Diagnosis study of carcinoma mammae (breast cancer) disease using fuzzy logic method

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Abstract. Breast cancer (Carcinoma mammae) is the second most common disease experienced by women in Indonesia. Lack of awareness or knowledge of this disease in young women is the main reason why there is a lot of case when doctor late to diagnose it and the patients were beyond help. The purpose of this study is to build a program that could show the risk of Carcinoma mammae based on the fuzzy logic method. Inputs of this program are parameters that related to this disease taken from study literature and interviewing a doctor. Methods that used in this study were literature study that related to the diagnosis of Carcinoma mammae disease by using the fuzzy logic method, interviewing a doctor who expert on Carcinoma mammae. Result of this study is a program that connects the fuzzy logic system to determine someone who has Carcinoma mammae or not. The risk is also measured by analyzing the symptoms of Carcinoma mammae such as lump, size, shape, papilla discharge and retraction, and change of skin of mammae. The program is quite good enough to detect an early stage of this disease from young women in early twenty.

1. Introduction
Nowadays, breast cancer or in a medical term called Carcinoma mammae, is the second-most common cancer diagnosed in women in Indonesia [1]. Breast cancer can also occur in both women and men, but it is far more common in women. Substantial support for breast cancer awareness and research funding has helped create advances in the diagnosis and treatment of breast cancer. To detect the early stage of breast cancer, we can utilize a simple logic system called fuzzy logic. Fuzzy logic concept is very easy to understand and flexible to apply to a patient. Fuzzy logic also uses an expert system to determine the variables used in the program [2]. This application of an expert system of fuzzy logic is applied to diagnose breast cancer for more efficient and effective to help people to detect an early stage of this disease. So people can prevent developing breast cancer to become more harmful using this fuzzy logic system. Based on this, the authors are interested to study the diagnosis of Carcinoma mammae disease using fuzzy logic method.

2. Methods
The first step to apply a fuzzy logic is to input sets of variable which is used to diagnose breast cancer. These variables are symptoms and factors of a person that could increase the risk of developing Carcinoma mammae. Then followed by the determination of the degree of fuzzy set membership for
each variable and calculation of the rule predicate ($\alpha$) of each variable that has been included in the fuzzy set. The rules are obtained by combining each variable with another variable with the respective linguistic attribute. The rules that have been obtained will be calculated the predicate value of the rules or rule predicate ($\alpha$) using the implication process. The implication process is carried out using the minimum operation (MIN($\cdot$)). The predicate rule is obtained by taking the minimum value of the degree of membership of one variable with another variable, which has been combined in a predetermined rule. Afterward, the defuzzification was carried out using the centroid method, a mean value of the fuzzy area. The result of this value is the decision to judge a patient, which show a high risk of breast cancer or not [1].

3. Results

3.1. Determination of membership degree

3.1.1. Risk factors.

| Variable  | Fuzzy Set | Range   | Parameter |
|-----------|-----------|---------|-----------|
| Risk Factor | Low       | [0-20]  |           |
| Risk Factor | Medium    | [20-50] |           |
| Risk Factor | High      | [50-100]|           |

The level of membership in the risk factor variable includes the membership level according to the following functions [3, 4]:

$$
\mu_{\text{Low}}[x] = \begin{cases} 
1; & x \leq a \\
\frac{(b-x)}{(b-a)}; & a < x < b \\
0; & x \geq b \\
1; & x \leq 0
\end{cases}
$$

$$
\mu_{\text{Medium}}[x] = \begin{cases} 
0; & x \leq a \text{ or } x > c \\
\frac{(x-a)}{(b-a)}; & a < x \leq b \\
\frac{(c-x)}{(c-b)}; & a < x \leq b \\
0; & x \leq 20 \text{ or } x > 50 \\
\frac{(x-20)}{(b-20)}; & 20 < x \leq 35 \\
\frac{(50-x)}{(50-35)}; & 20 < x \leq 35
\end{cases}
$$
The level of membership in the variable there is a lump in the breast including the membership level according to the following functions [3, 4]:

\[
\mu [x] = \begin{cases} 
1; & x \leq a \\
\frac{(b-x)}{(b-a)}; & a < x \leq b \\
0; & b < x \leq 0 
\end{cases}
\]

\[
\mu_{\text{No}} [x] = \begin{cases} 
1; & x \leq 0 \\
\frac{(1-x)}{(1-0)}; & 0 < x < 1 \\
0; & x \geq 1 
\end{cases}
\]
\[ \mu[x] = \begin{cases} 0; & x \leq a \\ \frac{x-a}{b-a}; & a < x \leq b \\ 1; & b < x \end{cases} \] (5)

\[ \mu_{\text{Yes}}[x] = \begin{cases} 0; & 0 < x \leq 1 \\ \frac{(x-0)}{(1-0)}; & 0 < x < 1 \\ 1; & x \geq 1 \end{cases} \]

**Figure 2.** Degree of membership lump on the breast variable.

### 3.1.3. Shape and size breast variable.

**Table 3.** Range for shape and size breast variable.

| Variable                  | Fuzzy Set | Range  | Parameter |
|---------------------------|-----------|--------|-----------|
| Changes in Shape and Size | Normal    | [0-1]  | [0 - 1]   |
|                           | Abnormal  | [0-1]  | [0 - 1]   |

The level of membership in the variable changes in the shape and size of the breast includes the membership level according to the following functions [3, 4]:

\[ \mu[x] = \begin{cases} 1;x \leq a \\ \frac{(b-x)}{(b-a)}; & a < x < b \\ 0;x \geq b \\ 1; & x \leq 0 \end{cases} \] (6)

\[ \mu_{\text{Normal}}[x] = \begin{cases} 0; & 0 < x \leq 1 \\ \frac{(1-x)}{(1-0)}; & 0 < x < 1 \\ 0; & x \geq 1 \end{cases} \]

\[ \mu[x] = \begin{cases} 0; & x \leq a \\ \frac{x-a}{(b-a)}; & a < x \leq b \\ 1; & b < x \end{cases} \] (7)
μ_{Abnormal}(x) = \begin{cases} 
0; x \leq 0 \\
\frac{x}{b-a}; a < x < b \\
0; x \geq b \\
1; x \geq 1 
\end{cases}

3.1.4. Papilla discharge variable.

Table 4. Range for papilla discharge.

| Variable          | Fuzzy Set | Range   | Parameter |
|-------------------|-----------|---------|-----------|
| Papilla Discharge | 1. No     | [0-1]   | [0 - 1]   |
|                   | 2. Yes    | [0-1]   | [0 - 1]   |

The membership level of the variable papilla discharge includes the membership level according to the following functions [3, 4]:

\[ \mu [x] = \begin{cases} 
1; x \leq a \\
\frac{x-a}{b-a}; a < x < b \\
0; x \geq b \\
1; x \geq 1 
\end{cases} \]

\[ \mu_{No}[x] = \begin{cases} 
0; x \leq a \\
\frac{1-x}{1-b}; 0 < x < 1 \\
0; x \geq 1 
\end{cases} \]

\[ \mu[x] = \begin{cases} 
0; x \leq a \\
\frac{b-x}{b-a}; a < x \leq b \\
1; b < x 
\end{cases} \]
The membership level in the variable papilla retraction is included in the membership level according to the following functions [3, 4]:

\[
\mu_{\text{No}}[x] = \begin{cases} 
0; & x \leq a \\
\frac{(1-x)}{(1-a)}; & a < x < b \\
0; & x \geq b \\
1; & x \leq 0 
\end{cases}
\]

\[
\mu_{\text{Yes}}[x] = \begin{cases} 
0; & x \leq 0 \\
\frac{(x-0)}{(1-0)}; & 0 < x < 1 \\
0; & x \geq 1 
\end{cases}
\]
3.1.6. Skin change in breast variable.

Table 6. Range skin change in breast variable.

| Variable                | Fuzzy Set | Range    | Parameter |
|-------------------------|-----------|----------|-----------|
| Skin Change in Breast   | 1. No     | [0-1]    | [0 - 1]   |
|                         | 2. Yes    | [0-1]    | [0 - 1]   |

The level of membership in the variable skin changes in breast includes membership level according to the following functions [3, 4]:

\[
\mu_{x} = \begin{cases} \frac{(b-x)}{(b-a)}; & a < x < b \\ 0; & x \leq 0 \\ 1; & x \geq 1 \end{cases}
\]

\[
\mu_{No}[x] = \begin{cases} \frac{(1-x)}{(1-0)}; & 0 < x < 1 \\ 0; & x \geq 1 \end{cases}
\]

\[
\mu_{Yes}[x] = \begin{cases} \frac{(x-0)}{(1-0)}; & 0 < x < 1 \\ 1; & x \geq 1 \end{cases}
\]
Figure 6. Degree of membership for skin change in breast variable.

3.2. Discussion

The weight value of each low set questionnaire is 5. The weight value of each Medium set questionnaire is 10. The weight value of each High set questionnaire is 10. The output in the membership function for risk factors is stated to be low if the value is less than 20, moderate for the value is 20 to 50 and is considered high if the value is 50 to 100 [3].

For lump, papilla discharge, papilla retraction, and skin change of breast variables, we set two types of fuzzy set logic. First is YES and we valued it to 1 and 0 value for NO. For the change in shape and size variable is defined as 2 fuzzy sets, namely Normal and Abnormal with parameters 0 to 1. The output of the membership function for changes in shape and size of the breast is stated as normal if the value is 0 and not normal if the value is 1 [5].

Output data of this system is a risk of Carcinoma mammae (breast cancer), thus defined as 3 fuzzy sets namely Low risk, Moderate risk, and High risk with value ranged from 0 to 100. Outputs on membership functions for potential Carcinoma mammae are considered low if the value is less than 30, considered moderate if the value is 30 to 70, and considered high if the value is 70 to 100 [3].

4. Conclusion

Based on the results of this research, it can be concluded that an application that can detect risk of Carcinoma mammae disease by analyzing the symptoms of Carcinoma mammae disease, such as risk factors, there is a lump in mammae, changes in size and shape in mammae, papilla discharge, papilla retraction, and changes in mammary skin. This application uses the Matlab programming language by building FIS (Fuzzy Inference System) and interface design using GUI (Graphic User Interface).

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