Determination of Breast Tumor BIRADS Variant Using Physical Parameter on the Mammography X-Ray Film

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Abstract

The research of the determination breast tumor BIRADS variant using the method of physical parameters on mammogram images are done. Usually, the radiology doctors to determine of BIRADS variant through out visual reading of mammograms. In this research a mathematical model to determine BIRADS variant by using the physical parameters on the mammogram images are derived. In previous studies for determining the stadium and histopathological types of breast cancer using mathematical models with physical parameters on mammogram images are obtained. The model have been tested on the mammogram 284 new patients at Sanglah Hospital and Denpasar Primamedika Hospital in Denpasar. The mathematical models had been determining the breast tumor BIRADS variant with 71.126% sensitivity are resulted. This article is better than in the previous article that uses fractal method, neural network and pattern, because the article is just able to detect the presence of microcalcification.

Keywords: BIRADS, mammography, breast tumors

1. Introduction

The breast tumor is our problem all together which a lot of women who died caused by breast tumor disease. So that the new methods for early detection of breast tumors are required. Generally, the medical determine BIRADS variant
before doing biopsies. The scientists efforts to research for early detection of breast tumors using digital image processing and pattern recognition are worked. The using Fractal methods by [1], [2] using the Neural Network methods, [3] using Pattern methods. Although these methods are only to determine the existence of any microcalcification not for determining BIRADS variant. In this study, we deriving a mathematical model using the physical parameters on the mammogram to for determining BIRADS variants. Physical parameters could be classified the types of breast tumors, effectively. As in my works in previous studies i.e.: determining the type of breast cancer histopathology by [4]. The stage determination of breast cancer by [5]. This paper is organized as follows. Part 2 discusses the materials and methods, section 3 discusses the results and discussion and conclusions discussed in Part 4.

2. Materials and Methods

A. Materials
The materials on this research using mammogram from Sanglah Hospital and Denpasar Primamedika Hospital. The data of mammogram in file form and stored in the radiology data base in bmp format. Mammography tool is the Kodak brand type 6800 laser imager with a potential of 30 KV and a current of 28 mAs every second.

B. Methods
The aims of this study can be done through observational study with cross-sectional study within 10 months. For the analysis of data using logistic multinomial statistical tests. The research methods are using the study of probability by calculating the physical parameters on mammography images such as: [4, 5, 6, 7, 8].

\[
\text{Entropy (E)} = - \sum_{y_q=y_1}^{y_t} \sum_{y_r=y_1}^{y_t} [H(y_q, y_r, d)] \log[H(y_q, y_r, d)] \tag{1}
\]

\[
\text{Contrast (C)} = \sum_{y_q=y_1}^{y_t} \sum_{y_r=y_1}^{y_t} (y_q - y_r)^2 H(y_t, y_r, d) \tag{2}
\]

\[
\text{Angular Second Moment (MA)} = \sum_{y_q=y_1}^{y_t} \sum_{y_r=y_1}^{y_t} [H(y_q, y_r, d)]^2 \tag{3}
\]

\[
\text{Moment Differential Invers (MD)} = \sum_{y_q=y_1}^{y_t} \sum_{y_r=y_1}^{y_t} \left[ \frac{H(y_q, y_r, d)}{1+(y_q-y_r)^2} \right] \tag{4}
\]

for \( y_t \neq y_q \)

\[
\text{Correlation (Corr)} = \frac{\sum_{y_q=y_1}^{y_t} \sum_{y_r=y_1}^{y_t} y_q y_r H(y_q, y_r, d) - \mu_H(y_q, d) \mu_H(y_r, d)}{\sigma_H(y_q, d) \sigma_H(y_r, d)} \tag{5}
\]

with
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\[
H_m(y_q, d) = \sum_{y_r=y_1}^{y_t} H(y_q, y_r, d)
\]  \hspace{1cm} (6)

\[
H_m(y_r, d) = \sum_{y_q=y_1}^{y_t} H(y_q, y_r, d)
\]  \hspace{1cm} (7)

\[
\text{Mean (MN)} = \sum_{y_q=y_1}^{y_t} y_q H_m(y_q, d)
\]  \hspace{1cm} (8)

\[
\text{Deviation (D)} = \sqrt{\sum_{y_q=y_1}^{y_t} [y_q - \sum_{y_p=y_1}^{y_t} y_p H_m(y_p, d)]^2 H_m(y_q, d)}
\]  \hspace{1cm} (9)

\[
H_{diff}(i,d) = \sum_{y_q=|y_q-y_1|}^{y_t} \sum_{y_r=y_1}^{y_t} H(y_q, y_r, d)
\]  \hspace{1cm} (10)

\[
\text{Entropy of } H_{diff} (EH) = -\sum_{i=t}^{t} H_{diff}(i, d) \log H_{diff}(i, d)
\]  \hspace{1cm} (11)

\[
\text{Angular Moment of } H_{diff} (MAH) = \sum_{i=t}^{t} [H_{diff}(i, d)]^2
\]  \hspace{1cm} (12)

\[
\text{Mean of } H_{diff} (MHD) = \sum_{i=t}^{t} i H_{diff}(i, d)
\]  \hspace{1cm} (13)

With \(H(y_q, y_r, d), d, y\) each are the probability of a pair of gray-level, the distance between the pixel and gray level value, respectively.[4,5,6,7].

### 3. Results and Discussion

**A. Results**

Figure 1 (a), 1 (b), 1 (c), 1 (d) and 1 (e) respectively is BIRADS 1, BIRADS 2, BIRADS 3, 4 and BIRADS BIRADS 5.

![Figure 1 (a) - BIRADS 1, (b) - BIRADS 2, (c) - BIRADS 3, (d) - BIRADS 4, (e) - BIRADS 5](image)

Figure 1 (a) BIRADS 1, (b) BIRADS 2, (c) BIRADS 3, (d) BIRADS 4 and (e) BIRADS 5

Figure 1 (a) BIRADS 1, its physical parameter value shown in table I, respectively for Fig. 1(b), 1(c), 1(d) and 1(e) also shown in Table I. Value ranges for every physical parameter differs each other as shown in Table I.
Table I. Range value of physical parameter for BIRADS 1, BIRADS 2, BIRADS 3, BIRADS 4 and BIRADS 5.

<table>
<thead>
<tr>
<th>Physical Quantity</th>
<th>BIRADS1</th>
<th>BIRADS2</th>
<th>BIRADS3</th>
<th>BIRADS4</th>
<th>BIRADS5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular Moment</td>
<td>0.00019 - 0.00399</td>
<td>0.00015 - 0.00592</td>
<td>0.00015 - 0.00099</td>
<td>0.00014 - 0.00175</td>
<td>0.00016 - 0.00103</td>
</tr>
<tr>
<td>Invers Differential Moment</td>
<td>0.02298 - 0.13252</td>
<td>0.01729 - 0.00529</td>
<td>0.01741 - 0.09587</td>
<td>0.01639 - 0.08273</td>
<td>0.01568 - 0.09506</td>
</tr>
<tr>
<td>Mean.</td>
<td>51.45837 - 143.60709</td>
<td>45.85171 - 198.98701</td>
<td>67.39831 - 189.72573</td>
<td>98.65057 - 207.68488</td>
<td>89.17413 - 213.44364</td>
</tr>
<tr>
<td>Two Order Differential Mean Histogram.</td>
<td>0.01576 - 0.10031</td>
<td>0.01107 - 0.09031</td>
<td>0.00983 - 0.06700</td>
<td>0.01003 - 0.05777</td>
<td>0.01102 - 0.07068</td>
</tr>
</tbody>
</table>
Determination of breast tumor BIRADS variant using physical parameter

Mathematical models for predicting BIRADS variant as follows:


\[
\begin{align*}
\text{MA}[2] &\quad -835.286 \times \text{MA}[3] + 15433.607 \times \text{MA}[4] + 89178.217 \times \text{MA}[5] \\
&\quad + 153071.798 \times \text{MA}[6] + 25881.184 \times \text{MA}[7] + 643545.801 \times \text{MA}[8] \\
&\quad - 119246.397 \times \text{MA}[9] - 1128.791 \times \text{MD}[1] + 1222.292 \times \text{MD}[2] - 17.574 \times \text{MD}[3] + 690.799 \times \text{MD}[4] - 518.056 \times \text{MD}[5] \\
&\quad - 1069.994 \times \text{MD}[6] - 1414.741 \times \text{MD}[7] + 249.269 \times \text{MD}[8] + 25881.184 \times \text{MD}[9] \\
&\quad + 643545.801 \times \text{MD}[10] + 1128.791 \times \text{MN}[1] + 47.225 \times \text{MN}[2] - 397542.350 \times \text{MN}[3] \\
\end{align*}
\]

\[
z_4 := 547.574 + 505.442 \times \text{E}[5] - 1.897 \times \text{E}[6] - 235.816 \times \text{E}[7] - 3449.142 \times \text{E}[8] + 5534.788 \times \text{E}[9] - 2409.663 \times \text{E}[10] - 0.258 \times \text{C}[1] - 0.099 \times \text{C}[2] - 0.309 \times \text{C}[3] + 1.036 \times \text{C}[4] + 0.441 \times \text{C}[5] - 1.413 \times \text{C}[6] + 0.622 \times \text{C}[7] + 0.084 \times \text{C}[8] + 0.257 \times \text{C}[9] - 0.440 \times \text{C}[10] + 508227.362 \times \text{MA}[1] - 985053.228 \times \text{MA}[2] + 5395.124 \times \text{MA}[3] + 379430.841 \times \text{MA}[4] + 273275.734 \times \text{MA}[5] - 481622.596 \times \text{MA}[6] + 19277.423 \times \text{MA}[7] - 318393.279 \times \text{MA}[8] + 2073496.030 \times \text{MA}[9] - 1529863.216 \times \text{MA}[10] + 1855.543 \times \text{MD}[1] - 5282.389 \times \text{MD}[2] + 408.004 \times \text{MD}[3] + 33.403 \times \text{MD}[4] - 10.013 \times \text{MD}[5] + 3216.969 \times \text{MD}[6] + 1169.461 \times \text{MD}[7] - 507.368 \times \text{MD}[8] + 1441.200 \times \text{MD}[9] + 5258.461 \times \text{MD}[10] + 7.972 \times \text{MN}[1] - 98.456 \times \text{MN}[2] + 118.475 \times \text{MN}[3] - \)
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The physical parameters for determining BIRADS variants are influenced by, Entropy, Angular Moment, Differential Inverse Moment, Mean, Deviation, Two Order Differential Entropy Histogram, Two Order Differential Angular Second Moment Histogram, and the Two Order Differential Mean Histogram. The distance between pixels are significant for determining the BIRADS variant on entropy parameter there are 5, 6, 7, 8, 9, 10. While for the Angular Parameter Mo-

\begin{equation}
1.734 \times MHD[10];
\end{equation}

The probability of occurrence for BIRADS 2
\[ = \frac{1}{1 + e^{-z_2}} \]

The probability of occurrence for BIRADS 3
\[ = \frac{1}{1 + e^{-z_3}} \]

The probability of occurrence for BIRADS 4
\[ = \frac{1}{1 + e^{-z_4}} \]

The probability of occurrence for BIRADS 5
\[ = \frac{1}{1 + e^{-z_5}} \]

The probability of BIRADS 1
\[ = 1 - \text{probability of occurrence probability for BIRADS 2} \]
\[ - \text{probability of occurrence probability for BIRADS 3} \]
\[ - \text{probability of occurrence probability for BIRADS 4} \]
\[ - \text{probability of occurrence probability of BIRADS 5}. \]
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In the prediction results of multinomial logistic statistical test, there are for BIRADS 1 = 96.1%, BIRADS 2 = 88.2%, BIRADS 3 = 76.2%, BIRADS 4 = 100%, BIRADS 5 = 95.2% and overall = 92.6%. The BIRADS 3 was difficult to predict because of his physical parameter value is between BIRADS 2 and BIRADS 4. According to [9] the majority of mammogram classified as BIRADS-1 and BIRADS-2, 5% to 9% of mammogram demanding the medical procedure or biopsy. BIRADS-1 is a negative mammogram (no cancer) and for BIRADS-2 is a normal mammogram (no cancer), but as for another finding there is a quantifiable cyst found that need a routine screening. BIRADS-3 is a possible normal mammogram and have to be screened in 6-month time. 2% of BIRADS-3 is possible for turning into cancer. BIRADS-4 is a suspected cancer-infected mammogram. 34% of BIRADS-4’s mammogram is possibly infected by cancer, which needs the biopsy. BIRADS-5 is BIRADS that is cancer suspected. 95% mammogram of BIRADS-5 is infected by breast cancer.

4. Conclusion

The mammogram tested results for the 284 new patients from Sanglah Hospital and Denpasar Primamedika Hospital in Denpasar which are the mathematical model are proposed could be determined the BIRADS variant of the breast tumors on the 71 126% sensitivity. This article is better than in the previous article that uses fractal method, neural network and pattern, because the article is just able to detect the presence of microcalcification.

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