,265	0,151	0,181
Correlation	0,876	0,951	0,940
Energy	0,176	0,190	0,181
Homogeneity	0,871	0,925	0,910

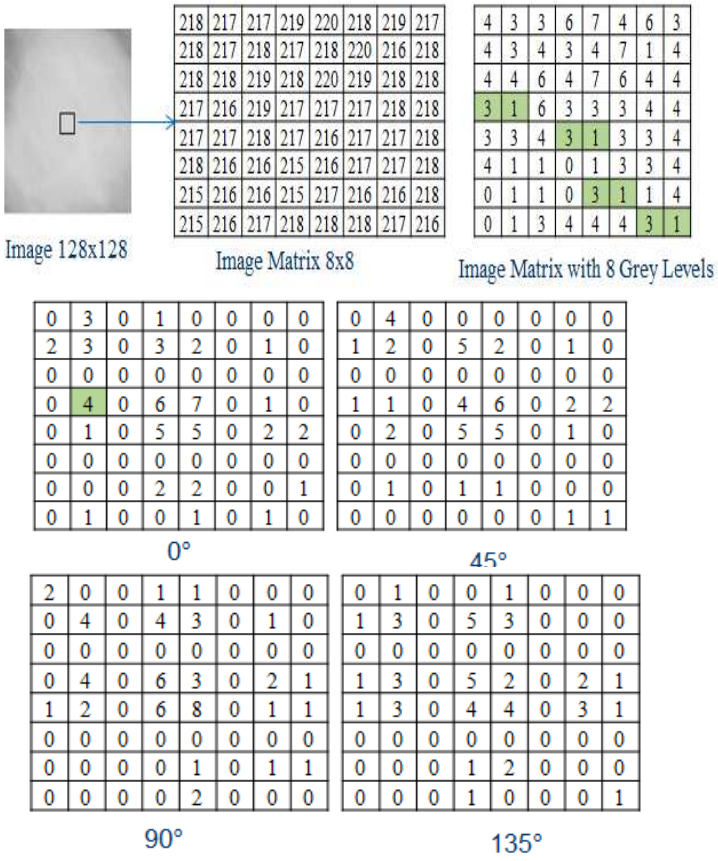

Fig 4. GLCM feature extraction

D. Model Evaluation

After modeling, it is necessary to carry out the process of evaluating or validating the model. This process is needed to choose the best model. In this paper, the technique used to measure the performance of the model uses a confusion matrix. The confusion matrix is a predictive analytic tool that displays and compares the actual value or the actual value with the predicted model value that can be used to generate evaluation metrics such as Accuracy (accuracy), Precision, Recall, and F1-Score or F-Measure. [18]. Table 3 below is a confusion matrix with four different combinations of predicted values and actual values. There are four terms as a representation of the results of the classification process in the confusion matrix. The four terms are True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN). The confusion matrix formed measures the model's performance, namely accuracy, precision, and recall.

Accuracy is the ratio of correct predictions (positive and negative) to the overall data. Precision is the ratio of positive correct predictions to the overall positive predicted results. Recall is the ratio of true positive predictions compared to the total number of true positive data.

TABLE III. CONFUSION MATRIX

		Actual Values	
		True	False
Prediction	True	TP Correct result	FP Unexpected result
	False	FN Missing result	TN Correct absence of result

III. RESULT AND DISCUSSION

After preprocessing, the next step is to build a classification model using Tree and Random Forest. The results of the three models are evaluated by measuring the success of the classification results based on the Accuracy, Precision, and Recall parameters.

The distribution of training data and testing data with proportions of 70 and 30 and the results of modeling the training data with the Tree algorithm obtained the value of accuracy = 0.93, precision = 0.94, and recall = 0.98 with 61 dense glandular predicted correctly and 1 incorrectly predicted, 55 fatty glands predicted correct and 10 predicted incorrectly, as well as a total of 68 predicted correct for glandular and 2 incorrect predictions. The results of modeling the training data with Random Forest obtained the value of accuracy = 0.93, precision = 0.92, and recall = 0.92 with 60 dense glandular which were predicted correctly and 5 were predicted incorrectly, 52 fatty glands were predicted to be correct and 1 were predicted to be incorrect, and a total of 73 were predicted to be correct for glandular and 7 were predicted to be incorrect.

TABLE IV. RESULTS OF TRAINING DATA

			Actual			Result		
			D	F	G	Accuracy	Precision	Recall
Prediction	Tree	D	61	2	2	0.93	0.94	0.98
		F	1	55	0			
		G	0	8	68			
	Random Forest	D	60	1	4	0.93	0.92	0.92
		F	1	52	3			
		G	4	0	73			

IV. CONCLUSION

Based on the test results, machine learning succeeded in classifying mammogram tissue into three categories, namely Glandular, Fatty Glandular, and Dense Glandular. The Tree algorithm has the same accuracy value as Random Forest with an accuracy value of 0.93, but the precision and recall values are higher with the Tree algorithm. The precision value for the Tree is 0.94 and the Random Forest is 0.92, the recall value for the Tree is 0.98 and the Random Forest is 0.92. The performance of the model on the training data built using the Tree algorithm is better than the Random Forest.

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