International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com || Volume 03 - Issue 08 || August 2018 || PP. 72-78

Glam Based Feature Extraction of Mammogram Images with Fixed Window

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Abstract: J K Annavarapu, et.al., (2018) have discussed various aspects of finding Region of Interest (ROI) and Gray Level Co-occurrence Matrix (GLCM) based feature extraction from the images of mammograms for the diagnosis of breast cancer. This paper is aimed at extracting GLAM based features with fixed window.

Keywords: ROI, Fixed Window, Segmentation, Textural Feature Extraction, Gray Level, Co-occurrence Matrix (GLCM), and Gray Level Aura Matrix (GLAM).

1. Introduction:

J K Annavarapu, et.al., (2018) have given detailed account of finding ROI with Fixed Window and the results of segmentation and those ROI Images used are presented for four images out of 322 images taken from MIAS database considered for this study as under for ready reference.

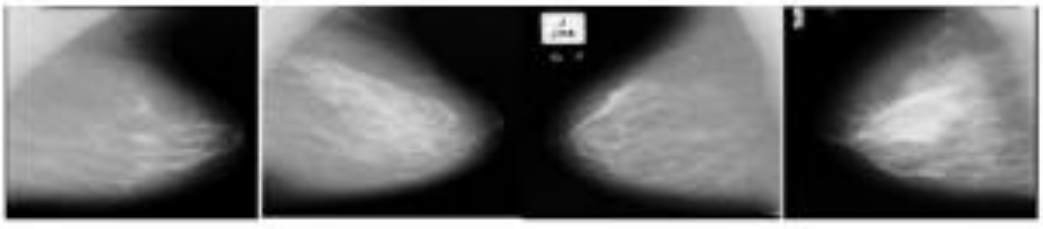

Fig.1.Original Images

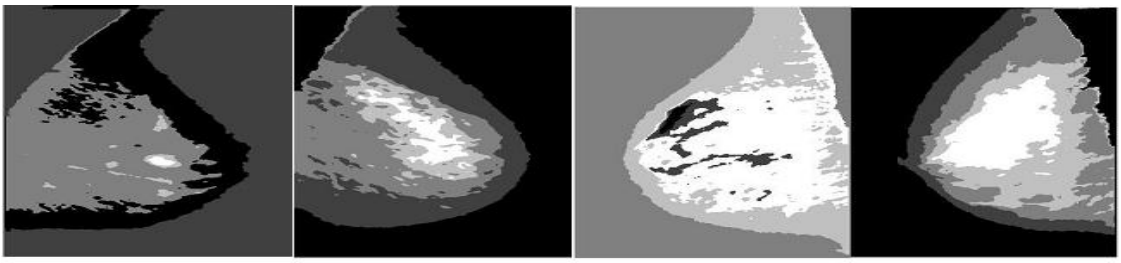

Fig.2: Segmented Image

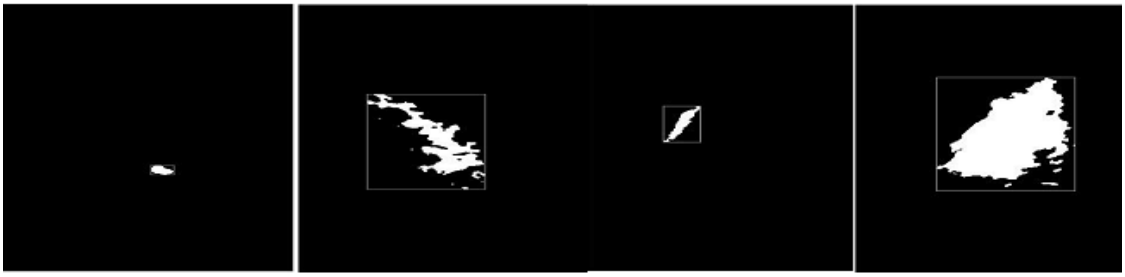

Fig.3: Binary ROIs of Images

Fig.4: ROIs of Images

They have also demonstrated construction of GLCM and presented the features extracted from GLCM.

In this paper, construction of GLAM hence feature extraction based on GLAM with Fixed Window has been presented in the subsequent sections.

2. Related Work

The texture analysis in applications such as Remote Sensing, Bio-metrics, Bio-Medical images of cells and tissues, Mammography (Sampaio, et.al., 2015) in particular is evaluated by one or more features like Coarseness, Smoothness, granulation, randomness and regularity, etc. Textural features can also be used to estimate orientation and depth of object surface [Horn (1986)]. Thus texture analysis and classifications (Rahimeh Rouhi, Mehdi jafari, 2015) (also sometimes called texture segmentation) involve determining the basic patterns as well as regularity/randomness in repetition. The Gray Level Co-occurrence Matrix (GLCM) is a technique of extracting second order statistical texture features (Kanchan Lata Kashyap, et. al., 2017). The aura matrix or miscibility matrix is a representation of the aura measures for all couples of the gray level sets on the image (Elfadel, and Picard, (1994)).

3. Construction of Glam and Feature Extraction

J K Annavarapu, et.al., (2018) have discussed construction of GLCM for Fixed Window ROI. GLCM can be constructed fixing distance of neighboring pixels and for various directions 0^0, 45^0, 90^0, 135^0.

Simple relationships exist among certain pairs of the estimated probability distributions P (d, θ). Let $P^T(d,\theta)$ denote the transpose of the matrix P (d, θ). Then

$$\mathrm{P}(d,0^0) = P^T(d,180^0)$$
$$\mathrm{P}(d,45^0) = P^T(d,225^0)$$
$$\mathrm{P}(d,90^0) = P^T(d,270^0)$$
$$\mathrm{P}(d,135^0) = P^T(d,315^0)$$

Thus, the knowledge of P (d, 180^0), P (d, 225^0), P (d, 270^0) and P (d, 315^0) adds nothing to the specification of the texture. In general, if $X \in Z^n$, the number of independent directions from X in Z^n is $\frac{3^n - 1}{2}$. For n=2, number of independent directions is equal to four. Hence, we have taken 0^0, 45^0, 90^0, and 135^0. Then GLAM can be represented as sum of GLCMs of the said 4 directions for fixed distance. Here, GLAM is constructed fixing distance as 1.

The following 13 textural features are extracted w.r.t. GLAM.

1. Angular Second Moment
2. Contrast
3. Correlation
4. Total Variance
5. Inverse Different Moment
6. Sum Average
7. Entropy
8. Sum Entropy
9. Sum Variance
10. Difference Entropy
11. Inertia
12. Cluster Shade
13. Cluster Prominence

ROI (No. of pixels) of Fixed Window is shown for 50 out of 322 images in Table 1. Time to construct GLCM and GLAM is shown for them in Table 2. Obviously, time taken for constructing GLAM will be more when compared to GLCM as it has to do computations in all four directions.

Table: 1 No. of pixels in Fixed Window ROI for the construction of GLCM and GLAM

S.No.	Fixed Window			S.No.	Fixed Window		
	No. of rows	No. of Columns	No. of Pixels		No. of rows	No. of Columns	No. of Pixels
1	20	51	1020	26	168	125	21000
2	421	435	183135	27	10	12	120
3	113	211	23843	28	10	5	50
4	568	523	297064	29	480	512	245760
5	339	175	59325	30	296	218	64528
6	29	36	1044	31	247	194	47918
7	6	5	30	32	6	5	30
8	506	6	3036	33	911	561	511071
9	238	262	62356	34	497	492	244524
10	492	348	171216	35	540	558	301320
11	42	61	2562	36	466	173	80618
12	635	274	173990	37	21	42	882
13	412	286	117832	38	313	147	46011
14	269	468	125892	39	188	133	25004
15	297	341	101277	40	823	631	519313
16	349	201	70149	41	877	709	621793
17	310	108	33480	42	610	559	340990
18	470	310	145700	43	961	757	727477
19	715	448	320320	44	442	203	89726
20	230	299	68770	45	87	109	9483
21	688	390	268320	46	56	67	3752
22	332	394	130808	47	428	985	421580
23	449	346	155354	48	491	512	251392
24	631	242	152702	49	34	51	1734
25	500	271	135500	50	77	59	4543

Table 2.Time to construct GLCM and GLAM using Fixed Window ROI

S.No.	Time in Sec. for Fixed window GLCM	Time in Sec. for Fixed window GLAM	S.No.	Time in Sec. for Fixed window GLCM	Time in Sec. for Fixed window GLAM
1	191.4232	423.9706	26	352.3359	370.4142
2	220.9597	406.6209	27	378.0338	408.2481
3	205.5852	314.8274	28	375.2003	388.803
4	275.5019	387.4853	29	374.6902	392.6921
5	259.5557	305.5605	30	374.9691	337.1127
6	271.5191	243.8996	31	374.997	438.0198
7	262.0639	315.1551	32	387.153	419.6116
8	271.3971	295.1555	33	429.9079	487.5725
9	262.7504	395.8247	34	321.4256	355.5579
10	348.723	235.8287	35	367.9449	373.0887

11	340.0404	154.3511	36	369.8923	447.0484
12	347.0623	157.4065	37	369.2466	490.0711
13	346.0856	457.7204	38	368.1403	647.3328
14	342.2221	403.0937	39	368.7954	928.912
15	341.8415	286.6165	40	424.6099	716.0837
16	340.6856	258.2849	41	559.2568	565.7389
17	339.8158	341.4162	42	506.6584	547.2386
18	339.6045	337.6345	43	600.2395	712.9709
19	339.3646	448.565	44	602.0003	674.3287
20	339.8335	387.6187	45	601.7651	562.1652
21	339.8262	273.0204	46	600.6544	662.2126
22	340.1292	345.4457	47	781.9132	883.514
23	340.0574	339.4681	48	833.469	387.3398
24	359.0893	493.6045	49	829.6447	389.1135
25	346.5055	480.4541	50	802.7796	398.1241

Table 2 depicts relative comparison of time taken to construct GLCM vs GLAM. The feature values computed from GLAM are presented in Table.3.

Table.3: Textural Feature of 50 images extracted using Fixed Window GLAM

S. No	ASM	CON TR-AST	IDM	CORR EL-ATIO N	DISSI MI-LARI TY	ENTR OPY	SUM OF SQUAR ES OF VARIA NCE	INER TIA	CLUST ER SHAD E	CLUST ER PROMI - NENC E	DIFFERE NCE ENTROP Y	SUM ENTR OPY	SUM AVER AGE
1	4.65E+00	5.39E-03	5.46E-01	1.00E+00	1.39E+00	1.32E-01	1.50E+04	4.65E+00	1.97E+07	6.86E+09	-2.55E-01	2.35E-01	1.01E+02
2	4.47E+00	1.65E-03	5.62E-01	1.00E+00	1.30E+00	-1.11E-01	2.00E+04	4.47E+00	2.89E+07	1.10E+10	-9.13E-02	-1.42E-01	1.22E+02
3	1.47E+01	3.88E-03	5.67E-01	9.99E-01	1.41E+00	-2.75E-01	2.25E+04	1.47E+01	3.38E+07	1.32E+10	-4.01E-01	-5.04E-01	1.28E+02
4	1.97E+01	2.37E-03	5.55E-01	9.98E-01	1.42E+00	1.06E-01	2.49E+04	1.97E+01	3.68E+07	1.40E+10	-1.79E-01	1.75E-01	1.42E+02
5	1.10E+01	2.95E-03	6.02E-01	9.98E-01	1.14E+00	2.27E-02	1.37E+04	1.10E+01	1.51E+07	4.27E+09	-1.80E-01	1.07E-01	1.05E+02
6	1.25E+01	4.36E-03	5.57E-01	9.96E-01	1.27E+00	-3.49E-02	1.73E+04	1.25E+01	1.97E+07	5.73E+09	-6.62E-02	-9.65E-02	1.24E+02
7	1.34E+01	2.75E-03	5.24E-01	9.98E-01	1.48E+00	1.15E-01	1.63E+04	1.34E+01	1.97E+07	6.13E+09	-3.50E-01	3.66E-01	1.13E+02
8	1.60E+01	1.82E-03	4.83E-01	9.97E-01	1.68E+00	-8.81E-02	1.83E+04	1.60E+01	2.22E+07	6.89E+09	-9.73E-02	-1.20E-01	1.26E+02
9	1.60E+01	4.30E-03	5.68E-01	9.98E-01	1.33E+00	3.41E-01	1.56E+04	1.60E+01	1.87E+07	5.70E+09	-3.23E-01	3.52E-01	1.10E+02
10	3.85E+00	5.39E-03	5.38E-01	1.00E+00	1.33E+00	1.59E-01	1.75E+04	3.85E+00	2.21E+07	7.14E+09	-1.34E-01	1.19E-01	1.16E+02
11	3.44E+00	3.91E-03	5.53E-01	1.00E+00	1.24E+00	1.68E-01	1.90E+04	3.44E+00	2.45E+07	8.11E+09	-1.61E-01	2.48E-01	1.24E+02
12	2.83E+00	7.58E-03	5.89E-01	1.00E+00	1.11E+00	-1.60E-01	1.47E+04	2.83E+00	1.72E+07	5.12E+09	-4.26E-01	-3.66E-01	1.06E+02
13	5.69E+00	1.60E-03	5.59E-01	9.99E-01	1.25E+00	-3.60E-02	2.13E+04	5.69E+00	2.92E+07	1.03E+10	-7.15E-02	-1.00E-01	1.32E+02
14	2.32E+00	2.50E-03	6.12E-01	1.00E+00	1.00E+00	1.29E-01	2.15E+04	2.32E+00	3.01E+07	1.09E+10	-2.36E-01	3.72E-01	1.30E+02
15	5.71E+00	1.74E-03	4.63E-01	9.99E-01	1.67E+00	6.92E-02	2.17E+04	5.71E+00	2.85E+07	9.55E+09	-8.46E-02	5.57E-02	1.38E+02
16	5.22E+00	2.47E-03	4.67E-01	9.99E-01	1.63E+00	-1.27E-01	1.82E+04	5.22E+00	2.24E+07	7.06E+09	-1.35E-01	-1.42E-01	1.24E+02
17	4.99E+00	1.51E-02	5.38E-01	1.00E+00	1.43E+00	1.57E-01	1.93E+04	4.99E+00	2.65E+07	9.28E+09	-3.91E-01	3.81E-01	1.19E+02
18	4.34E+00	2.34E-02	5.84E-01	1.00E+00	1.27E+00	-5.92E-02	1.66E+04	4.34E+00	2.23E+07	7.62E+09	-5.54E-01	-5.40E-01	1.05E+02
19	7.30E+00	1.56E-03	5.02E-01	9.99E-01	1.47E+00	4.32E-02	2.14E+04	7.30E+00	2.79E+07	9.31E+09	-5.74E-03	1.00E-02	1.37E+02
20	4.07E+00	2.51E-03	5.11E-01	9.99E-01	1.40E+00	4.75E-02	1.99E+04	4.07E+00	2.51E+07	8.09E+09	-9.63E-02	1.15E-01	1.31E+02
21	4.86E+00	2.97E-03	5.26E-01	9.99E-01	1.43E+00	9.26E-02	1.82E+04	4.86E+00	2.37E+07	7.94E+09	-1.99E-01	2.33E-01	1.19E+02
22	3.64E+00	1.13E-02	5.70E-01	1.00E+00	1.25E+00	-1.09E-01	1.73E+04	3.64E+00	2.32E+07	7.98E+09	-4.95E-01	-5.16E-01	1.10E+02
23	2.50E+00	3.96E-03	5.96E-01	1.00E+00	1.06E+00	-3.23E-01	2.24E+04	2.50E+00	3.11E+07	1.10E+10	4.12E-02	-4.20E-02	1.35E+02

S. No.	ASM	CONTR- AST	IDM	CORREL- ATION	DISSIMI- LARITY	ENTROPY	SUM OF SQUARES OF VARIANCE	INERTIA	CLUSTER SHADE	CLUSTER PROMI- NENCE	DIFFERENCE ENTROPY	SUM ENTROPY	SUM AVERAGE
24	2.59E+00	4.85E-03	6.23E-01	1.00E+00	9.93E-01	-8.72E-02	1.73E+04	2.59E+00	2.25E+07	7.49E+09	1.20E-02	7.43E-02	1.13E+02
25	4.32E+00	1.69E-03	5.48E-01	9.99E-01	1.34E+00	6.08E-02	1.24E+04	4.32E+00	1.37E+07	4.05E+09	-1.59E-01	-1.44E-01	9.82E+01
26	5.01E+00	1.37E-03	5.03E-01	9.99E-01	1.52E+00	-1.22E-01	1.23E+04	5.01E+00	1.35E+07	3.93E+09	-2.39E-01	-2.38E-01	9.85E+01
27	2.33E+00	4.11E-03	6.50E-01	9.99E-01	9.27E-01	-8.51E-02	8.65E+03	2.33E+00	8.08E+06	1.98E+09	-4.99E-01	-4.99E-01	8.06E+01
28	2.64E+00	2.54E-03	6.21E-01	9.99E-01	1.02E+00	-1.36E-01	1.01E+04	2.64E+00	1.03E+07	2.85E+09	1.94E-01	1.92E-01	8.77E+01
29	2.74E+00	8.12E-03	6.17E-01	1.00E+00	1.04E+00	-2.34E-01	2.67E+04	2.74E+00	4.12E+07	1.62E+10	-7.20E-02	1.70E-01	1.44E+02
30	2.97E+00	8.29E-03	5.98E-01	1.00E+00	1.10E+00	-3.21E-01	2.53E+04	2.97E+00	3.84E+07	1.49E+10	7.79E-03	5.28E-02	1.39E+02
31	5.22E+00	2.06E-03	5.36E-01	9.99E-01	1.41E+00	-3.08E-02	1.85E+04	5.22E+00	2.49E+07	8.67E+09	-4.21E-02	-4.28E-02	1.18E+02
32	5.22E+00	1.51E-03	4.88E-01	9.99E-01	1.58E+00	2.58E-02	2.22E+04	5.22E+00	3.04E+07	1.07E+10	-2.01E-01	1.83E-01	1.36E+02
33	4.25E+00	4.92E-03	5.54E-01	1.00E+00	1.33E+00	-3.26E-01	1.81E+04	4.25E+00	2.43E+07	8.41E+09	-9.52E-02	-7.99E-02	1.14E+02
34	3.91E+00	4.35E-03	5.75E-01	1.00E+00	1.25E+00	1.29E-01	1.56E+04	3.91E+00	2.02E+07	6.74E+09	-4.05E-01	4.20E-01	1.04E+02
35	3.80E+00	4.66E-03	5.61E-01	1.00E+00	1.28E+00	-2.35E-01	1.45E+04	3.80E+00	1.89E+07	6.45E+09	-7.93E-02	-5.09E-02	9.85E+01
36	3.21E+00	1.39E-02	6.03E-01	1.00E+00	1.13E+00	-2.57E-01	1.36E+04	3.21E+00	1.75E+07	5.86E+09	-3.31E-01	-3.40E-01	9.33E+01
37	3.54E+00	6.62E-03	5.91E-01	1.00E+00	1.18E+00	1.96E-01	1.90E+04	3.54E+00	2.62E+07	9.45E+09	-2.83E-01	2.74E-01	1.18E+02
38	3.67E+00	1.62E-03	5.43E-01	9.99E-01	1.29E+00	8.07E-02	1.85E+04	3.67E+00	2.37E+07	7.86E+09	-6.85E-02	2.21E-02	1.23E+02
39	6.84E+00	1.35E-03	4.63E-01	9.99E-01	1.72E+00	5.70E-03	2.37E+04	6.84E+00	3.46E+07	1.29E+10	-5.14E-02	6.06E-02	1.37E+02
40	4.86E+00	1.41E-03	4.94E-01	1.00E+00	1.53E+00	-6.72E-02	2.10E+04	4.86E+00	3.05E+07	1.15E+10	-1.85E-02	-3.36E-02	1.25E+02
41	3.13E+00	3.17E-03	5.75E-01	1.00E+00	1.16E+00	1.53E-01	1.55E+04	3.13E+00	1.93E+07	6.28E+09	-3.16E-01	3.85E-01	1.08E+02
42	4.27E+00	1.41E-03	5.47E-01	9.99E-01	1.28E+00	3.44E-03	1.44E+04	4.27E+00	1.68E+07	5.11E+09	-4.09E-02	3.59E-02	1.07E+02
43	3.51E+00	5.71E-03	5.64E-01	1.00E+00	1.24E+00	5.30E-02	1.42E+04	3.51E+00	1.73E+07	5.46E+09	4.98E-03	-7.00E-03	1.02E+02
44	4.01E+00	9.58E-03	5.62E-01	1.00E+00	1.29E+00	-2.75E-02	1.77E+04	4.01E+00	2.32E+07	7.79E+09	-4.41E-01	-4.83E-01	1.14E+02
45	4.24E+00	3.46E-03	5.37E-01	9.99E-01	1.37E+00	-5.30E-02	1.44E+04	4.24E+00	1.71E+07	5.28E+09	2.26E-01	-2.27E-01	1.04E+02
46	4.45E+00	2.92E-03	5.30E-01	9.99E-01	1.41E+00	1.69E-01	1.35E+04	4.45E+00	1.58E+07	4.86E+09	-4.18E-01	4.33E-01	1.01E+02
47	1.76E+01	3.94E-03	5.77E-01	9.97E-01	1.36E+00	4.09E-02	1.08E+04	1.76E+01	1.20E+07	3.57E+09	-3.25E-01	-3.31E-01	8.70E+01
48	3.76E+00	5.01E-03	5.60E-01	9.99E-01	1.28E+00	-6.86E-02	1.24E+04	3.76E+00	1.41E+07	4.21E+09	-3.03E-01	2.85E-01	9.48E+01
49	3.00E+00	3.15E-03	5.76E-01	1.00E+00	1.15E+00	-1.76E-01	2.45E+04	3.00E+00	3.48E+07	1.26E+10	-1.89E-01	-1.59E-01	1.44E+02
50	3.34E+00	4.29E-03	5.73E-01	1.00E+00	1.17E+00	-2.29E-01	2.16E+04	3.34E+00	2.93E+07	1.02E+10	-2.33E-01	-3.43E-01	1.32E+02

It may be noted that the results pertaining to remaining 272 images are available with the first author and not presented here to save space.

4. Future Work

Considering the features extracted from GLCM and GLAM it is planned to work on classification problem using multi Support Vector machine (SVM).

5. Acknowledgements

First Author is happy to acknowledge UGC- New Delhi for providing me financial Assistance to carry out this project under UGC BSR RFSMS Scheme.

6. References

[1]. Annavarapu, J.K., Dattatreya Rao,A.V., Karteeka Pavan,K., 2018, Region of Interest (ROI) And Feature Extraction From The Images of mammograms For the diagnosis of Breast cancer. The International Journal Research Publication's, Research Journal of Science & IT management, Vol.No.07, pp.9-28.

[2]. Annavarapu, J.K., Dattatreya Rao, A.V., Karteeka Pavan,K., 2018, Pre-Processing of Images For the Diagnosis of Breast Cancer, The International Journal Research Publication's, Research Journal of Science & IT Management, Vol.No.07, pp.1-8.

[3]. Kanchan Lata Kashyap, Koushlendra Kumar Singh, Manish Kumar Bajpai, Pritee Khanna, 2017. Fractional Order Filter based Enhancement of Digital Mammograms. Proceedings of the World Congress on Engineering and Computer Science. Vol.1.

[4]. Dattatreya Rao, A.V., Annavarapu, J.K., 2016, Big Data Analytics, proceedings of Conference 'Emerging Trends in Statistical Research", Narosa Publications, New Delhi, pp.31-41.

[5]. Rahimeh Rouhi, Mehdi Jafari, 2015. Classification of benign and malignant breast tumors based on hybrid level set segmentation, Expert Systems With Applications, 46, 45–59.

[6]. J K Annavarapu, 2015, Statistical Feature Selection for Image Texture Analysis, International Research Journal of Engineering And Technology, Vol.02, pp.546-550.

[7]. Sampaio,W., CorrêaSilva, A., Cardoso de Paiva, A. Marcelo Gattass, 2015, Detection of masses in mammograms with adaption to breast density using genetic algorithm, phylogenetictrees, LBP and SVM, Expert Systems With Applications 42, 8911–8928.

[8]. Elfadel, I.-M., & Picard, R.-W. 1994, Gibbs random fields, co-occurrences, and texture modeling. IEEE Transaction on Pattern Analysis and Machine Intelligence, 16(1), 24–37.

[9]. Horn, B.K.P., 1986, Robot Vision, MIT press, Cambridge, Massachusetts.