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Readability Increase of Mammography X-Ray Photos Results in Determining the Breast Cancer Histopathology Types Using Special Pattern Cropping With Physical Parameter

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Abstract

The research had determined the type of infiltrating ductal carcinoma histopathology (IDC) and infiltrating lobuler carcinoma (ILC) using specific cropping pattern with physical parameters. Physical parameters have a great potential to differ types of histopathological IDC and ILC.,Usually, the scientists have developed a method of fine needle biobsi to determine the types of histopathological IDC and ILC. In previous studies we have been able to determine the type of histopathology IDC and ILC with a sensitivity of 86.36%. In this research, we have succeeded in increasing the sensitivity of the determination of the type of histopathology using IDC and ILC particular cropping pattern with physical parameter of 97.5%. The special cropping pattern with physical parameters method are used in this research.

Keywords: Mammographic, Histopatologi, Breast Cancer, Infiltrating Duktal Carcinoma, Infiltrating Lobuler Carcinoma

1.Introduction

The Histopathology of infiltrating ductal carcinoma (IDC) and infiltrating lobuler carcinoma (ILC) is a malignant tumor cause of death in women. According to the National Cancer Fund American Institute estimated that every three minutes, a woman diagnosed with Breast cancer, and every 13 minutes people died of Breast Cancer [8]. Many methods have been carried out for the early detection of breast cancer, there are, Edge detection algorithm [5], System Hybrid [7], Foveal [9], Wavelet [11], Gabor [12], Ortogonal polynomials, [10], Texture coding [6], but determining the type of IDC and ILC had not done. For that reason it must been to create a mathematical equation models with physical parameters to facilitate determining the type of histopathology IDC and ILC. The advantages of special patterns cropping method with physical parameters is only suspected masses are ana lyzed so that it can minimize errors.

2.MATERIALS AND METHODS

A. Acquisition Data

The research was approved by the Research Ethics Committee of the Faculty of Medicine Udayana University / General Hospital Center Sanglah number: 894 / UN.14.2 / R & D / 2014. This research was funded by the University of Udayana, Bali SBRC using 2014 tax revenues fund research contract letter number 238-9 / UN14.2 / PNL.o1.03.00 / 2014. Mammography image data base were collected from hospital radiology computer denpasar international primamedika. of the images of mammography equipment with ICR type 3600M. Pictures are stored in bmp format and sampled with matrix size 2 cm x 2 cm.

B. Radiation Intensity with Breast Tumor

The larger the tumor the greater the density the intensity of the radiation is absorbed and the less that is forwarded, this resulted in pixel intensity values for histopathological types of IDC and ILC different. So the physical parameters between IDC and IDC histopathological types are also different. The relationship between the intensity of the radiation beam x-ray that comes with the passed are as follows [1, 2, 3]

$$I_t = I_0 e^{-\mu L} \tag{1}$$

With I, I_0, μ, and L is the intensity of each of the transmitted radiation, the radiation intensity at first, the linear absorption coefficient of materials, and material thickness.

C. The Physical Parameters in The Histopathological Type Of IDC and IDC Each Type Of Histopathology IDC and ILC Have Different Physical Parameters

As lack of uniformity (entropy), sharpness strukture variations (contrast), structural uniformity (angular second moment), the local homogeneity (inverse difference moment), linear dependence (correlation), authenticity properties (mean), density (deviation), lack of uniformity of the distribution of probability of occurrence gray-level pair at a certain distance (entropy of hdiff), structural uniformity of the distribution of probability of occurrence gray-level pair at a certain distance (angular second moment of hdiff) and the nature of the authenticity of the pair probability distribution of gray-level events at a certain distance (mean hdiff) as follows: [1,2,3,4]

$$Entropy\,(E) = -\sum_{y_q=y_1}^{y_t}\sum_{y_r=y_1}^{y_t}[H(y_q,y_r,d)]\log[H(y_q,y_r,d)] \quad (2)$$

$$Contrast\,(C) = \sum_{y_q=y_1}^{y_t}\sum_{y_r=y_1}^{y_t}(y_q-y_r)^2 H(y_t,y_r,d) \quad (3)$$

$$\text{Anguler Second Moment (ASM)} = \sum_{y_q=y_1}^{y_t}\sum_{y_r=y_1}^{y_t}[H(y_q,y_r,d)]^2 \quad (4)$$

$$Momen\,Differensial\,Invers\,(MDI) = \sum_{y_q=y_1}^{y_t}\sum_{y_r=y_1}^{y_t}\left[\frac{H(y_q,y_r,d)}{1+(y_q-y_r)^2}\right] \quad (5)$$

for $y_r \neq y_q$

$$Correlation\,(Corr) = \frac{\sum_{y_q=y_1}^{y_t}\sum_{y_r=y_1}^{y_t} y_q y_r H(y_q,y_r,d) - \mu H_m(y_q,d)\mu H_m(y_r,d)}{\sigma H_m(y_{qq},d)\sigma H_m(y_r,d)} \quad (6)$$

With

$$H_m(y_q,d) = \sum_{y_r=y_1}^{y_t} H(y_q,y_r,d) \quad (7)$$

$$H_m(y_r, d) = \sum_{y_q=y_1}^{y_t} H(y_q, y_r, d) \quad (8)$$

$$Mean\ (M) = \sum_{y_q=y_1}^{y_t} y_q H_m(y_q, d) \quad (9)$$

$$Deviation\ (D) = \sqrt{\sum_{y_q=y_1}^{y_t} [y_q - \sum_{y_p=y_1}^{y_t} y_p H_m(y_p, d)]^2 H_m(y_q, d)} \quad (10)$$

$$H_{diff}(i, d) = \sum_{y_q=|y_q-y_r|=i}^{y_t} \sum_{y_r=y_1}^{y_t} H(y_q, y_r, d) \quad (11)$$

$$Entropy\ of\ H_{diff}\ (EHD) = -\sum_{i=i_1}^{i_t} H_{diff}(i, d) \log H_{diff}(i, d) \quad (12)$$

$$ASM\ of\ H_{diff}(i, d)\ (ASMHD) = \sum_{i=i_1}^{i_t} [H_{diff}(i, d)]^2 \quad (13)$$

$$Mean\ of\ H_{diff}\ (MHD) = \sum_{i=i_1}^{i_t} i\, H_{diff}(i, d) \quad (14)$$

With y_q, y_r, d are the first pixel gray-level values, the second pixel gray-level values and the distance between the first pixel to the second pixel respectively. H (y_q, y_r, d) is second-order histogram that describes the distribution of the event probability for a gray-level pair [1, 2, 3, 4].

D. Logistic mapping function

Review the following probability function:
$P_r(Y)$ and $Y = f(X)$ where the dependent variable that is bound to free variables $\{X_i\}$, and X_i linearly independent with X_j that is $X_i \neq \sum_j a_j X_j$ Where Y, is output category, eg: y=0, normal category, y = 1, The category is rather normal, and so on, y=k, particular category.
This form is multinomial, or multiple linear rate.

Review the logistic function (logit) the following: [1, 2, 3]

$$logit\{P_r(Y=1|X\} = log\left\{\frac{P_r(Y=1|X)}{1-P_r(Y=1|X)}\right\} \cong ln\left\{\frac{P_r(Y=1|X)}{1-P_r(Y=1|X)}\right\} = Y \quad (15)$$

Further $Y: \{Z_1, Z_2, Z_3, Z_4\}$ with X : {all of Entropy}

For example the category Y = Z_k

$$ln\left\{\frac{P_r(Y=1|X)}{1-P_r(Y=1|X)}\right\} = Z_k, \quad (16)$$

Note: Use of functional ln (natural logarithm related to qualitative mapping (Entropy) to qualitative (histological types of breast cancer), which is not satisfy the normal Gaussian, statistically

$\frac{P_r(Y=1|X)}{1-P_r(Y=1|X)} = e^{Z_k}$ or $\frac{1-P_r(Y=1|X)}{P_r(Y=1|X)} = e^{-Z_k}$ to obtain:

$$1 - P_r(Y=1|X) = P_r(Y=1|X)e^{-Z_k},$$

$$P_r(Y=1|X)\{1+e^{-Z_k}\} = 1,$$

$$P_r(Y=1|X) = \frac{1}{\{1+e^{-Z_k}\}}, \quad (17)$$

And $P_r(Y=1|X)$ as a multinomial logistic regression of statistical model.

eg for $\{Y = Z_k\}_{k=1,2,}$, it will be found in all categories $\sum_{k=1}^{2} P_r(Z_k = 1|X) = 1$,

to

$$\{Z_k = 1\}\begin{Bmatrix} Z_1 = 1, IDC, detected \\ Z_2 = 1, ILC, detected \end{Bmatrix}$$

$$P_r(Z_2 = 1|X) = \frac{1}{\{1+e^{-Z_2}\}}, \quad (18)$$

And because the fulfillment of all categories / infiltrating into force,

$$\sum_{k=1}^{4} P_r\,(Z_k = 1|X) = 1$$

$P_r(Z_1 = 1|X) + P_r(Z_2 = 1|X) = 1$, so that

$$P_r(Z_1 = 1|X) = 1 - P_r(Z_2 = 1|X)$$

$$P_r(Z_1 = 1|X) = 1 - \left[\frac{1}{\{1+e^{-Z_2}\}}\right] \tag{19}$$

E. Linear Regression Multinomial Function as Outcome of The Histological Type

Review the following linear regression: [1, 2, 3]

$$Z_k = Z_{k0} + \{\textstyle\sum_{k,j=1}^{n} B_{kj}\, Entr_j\} + \mathrm{Bkn.MeanHd10} \tag{20}$$

Z_k is the outcome / impact of a number of $\{Entr_j\}$

Z_{k0} is the intersection / intersection of the axis, or the initial value of outcome, $Z_k = Z_{k0}$

For the tribe $\{\sum_{k,j=1}^{n} B_{kj}\, Entr_j\} + \mathrm{Bkn.MeanHd10} = 0$

$\sum_{k,j=1}^{n} B_{kj}\, Entr_j$ is a nuisance parameter / variable-free number $\{Entr_j\}$ the rank of 1 (one) or linear.

$\mathrm{Bkn.MeanHd10}$ is the correction factor by the number of outcome $\{Entr_j\}$

For example:

$$Z_2 = Z_{20} + \{\textstyle\sum_{2,j=1}^{n} B_{2j}\, Entr_j\} + \mathrm{B2n.MeanHd10} \tag{21}$$

$$Z_3 = Z_{30} + \{\textstyle\sum_{3,j=1}^{n} B_{3j}\, Entr_j\} + \mathrm{B3n.MeanHd10} \tag{22}$$

$$Z_4 = Z_{40} + \{\textstyle\sum_{4,j=1}^{n} B_{4j}\, Entr_j\} + \mathrm{B4n.MeanHd10} \tag{23}$$

There are illustrated as bellows:

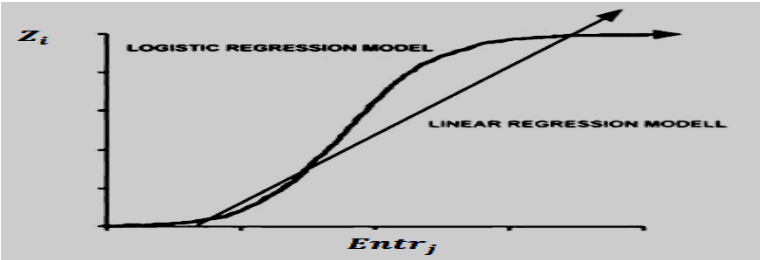
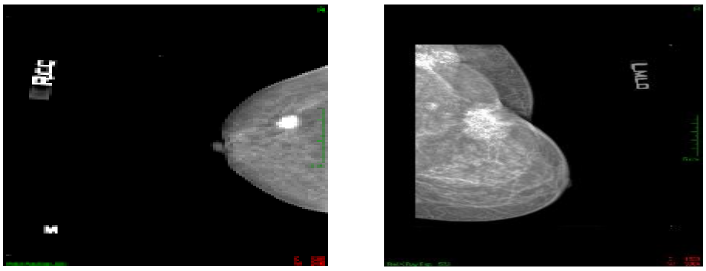


Figure 1. Linear Regression Mod

3.

4.Result and Discussion

Figure 1(a) and 1(b), depict a mammogram images IDC and ILC are respectively



(a) (b)

Figure.1. (a) IDC dan (b) ILC.

Table 1. Range value of physical parameter IDC dan ILC

No	Besaran Fisis	ILC	IDC
1	Moment Differential Invers.	0.01969 - 0.06482	0.00293 – 0.39200
2	Mean.	127.05144 – 211.81712	71.16284 - 220.92240
3	Deviation.	19.39466 – 48.20695	11.06751- 93.33126
4	Entropy of H_{diff}.	1.41346 - 2.01246	1.29424 - 2.14790
5	ASM of H_{diff}	0.01271 – 0.04542	0.00806 – 0.11134
6	Mean of H_{diff}	9.72898 - 38.68645	7.27355 - 55.92737

Mode of mathematical equation to determine the breast cancer histophatology as described:

$$Z := -914.297 - 18254.503 * MD[10] + 132.956 * MN[1] - 56.595 * MN[2] - 252.844 * MN[3] + 30.759 * MN[4] + 155.175 * MN[5] + 44.535 * MN[6] - 58.813 * MN[7] + 5.247 * MN[8] + 17.990 * MN[9] - 19.202 * MN[10] + 108.653 * D[1] - 218.358 * D[2] + 7.523 * D[3] + 162.733 * D[4] + 18.556 * D[5] - 80.810 * D[6] - 1.005 * D[7] + 3.509 * D[8] - 1.570 * D[9] + 0.587 * D[10] - 342.801 * EH[1] - 2732.608 * EH[2] + 6608.335 * EH[3] - 3620.180 * EH[4] - 2533.042 * EH[5] + 9094.463 * EH[6] + 30.415 * EH[7] - 4325.482 * EH[8] - 6433.383 * EH[9] + 4528.959 * EH[10] + 12451.486 * MAH[1] + 5.284 * MAH[2] - 57078.307 * MAH[3] + 129282.396 * MAH[4] - 137063.928 * MAH[5] + 85692.873 * MAH[6] - 83031.119 * MAH[7] + 89261.036 * MAH[8] - 130586.133 * MAH[9] + 134493.137 * MAH[10] + 33.982 * MHD[1] + 94.475 * MHD[2] - 162.638 * MHD[3] + -11.911 * MHD[4] + 39.089 * MHD[5] - 32.853 * MHD[6] - 5.818 * MHD[7] + 57.197 * MHD[8] + 28.324 * MHD[9] - 20.558 * MHD[10];$$

Probability *Infiltrating Duktal Carcinoma* (IDC)

$$= \frac{1}{1 + e^{-z}}$$

Probability *Infiltrating Lobuler Carcinoma* (ILC) = 1 - Probability IDC

The optimum physical parameters for classifying breast cancer histopathology there are Moment Differential Inverse, Mean, Deviation, Entropy of H_{diff}, ASM of H_{diff}, Mean of H_{diff}. The distance between pixels are affected on the classifying breast cancer histopathology there are 1,2,3,4,5,6,7,8,9,10 and specifically for 10 distance affected on the moment differential inverse.

5. Conclusion

The experiments for determining the type of breast cancer histopathology using the physical parameters of 80 mammograms for new patients are done. There are 2 errors and 78 in accuracy, so the 97.5% sensitivity are obtained for 2 x 2 cm area and α = 1%. So the determination of the breast cancer histopathology types using physical parameters could be increase performance of the breast cancer histopathological diagnosis. The distance between pixels are affected on the classifying breast cancer histopathology there are 1,2,3,4,5,6,7,8,9,10 and specifically for 10 distance affected on the moment differential inverse.

References

[1] A.A.N. Gunawan, Suhariningsih, K.S.P. Triyono, and B. Widodo, Determination of physical parameter model for the photo film mammographic X-ray results on the breast cancer histology classification, *International Journal of Contemporary Mathematical Sciences*, vol.45, no.7, pp. 2235-2244, 2012

[2] A.A.N. Gunawan, Suhariningsih, K.S.P. Triyono, and Yasin, Conversion of Images into Numerical Models to Determine the Condition of Breast Health on Contralateral, *Applied Mathematical Sciences*,vol 7,no.104, pp.5185-5191, 2013.

[3] A.A.N. Gunawan, A Novel Model Determination of Breast Cancer Stage Using Physical Parameter, *Far East Journal of Matematical Sciences*, vol 87, no.1,pp.23-35, 2014.

[4] A.P. Dhawan, Y. Chitre, C.K. Bonasso and M. Moskowits, Analysis of Mammographic Microcalcifications Using Gray Level Image Structure Feature, *IEEE, Trans. Medical Imaging*, vol.15, no.3, pp.246-257, 1996.

[5] B. Senthilkumar, and G. Umamaheswari, A novel edge detection algorithm for the detection of breast cancer, *European Journal of Scientific Research*, vol.53, no.1, pp.51-55, 2011.

[6] F. Eddaoudi, and F. Regragui, Microcalcifications detection in mammographic images using texture coding, *Applied Mathematical Sciences*, vol.5, no.8, pp.381-393, 2011.

[7] Humberto Ochoa, Osslan Vergara, Vianey Cruz, Efrén Gútierrez," A hybrid system based on a filter bank and a successive approximations threshold for microcalcifications detection, " *journal of computers*, vol. 4, no. 8, pp. 691 – 696, August 2009.

[8] Leonardo de Oliveira Martins, Geraldo Braz Junior, Detection of Masses in Digital Mammograms using K-Means and Support Vektor Machine, *Electronic Letters on Computer Vision and Image Analysis* , vol.8, no.2, pp.39-50, 2009.

[9] Oh Whi-Vin, and Kim KwangGi, a Kim Young-Jae, Detection of microcalcifications in digital mammograms using foveal method, *J Kor Soc Med Informatics*, vol.15, no.1, pp.165-172, 2009.

[10] R. Krishnamoorthy, N. Amudhavalli, and M.K. Sivakolundu, Identification of microcalcifications with orthogonal polynomials model, *International Journal of Engineering Science and Technology*, vol.2, no.5, pp.1204-1210, 2010.

[11] S. Bouyahia, J. Mbainaibeye, and N. Ellouze, Wavelet based microcalcifications detection in digitized mammograms, *ICGST-GVIP Journal*, vol.8, pp.23-31, 2009.

[12] Yufeng Zheng," Breast Cancer detection with gabor features from digital mammograms, " *algorithms,*ISSN 1999-4893, pp. 44-62, 2010.

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