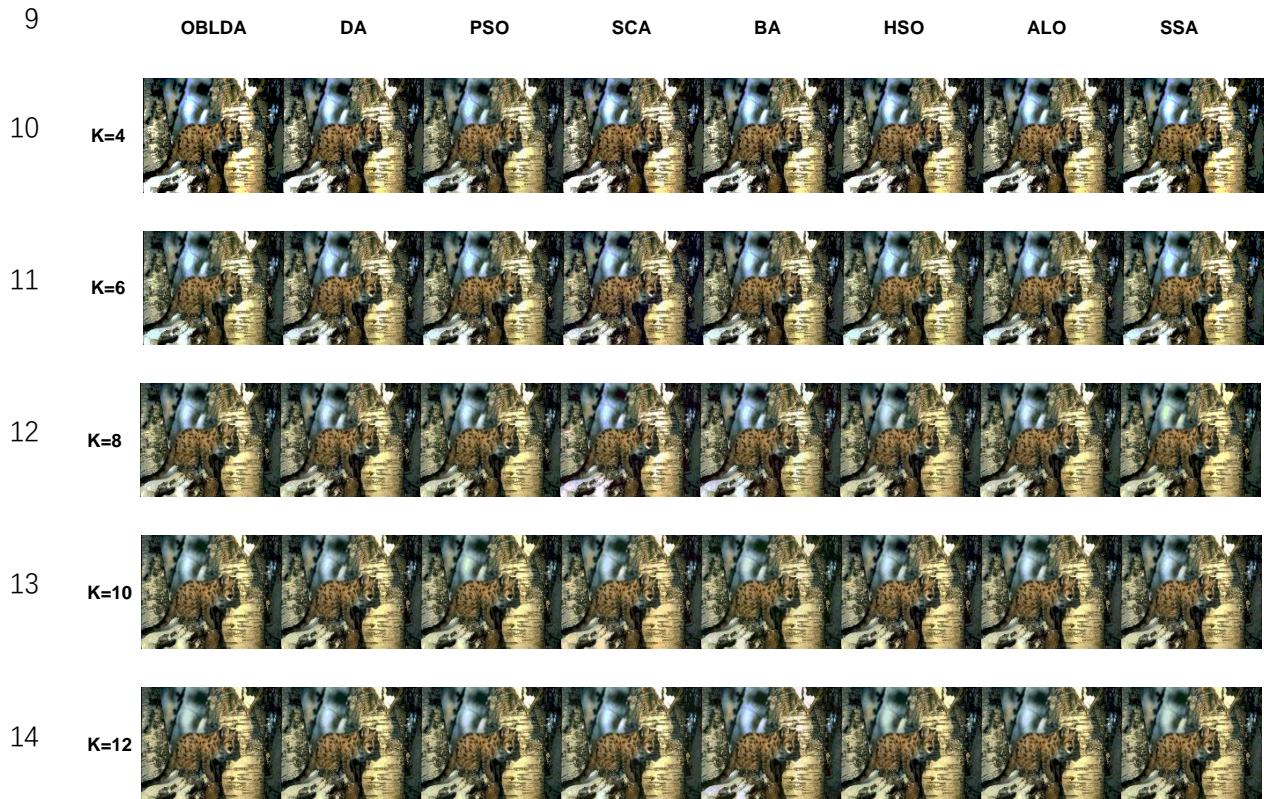


(a) Image1

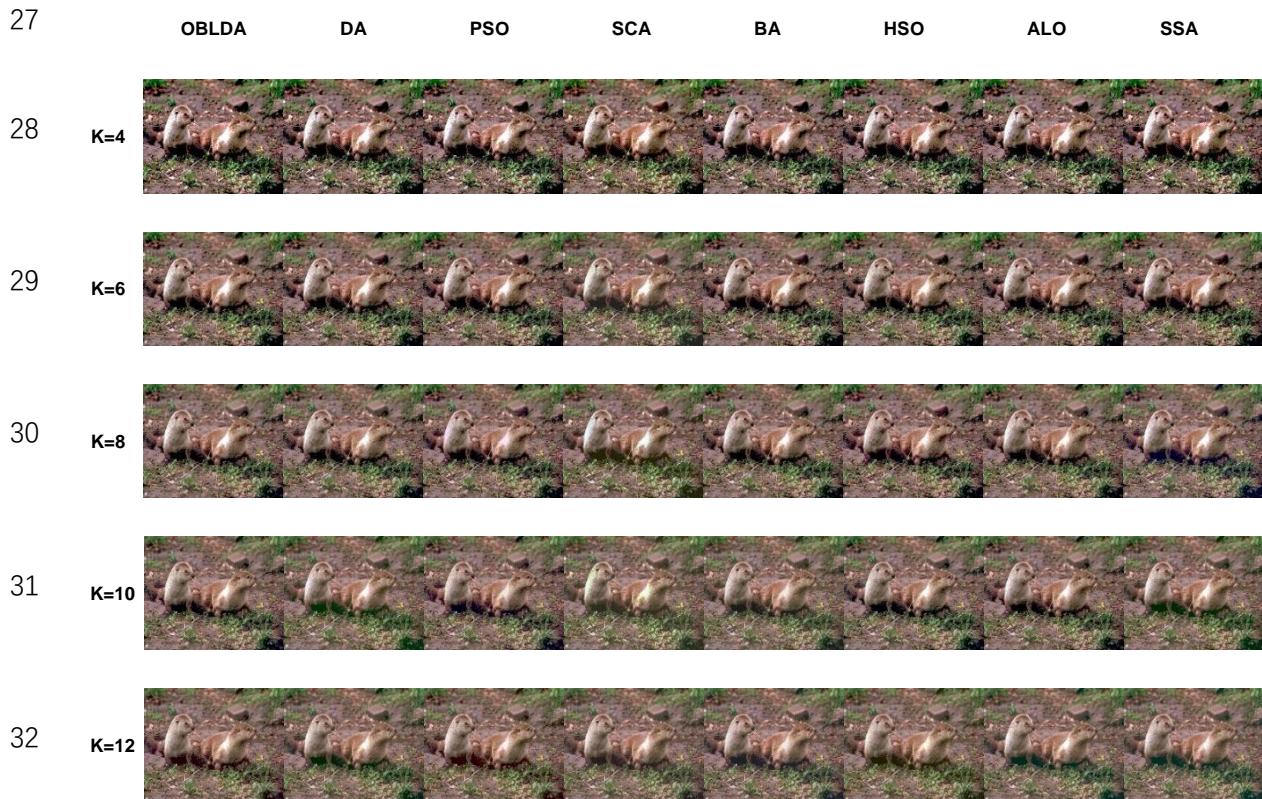


(b) Image2

15
16
17
18



(c) Image3

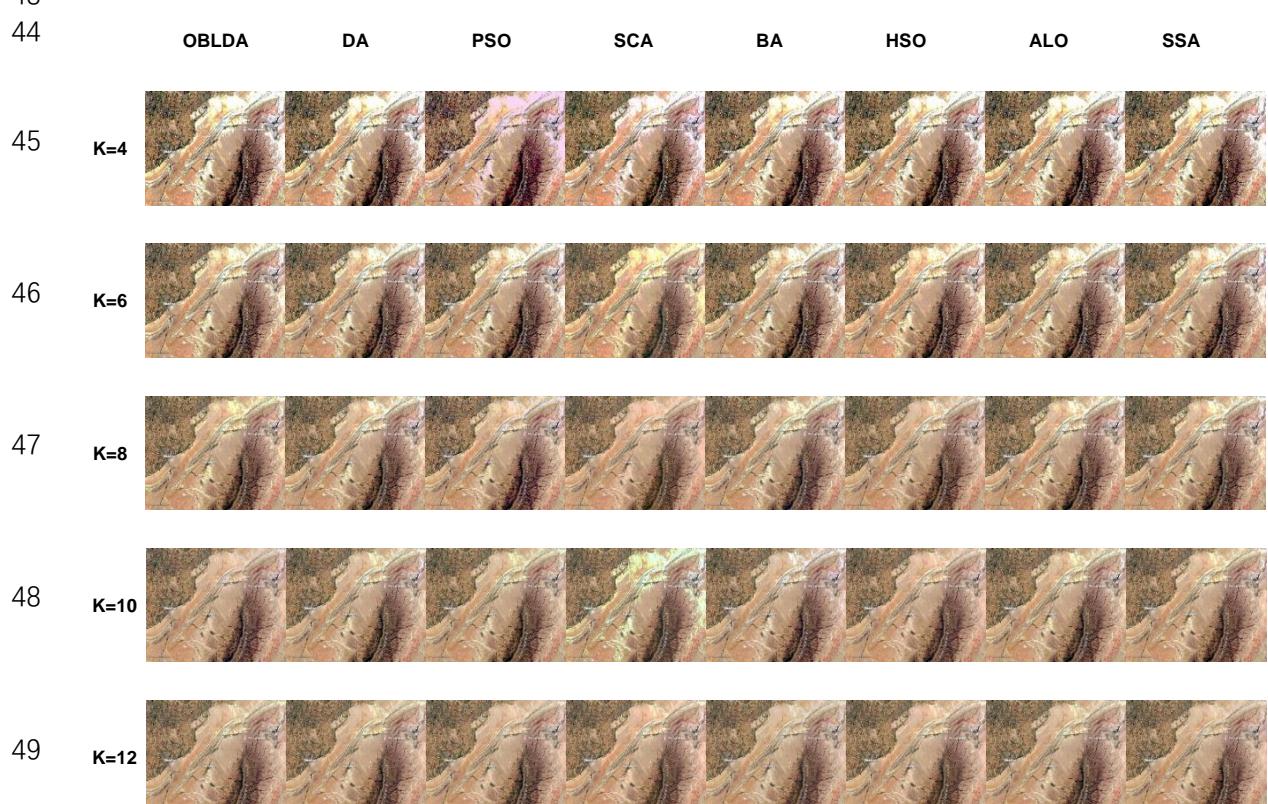


(d) Image4

33 OBLDA DA PSO SCA BA HSO ALO SSA



(e) Image5



(f) Image6

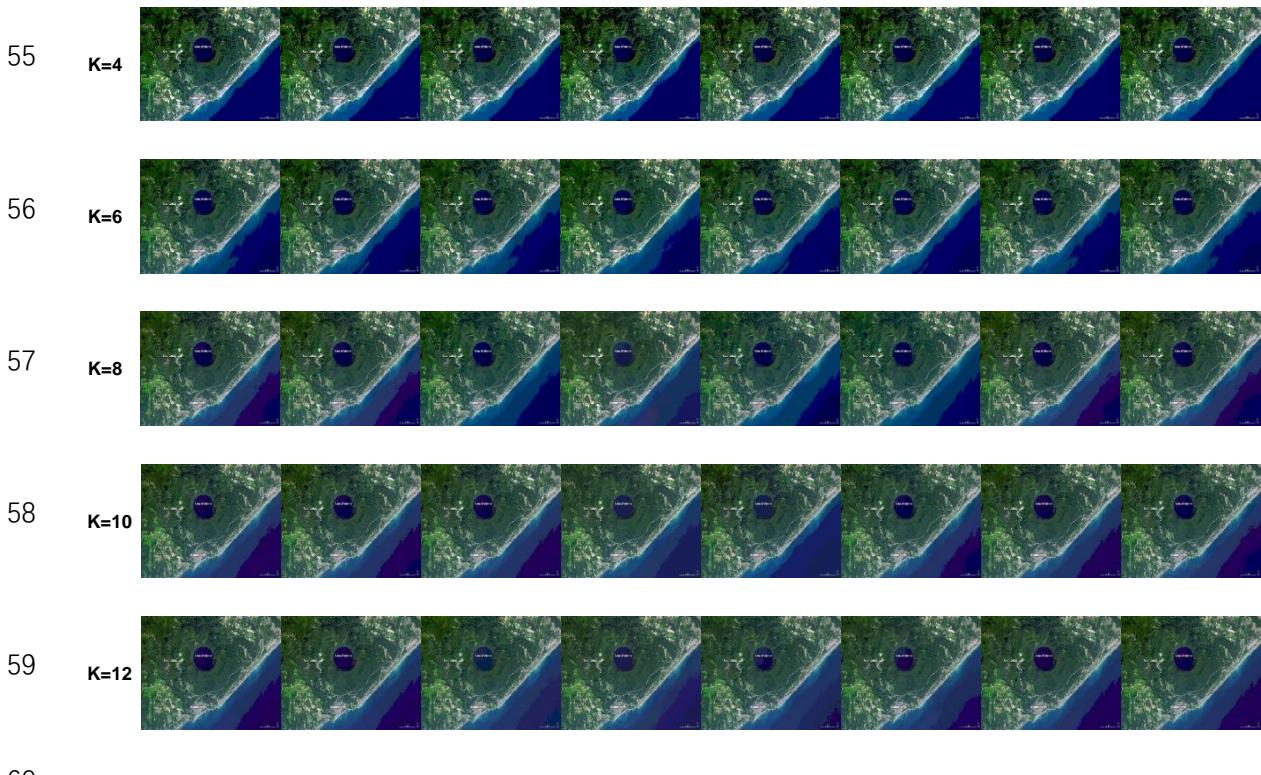
50

51

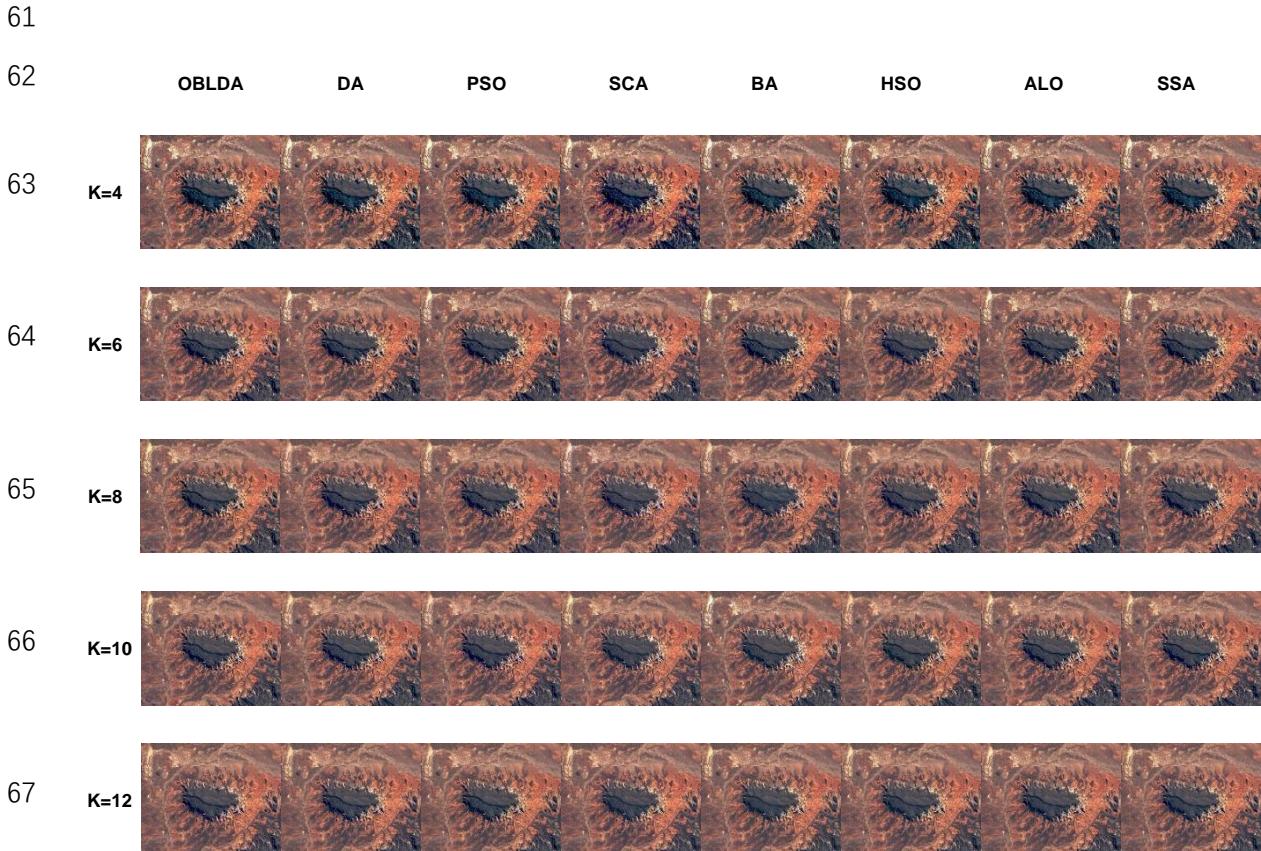
52

53

54 OBLDA DA PSO SCA BA HSO ALO SSA

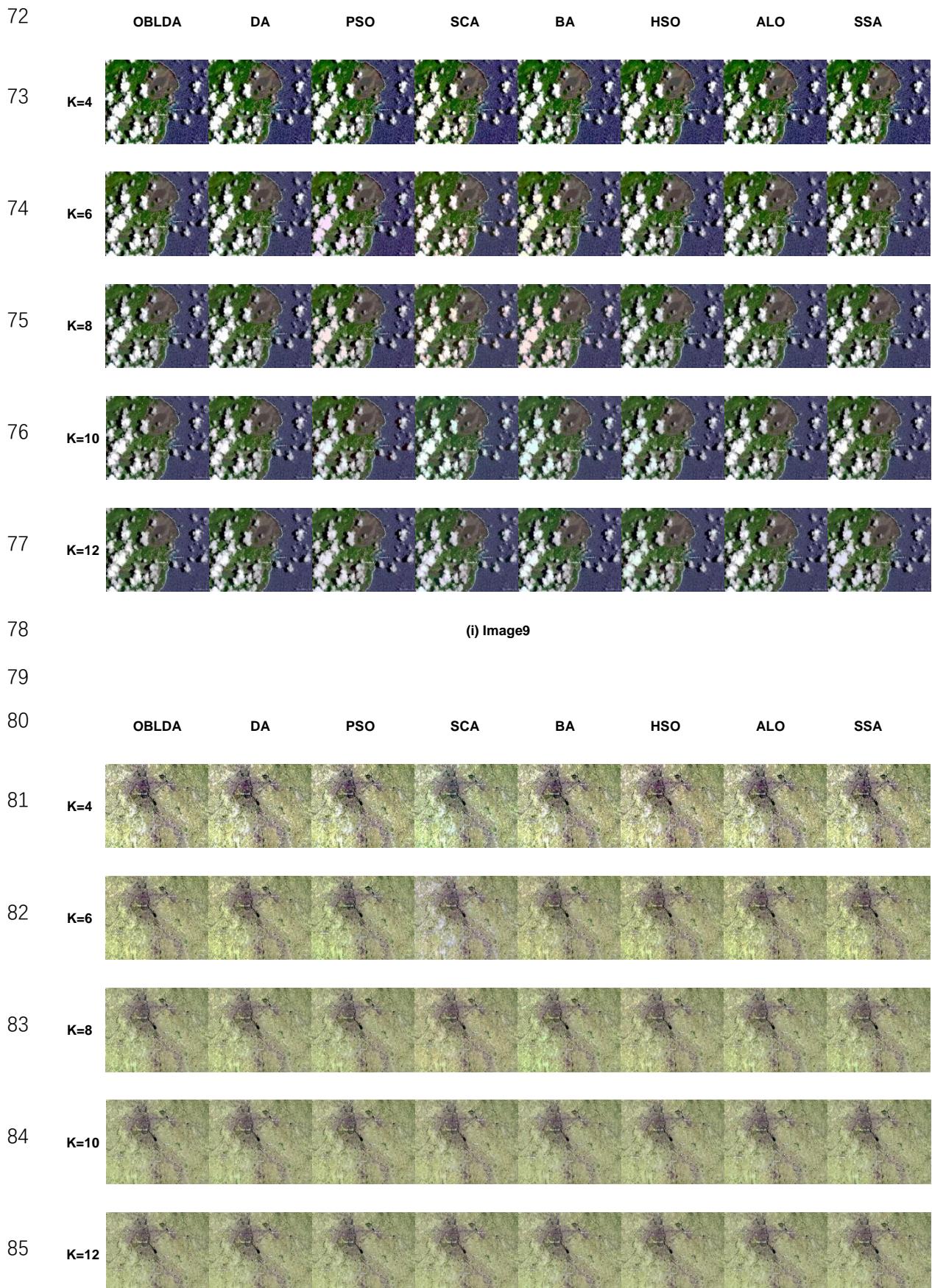


(g) Image7



(h) Image8

68
69
70
71



86 (j) Image10
 87 **Figure 1.** The segmented images using Otsu's method

88

89

OBLDA DA PSO SCA BA HSO ALO SSA

90



91



92



93



94



(a) Image1

95

96

97

OBLDA DA PSO SCA BA HSO ALO SSA

98



99



100



101



102



(b) Image2

103

104
105

OBLDA DA PSO SCA BA HSO ALO SSA

106
K=4



107
K=6



108
K=8



109
K=10



110
K=12



111

(c) Image3

112
113

OBLDA DA PSO SCA BA HSO ALO SSA

114
K=4



115
K=6



116
K=8



117
K=10



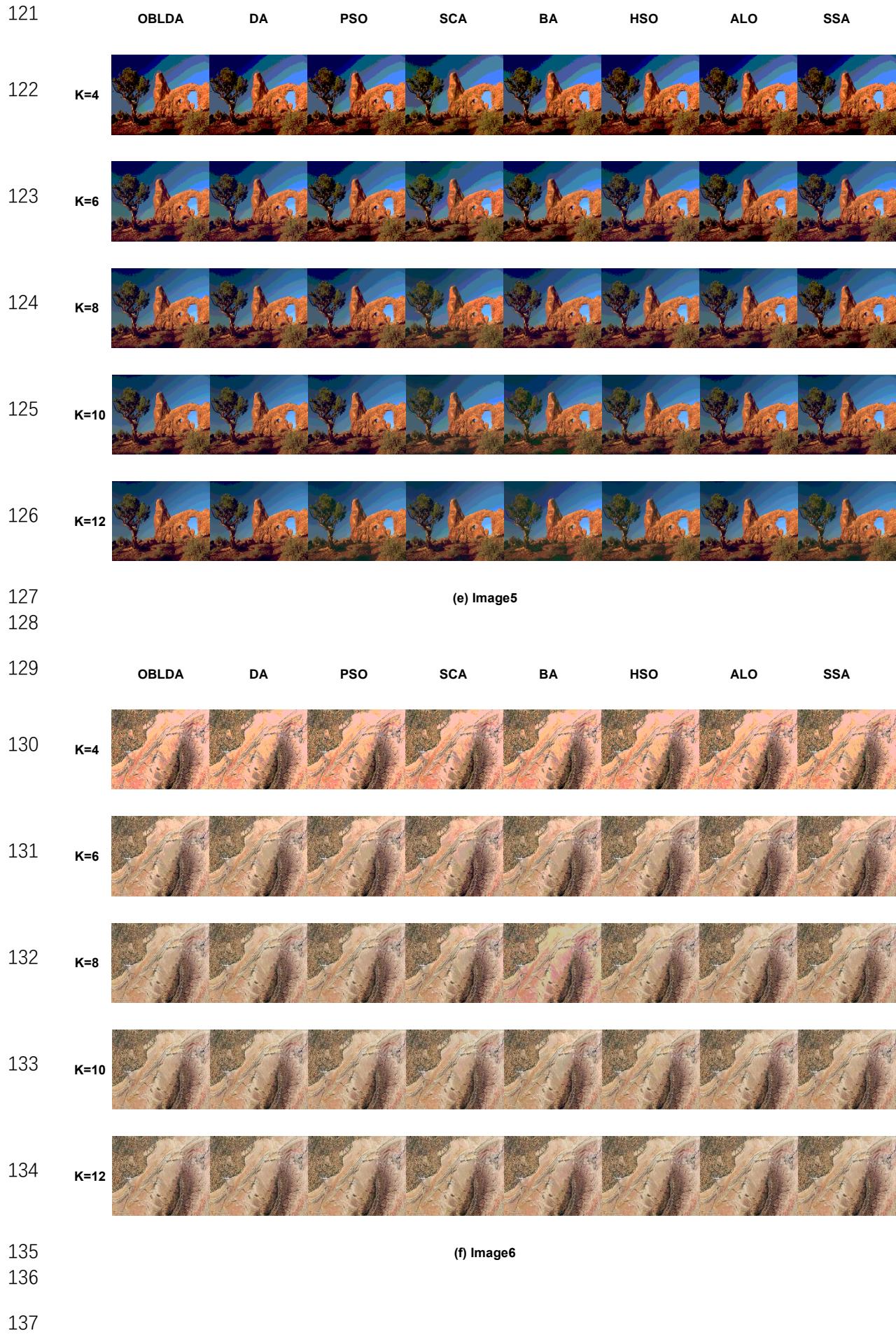
118
K=12



119

(d) Image4

120



138 OBLDA DA PSO SCA BA HSO ALO SSA

139 K=4

140 K=6

141 K=8

142 K=10

143 K=12

144 (g) Image7

145

146 OBLDA DA PSO SCA BA HSO ALO SSA

147 K=4 

148 K=6 

149 K=8 

150 K=10 

151 K=12 

152 (h) Image8

153

154

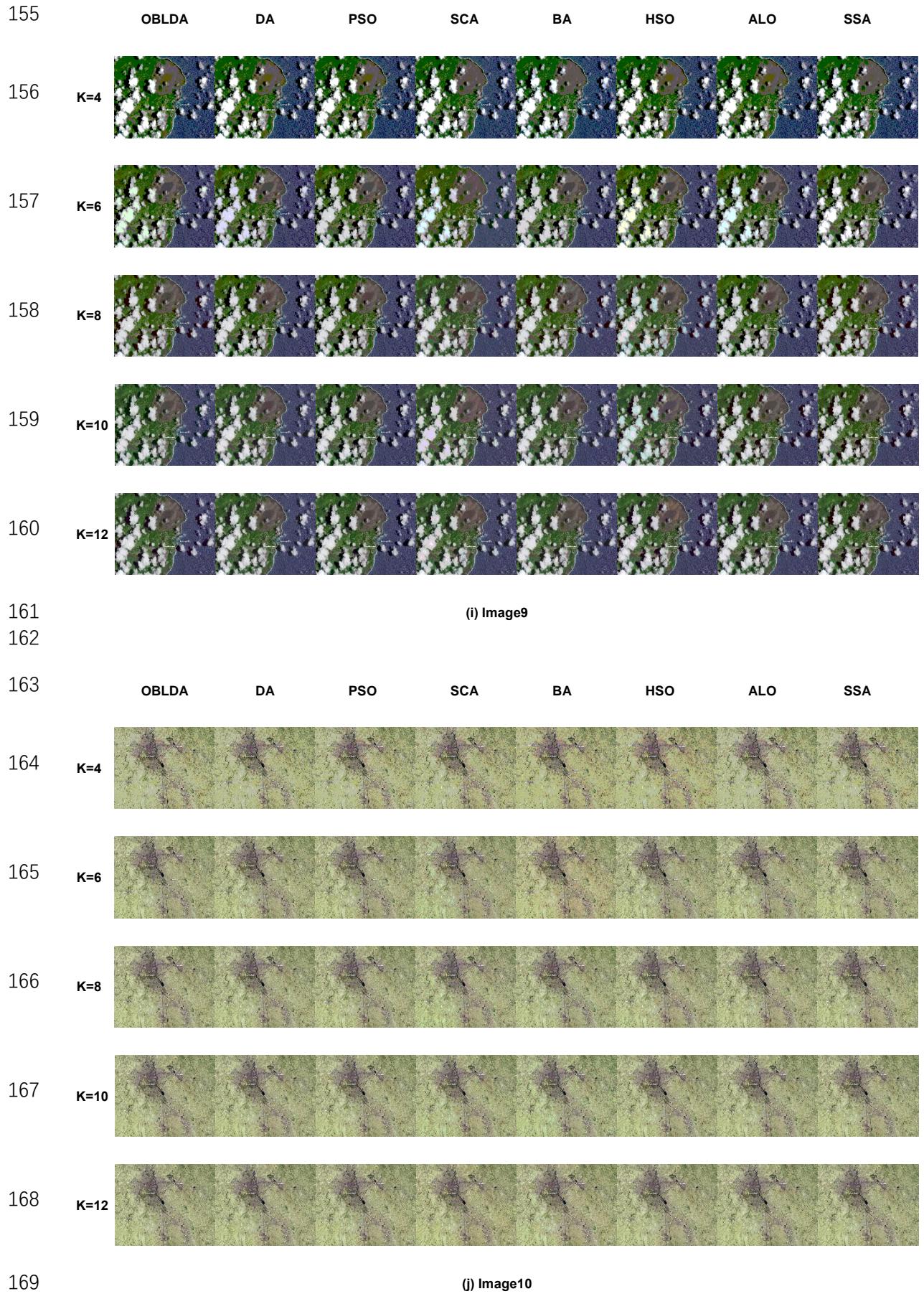


Figure 2. The segmented images using Kapur's entropy

Table 1. Comparison of optimal thresholds for different algorithms using Otsu's method at 4, 6, 8, 10, and 12 levels

Table 3. The PSNR values using Otsu's method in comparison with other algorithms

Images	K	OBLDA	DA	PSO	SCA	BA	HSO	ALO	SSA
Image1	4	19.7033	19.7013	19.600	19.6186	19.6601	19.5234	19.7033	19.7033
	6	21.8649	21.8189	21.655	21.6041	21.4816	21.4611	21.5362	21.5369
	8	23.4972	23.1839	23.1208	23.2054	22.6285	23.2486	23.3038	23.3073
	10	25.6864	25.2335	25.1624	25.148	24.5879	25.4305	25.3776	25.4946
	12	27.3897	26.9431	26.9885	25.9617	27.0112	27.0671	27.0406	26.143
Image2	4	19.9135	19.6017	19.5352	19.3290	19.2107	19.4322	19.9135	19.5517
	6	23.2804	23.0052	22.9732	22.5877	22.885	23.2804	23.0664	23.0738
	8	26.2533	25.9845	24.9794	24.1305	24.8595	25.9982	26.0905	25.6888
	10	28.9395	28.4902	28.2119	27.879	27.7862	28.0375	28.2625	28.1941
	12	31.3912	29.7802	29.8094	28.5135	29.7677	31.0032	29.9079	31.0095
Image3	4	17.7278	17.4278	17.2685	17.2833	17.4849	17.2554	17.7270	17.7268
	6	20.1331	20.0389	20.1276	20.1286	20.1239	19.8524	20.0422	20.0423
	8	21.9897	21.3036	20.9691	20.946	21.3404	21.5033	21.4431	21.5688
	10	24.0625	23.9133	24.054	23.9914	23.7254	23.9112	23.7495	23.4686
	12	27.9966	26.4174	26.4214	27.493	25.6114	27.4125	25.5777	27.5016
Image4	4	17.9481	17.9079	17.8881	17.8483	17.8859	17.9023	17.9481	17.9478
	6	20.9517	20.9412	20.8772	20.2104	20.6978	20.3277	20.9007	20.9109
	8	23.2585	23.1969	22.690	23.0061	22.9611	22.2352	23.0629	22.9587
	10	28.045	27.7032	26.6908	27.6716	25.7947	24.3622	26.584	26.857
	12	30.6278	28.4995	27.7143	30.0034	29.5504	30.1566	30.029	30.0012
Image5	4	19.6629	19.0959	19.6629	19.4531	19.4549	19.413	19.0429	19.6629
	6	23.2763	23.0646	22.5352	23.0648	22.8631	22.9148	23.0768	23.0763
	8	25.6073	25.1607	25.0672	25.0543	25.0796	25.1999	25.255	25.3789
	10	27.3709	27.0939	26.3669	27.1081	26.3639	27.0202	27.0111	27.0624
	12	29.3325	28.8226	29.0715	29.0485	28.9539	28.930	29.0663	29.0679
Image6	4	17.5938	17.5938	17.4302	17.4934	17.5439	17.5319	17.5938	17.5938
	6	21.4539	21.1178	21.0694	20.9656	21.042	20.9784	21.1761	21.1806
	8	25.698	24.8418	25.1531	25.1862	25.0441	24.551	24.7773	24.9808
	10	28.9968	27.8246	28.0103	28.2305	27.003	28.3563	27.4537	28.1933
	12	30.9243	29.5892	29.3285	28.9393	30.1188	30.0701	30.3753	30.3459
Image7	4	19.1099	19.0931	19.0931	18.6358	19.0946	19.0638	19.0331	19.0231
	6	21.7178	21.0705	20.7217	21.0922	20.9022	21.0713	21.3445	21.7223
	8	25.5061	25.3034	24.0494	25.1621	24.9356	25.4958	25.4275	25.2951
	10	27.7526	27.1161	27.0466	26.9274	27.0499	27.0001	27.5672	26.8535
	12	28.7689	28.4672	28.3964	28.600	28.3072	28.3893	28.0723	28.0633
Image8	4	21.0402	21.0002	21.0400	20.0306	20.0304	20.0109	21.0302	21.0402
	6	25.6341	25.5060	25.5196	24.5882	25.2380	25.1438	25.5021	25.5314
	8	28.3869	28.0797	27.9839	27.9604	28.0032	28.1241	28.2974	28.1922
	10	31.0668	30.9264	30.8508	30.7022	30.9291	30.9623	31.0095	31.0051
	12	32.9738	32.1190	31.9224	31.7351	32.2205	32.1691	32.6930	32.3057
Image9	4	18.8874	18.8874	18.8874	18.7372	18.8024	18.8784	18.8874	18.8874
	6	22.1063	21.9519	21.4675	21.9566	21.9881	21.7803	21.9279	21.9953
	8	24.5687	24.4303	24.3599	24.2723	24.3586	24.3810	24.3258	24.3198
	10	25.9981	25.8817	25.5570	25.3325	25.1005	25.8147	25.9219	25.9211
	12	27.4864	27.4158	27.0575	27.3899	27.0975	27.3056	27.3506	27.4006
Image10	4	18.2657	18.2062	18.2051	18.2332	18.2614	18.2038	18.2657	18.2657
	6	24.3971	24.2836	24.1443	22.9569	24.0071	24.1080	24.1143	24.2971
	8	28.4264	27.8217	28.1905	27.4765	27.2180	28.1973	27.9721	28.1360
	10	31.5970	31.3952	30.8956	30.5105	31.3302	31.2475	31.3435	31.3022
	12	33.9870	33.4820	32.8541	32.3615	31.7282	33.1746	33.2766	33.8361

Table 4. The PSNR values using Kapur's method in comparison with other algorithms

Images	K	OBLDA	DA	PSO	SCA	BA	HSO	ALO	SSA
Image1	4	19.4750	19.3356	19.3706	19.3806	19.4689	19.4744	19.3706	19.3706
	6	23.8210	23.8085	23.8193	23.3457	23.3029	23.4661	23.8195	23.8205
	8	26.4949	26.3995	26.4632	25.6860	26.0663	26.3664	26.3772	26.3399
	10	29.8752	29.5593	27.3546	27.7523	28.2441	29.2968	29.8428	29.8475
	12	30.5762	30.5130	30.5617	29.0523	30.4961	30.4026	30.1777	30.4134
Image2	4	20.7093	20.7057	20.7039	20.5676	20.6287	20.7049	20.7039	20.7039
	6	24.7169	24.6151	24.6293	23.4359	24.7080	24.0609	24.6209	24.6209
	8	26.9450	26.0753	26.9355	25.6847	26.9416	26.9123	26.9382	26.9350
	10	28.9597	28.9432	28.2014	28.8242	28.2416	28.4495	28.8604	28.8834
	12	31.2273	31.0342	31.0524	31.0769	30.7237	30.7580	30.7323	31.2044
Image3	4	15.8514	15.8500	15.8046	15.2550	15.0207	15.6000	15.8046	15.8496
	6	19.3513	19.3237	19.3511	19.2672	19.0172	18.8515	19.3511	19.2556
	8	23.9135	23.3676	21.0652	23.9021	23.6011	23.7920	23.9036	23.8593
	10	28.9140	28.2481	26.5681	28.1633	28.0198	28.7127	28.4303	28.7283
	12	30.3360	30.2954	30.2453	30.1170	29.9916	29.3663	29.7551	30.0429
Image4	4	17.5402	17.5432	17.5430	17.4082	17.4320	17.5064	17.5402	17.5402
	6	21.0287	20.8622	20.9463	21.0111	21.0027	21.0224	21.0190	20.9463
	8	23.6951	23.0057	23.5741	23.2311	23.2877	23.5594	22.9985	23.6688
	10	27.4367	27.3158	27.3663	27.2996	27.4253	27.3368	27.4272	27.3232
	12	29.8606	29.2868	29.3172	29.8050	29.1546	29.5117	29.4611	29.7782
Image5	4	19.5459	19.5456	19.5459	19.5360	19.9356	19.5399	19.5459	19.5405
	6	23.2976	23.2897	22.3092	23.2746	22.6859	23.2530	22.3994	23.2941
	8	26.3319	26.1589	25.8872	26.3282	25.7686	26.2365	26.3241	25.5760
	10	27.9426	27.8632	27.6461	27.8923	27.8778	27.7056	27.4648	27.8665
	12	29.6375	29.6018	29.6139	28.9346	28.3683	29.6299	29.0308	29.4359
Image6	4	20.9339	20.7613	20.9238	20.1705	20.9285	20.8635	20.8660	20.9130
	6	25.6136	25.5797	25.4875	24.5233	25.4788	25.8449	25.5849	25.5031
	8	29.5949	29.4437	29.5942	27.7031	26.8124	28.9011	29.5669	29.5023
	10	31.2752	31.2391	31.2632	29.1699	29.0723	30.4147	31.2416	31.1817
	12	32.7062	32.7057	32.6528	31.4706	31.5570	31.4130	31.7004	31.7054
Image7	4	19.6073	19.6070	17.7962	19.5500	19.4862	19.3513	17.7962	19.4469
	6	23.9781	23.9160	23.9769	26.3119	23.8114	23.2545	23.3820	23.9610
	8	29.4077	29.4029	29.3525	29.0220	29.3681	29.0404	29.3606	28.6433
	10	31.2740	31.2685	30.9379	30.8732	30.4239	30.0603	31.2221	30.6465
	12	32.8087	32.8051	31.8051	31.5437	30.5348	31.7261	32.7316	32.5315
Image8	4	23.1908	23.1880	23.1896	22.5049	23.1099	23.1332	23.1911	23.1911
	6	26.5493	26.4671	26.5431	25.5831	25.9652	26.4371	26.4842	26.3018
	8	29.4421	29.4371	29.3587	28.8669	28.3915	29.4009	29.1930	29.1201
	10	31.0298	30.9124	31.0130	30.9193	30.0281	30.9286	31.0160	31.0242
	12	32.5960	32.5613	32.5810	32.5112	32.2456	31.3975	32.5697	32.3718
Image9	4	18.8490	18.8490	18.4584	18.8398	18.5748	18.7000	18.4584	18.6894
	6	22.4570	22.3798	22.3829	23.4000	22.0565	22.4511	22.3999	22.3822
	8	26.1876	25.7069	25.5774	26.1860	26.0718	26.0935	25.5890	25.7421
	10	28.9195	28.9091	28.9037	28.5837	28.2289	28.8733	28.6700	28.0352
	12	31.6151	31.5256	31.4884	30.2003	31.2357	31.5339	31.6147	30.1877
Image10	4	23.6410	23.6410	23.6362	23.6200	23.4499	23.6394	23.5247	23.6362
	6	27.4453	27.4391	27.4181	26.3370	26.8253	27.0323	27.2658	27.3044
	8	29.6973	29.6682	29.6356	29.5843	28.9887	29.3319	29.6642	29.6924
	10	31.6905	31.4941	31.4582	30.7384	30.8928	31.2535	31.4782	31.6231
	12	32.8536	32.8503	32.8479	31.9603	32.5720	32.5949	32.7922	32.7666

Table 5. The FSIM values using Otsu's method in comparison with other algorithms

Images	K	OBLDA	DA	PSO	SCA	BA	HSO	ALO	SSA
Image1	4	0.7988	0.7988	0.7983	0.7977	0.7987	0.7984	0.7988	0.7983
	6	0.8699	0.8697	0.8695	0.8598	0.8638	0.8665	0.8687	0.8696
	8	0.9021	0.9015	0.8940	0.8821	0.8878	0.8997	0.9015	0.9017
	10	0.9221	0.9213	0.9186	0.9089	0.9191	0.8988	0.9199	0.9209
	12	0.9331	0.9321	0.9224	0.9179	0.9224	0.9306	0.9331	0.9291
Image2	4	0.7577	0.7570	0.7576	0.7535	0.7562	0.7567	0.7577	0.7574
	6	0.8369	0.8367	0.8341	0.8212	0.8289	0.8369	0.8369	0.8340
	8	0.8815	0.8809	0.8804	0.8568	0.8661	0.8792	0.8810	0.8753
	10	0.9156	0.9151	0.9148	0.8933	0.8989	0.9100	0.9140	0.9134
	12	0.9357	0.9331	0.9324	0.9163	0.9108	0.9300	0.9344	0.9354
Image3	4	0.7567	0.7567	0.7563	0.7514	0.7564	0.7566	0.7563	0.7512
	6	0.8176	0.8164	0.8171	0.8143	0.8170	0.8143	0.8163	0.8163
	8	0.8600	0.8599	0.8560	0.8516	0.8484	0.8571	0.8594	0.8574
	10	0.8901	0.8899	0.8897	0.8888	0.8671	0.8850	0.8813	0.8868
	12	0.9227	0.9028	0.8986	0.9156	0.8990	0.9203	0.9158	0.9220
Image4	4	0.7512	0.7502	0.7512	0.7484	0.7503	0.7510	0.7512	0.7504
	6	0.8326	0.8310	0.8316	0.8166	0.8291	0.8320	0.8226	0.8316
	8	0.8793	0.8785	0.8711	0.8743	0.8749	0.8646	0.8776	0.8750
	10	0.9116	0.9061	0.9104	0.9021	0.8945	0.8968	0.9105	0.9109
	12	0.9268	0.9177	0.9253	0.9247	0.9246	0.9171	0.9227	0.9264
Image5	4	0.7855	0.7730	0.7855	0.7783	0.7708	0.7701	0.7855	0.7855
	6	0.8472	0.8401	0.8411	0.8372	0.8410	0.8412	0.8422	0.8422
	8	0.8817	0.8778	0.8761	0.8760	0.8694	0.8765	0.8792	0.8773
	10	0.8988	0.8954	0.8915	0.8953	0.8844	0.8921	0.8941	0.8957
	12	0.9206	0.9140	0.9149	0.9200	0.9178	0.9193	0.9183	0.9174
Image6	4	0.7759	0.7759	0.7747	0.7753	0.7750	0.7771	0.7759	0.7759
	6	0.8513	0.8496	0.8464	0.8493	0.8435	0.8473	0.8500	0.8495
	8	0.9131	0.9001	0.9060	0.9054	0.9021	0.9118	0.8997	0.9020
	10	0.9482	0.9344	0.9462	0.9384	0.9232	0.9476	0.9309	0.9398
	12	0.9597	0.9453	0.9510	0.9464	0.9571	0.9547	0.9587	0.9555
Image7	4	0.7853	0.7850	0.7850	0.7762	0.7845	0.7838	0.7850	0.7850
	6	0.8552	0.8548	0.8524	0.8409	0.8524	0.8465	0.8504	0.8552
	8	0.9037	0.9014	0.8982	0.9002	0.8934	0.9017	0.9029	0.9017
	10	0.9314	0.9284	0.9313	0.9310	0.9301	0.9310	0.9305	0.9239
	12	0.9459	0.9447	0.9417	0.9423	0.9457	0.9409	0.9420	0.9372
Image8	4	0.8253	0.8253	0.8250	0.8160	0.8219	0.8196	0.8250	0.8253
	6	0.9093	0.9091	0.9084	0.9078	0.9047	0.9040	0.9087	0.9085
	8	0.9413	0.9404	0.9407	0.9370	0.9326	0.9322	0.9359	0.9366
	10	0.9648	0.9645	0.9638	0.9607	0.9406	0.9611	0.9648	0.9643
	12	0.9742	0.9734	0.9682	0.9655	0.9690	0.9736	0.9725	0.9725
Image9	4	0.7689	0.7689	0.7689	0.7675	0.7682	0.7689	0.7689	0.7689
	6	0.8306	0.8302	0.8150	0.8290	0.8267	0.8258	0.8303	0.8303
	8	0.8689	0.8677	0.8680	0.8604	0.8670	0.8672	0.8668	0.8678
	10	0.8927	0.8917	0.8918	0.8723	0.8911	0.8907	0.8921	0.8924
	12	0.9104	0.9101	0.9083	0.9067	0.9040	0.9059	0.9091	0.9101
Image10	4	0.7939	0.7934	0.7929	0.7909	0.7913	0.7934	0.7939	0.7939
	6	0.9115	0.9023	0.9020	0.8673	0.9082	0.9064	0.9017	0.9115
	8	0.9453	0.9415	0.9420	0.9384	0.9359	0.9442	0.9432	0.9451
	10	0.9706	0.9700	0.9680	0.9639	0.9702	0.9631	0.9704	0.9618
	12	0.9825	0.9823	0.9780	0.9758	0.9695	0.9792	0.9813	0.9817

Table 6. The FSIM values using Kapur's method in comparison with other algorithms

Images	K	OBLDA	DA	PSO	SCA	BA	HSO	ALO	SSA
Image1	4	0.7729	0.7729	0.7726	0.7771	0.7731	0.7779	0.7726	0.7726
	6	0.8906	0.8528	0.8517	0.8424	0.8429	0.8486	0.8525	0.8519
	8	0.9274	0.9003	0.8958	0.8837	0.8931	0.8948	0.9005	0.9000
	10	0.9452	0.9243	0.9181	0.9115	0.9024	0.9242	0.9250	0.9240
	12	0.9732	0.9334	0.9300	0.9185	0.9177	0.9392	0.9381	0.9397
	4	0.7437	0.7437	0.7423	0.7392	0.7330	0.7329	0.7343	0.7343
Image2	6	0.8341	0.8331	0.8331	0.8221	0.8324	0.8341	0.8334	0.8334
	8	0.8926	0.8820	0.8819	0.8695	0.8774	0.8816	0.8819	0.8824
	10	0.9130	0.9129	0.9123	0.8958	0.8963	0.9128	0.9129	0.9121
	12	0.9371	0.9363	0.9365	0.9238	0.9226	0.9320	0.9358	0.9357
	4	0.7349	0.7349	0.7339	0.7332	0.7330	0.7319	0.7339	0.7346
	6	0.7848	0.7825	0.7839	0.7818	0.7756	0.7770	0.7840	0.7757
Image3	8	0.8561	0.8539	0.8277	0.8549	0.8522	0.8550	0.8546	0.8550
	10	0.9079	0.9076	0.8968	0.8862	0.8994	0.8998	0.9022	0.9036
	12	0.9259	0.9239	0.9230	0.9037	0.8924	0.9240	0.9211	0.9206
	4	0.7243	0.7241	0.7240	0.7210	0.7208	0.7217	0.7243	0.7243
	6	0.8183	0.8166	0.8178	0.8127	0.8133	0.8175	0.8173	0.8178
	8	0.8740	0.8737	0.8732	0.8724	0.8431	0.8738	0.8736	0.8675
Image4	10	0.9182	0.9109	0.9178	0.9099	0.9068	0.9137	0.9169	0.9139
	12	0.9277	0.9273	0.9213	0.9264	0.9161	0.9264	0.9215	0.9266
	4	0.7476	0.7474	0.7476	0.7473	0.7431	0.7468	0.7476	0.7471
	6	0.8383	0.8377	0.8302	0.8135	0.8340	0.8322	0.8310	0.8380
	8	0.8835	0.8773	0.8773	0.8673	0.8718	0.8791	0.8835	0.8619
	10	0.9030	0.9029	0.9000	0.8961	0.8920	0.8947	0.8983	0.9019
Image5	12	0.9174	0.9164	0.9171	0.9002	0.9036	0.9117	0.9168	0.9108
	4	0.8141	0.8117	0.8139	0.8140	0.8120	0.8136	0.8095	0.8106
	6	0.9006	0.9002	0.8995	0.8820	0.8953	0.9003	0.9003	0.8999
	8	0.9474	0.9455	0.9474	0.9258	0.9291	0.9405	0.9462	0.9466
	10	0.9642	0.9641	0.9632	0.9403	0.9446	0.9566	0.9630	0.9634
	12	0.9732	0.9730	0.9728	0.9571	0.9523	0.9702	0.9715	0.9726
Image6	4	0.7625	0.7626	0.7564	0.7568	0.7592	0.7581	0.7564	0.7626
	6	0.8507	0.8483	0.8503	0.8502	0.8447	0.8500	0.8496	0.8492
	8	0.9160	0.9159	0.9138	0.9102	0.9155	0.9115	0.9159	0.9034
	10	0.9408	0.9402	0.9358	0.9354	0.9329	0.9397	0.9403	0.9331
	12	0.9591	0.9560	0.9581	0.9537	0.9500	0.9514	0.9563	0.9528
	4	0.8307	0.8304	0.8306	0.8153	0.8266	0.8304	0.8307	0.8307
Image7	6	0.9095	0.9094	0.9077	0.8919	0.9023	0.9040	0.9083	0.9073
	8	0.9487	0.9484	0.9480	0.9391	0.9311	0.9460	0.9455	0.9449
	10	0.9625	0.9624	0.9623	0.9621	0.9587	0.9578	0.9617	0.9620
	12	0.9730	0.9724	0.9727	0.9726	0.9625	0.9654	0.9721	0.9719
	4	0.7548	0.7548	0.7540	0.7538	0.7539	0.7545	0.7541	0.7539
	6	0.8315	0.8311	0.8310	0.8225	0.8290	0.8311	0.8306	0.8309
Image9	8	0.8785	0.8719	0.8722	0.8563	0.8564	0.8720	0.8722	0.8768
	10	0.9169	0.9145	0.9011	0.9043	0.9083	0.9155	0.9096	0.9073
	12	0.9366	0.9326	0.9287	0.9352	0.9278	0.9362	0.9363	0.9270
	4	0.8599	0.8599	0.8512	0.8566	0.8495	0.8589	0.8580	0.8592
	6	0.9372	0.9365	0.9369	0.9279	0.9264	0.9315	0.9353	0.9347
	8	0.9600	0.9594	0.9589	0.9538	0.9521	0.9574	0.9577	0.9596
Image10	10	0.9737	0.9725	0.9726	0.9707	0.9651	0.9705	0.9726	0.9731
	12	0.9799	0.9798	0.9795	0.9756	0.9778	0.9785	0.9795	0.9799

Table 7. The SSIM values using Otsu's method in comparison with other algorithms

Images	K	OBLDA	DA	PSO	SCA	BA	HSO	ALO	SSA
Image1	4	0.7231	0.7231	0.7230	0.7203	0.7231	0.7223	0.7231	0.7231
	6	0.8052	0.8049	0.8044	0.8004	0.7948	0.7997	0.8044	0.8048
	8	0.8494	0.8463	0.8349	0.8474	0.8255	0.8416	0.8456	0.8445
	10	0.8795	0.8758	0.8664	0.8753	0.8769	0.8667	0.8778	0.8681
	12	0.8916	0.8912	0.8904	0.8854	0.8896	0.8898	0.8904	0.8708
Image2	4	0.6805	0.6775	0.6667	0.6606	0.6629	0.6627	0.6805	0.6655
	6	0.7857	0.7754	0.7753	0.7628	0.7673	0.7857	0.7768	0.7752
	8	0.8364	0.8354	0.8350	0.8319	0.8360	0.8354	0.8361	0.8360
	10	0.8798	0.8788	0.8785	0.8717	0.8578	0.8699	0.8785	0.8760
	12	0.9031	0.9004	0.8775	0.9005	0.8817	0.8979	0.9005	0.9006
Image3	4	0.6178	0.6178	0.6166	0.6034	0.6160	0.6162	0.6175	0.6150
	6	0.7302	0.7288	0.7301	0.7299	0.7296	0.7225	0.7286	0.7287
	8	0.8011	0.8005	0.7959	0.8006	0.7829	0.7927	0.8010	0.8007
	10	0.8481	0.8469	0.8459	0.8400	0.8332	0.8326	0.8306	0.8415
	12	0.8914	0.8756	0.8718	0.8838	0.8768	0.8835	0.8882	0.8895
Image4	4	0.6450	0.6448	0.6450	0.6370	0.6441	0.6441	0.6450	0.6128
	6	0.7702	0.7700	0.7678	0.7577	0.7606	0.7680	0.7700	0.7384
	8	0.8384	0.8382	0.8246	0.8339	0.8321	0.8117	0.8373	0.8134
	10	0.8910	0.8901	0.8880	0.8901	0.8673	0.8644	0.8895	0.8908
	12	0.9066	0.9023	0.9016	0.9037	0.9024	0.9014	0.9006	0.9064
Image5	4	0.6757	0.6732	0.6757	0.6517	0.6473	0.6479	0.6757	0.6757
	6	0.7599	0.7573	0.7510	0.7591	0.7549	0.7539	0.7580	0.7579
	8	0.8385	0.8300	0.8177	0.8335	0.8055	0.8174	0.8310	0.8112
	10	0.8656	0.8536	0.8334	0.8536	0.8386	0.8419	0.8624	0.8631
	12	0.8792	0.8701	0.8705	0.8755	0.8725	0.8777	0.8736	0.8787
Image6	4	0.6881	0.6881	0.6852	0.6842	0.6815	0.6878	0.6881	0.6881
	6	0.8071	0.8069	0.8026	0.8070	0.7995	0.7955	0.8055	0.8058
	8	0.8836	0.8771	0.8759	0.8797	0.8736	0.8811	0.8757	0.8789
	10	0.9323	0.9226	0.9303	0.9316	0.9107	0.9238	0.9176	0.9205
	12	0.9480	0.9345	0.9466	0.9408	0.9365	0.9321	0.9472	0.9403
Image7	4	0.5780	0.5777	0.5777	0.5494	0.5776	0.5733	0.5777	0.5777
	6	0.6793	0.6743	0.6790	0.6580	0.6705	0.6503	0.6721	0.6793
	8	0.8269	0.8147	0.7477	0.8243	0.7511	0.7678	0.8208	0.8144
	10	0.8741	0.8678	0.8732	0.8717	0.8716	0.8705	0.8728	0.8524
	12	0.8923	0.8902	0.8900	0.8893	0.8912	0.8921	0.8920	0.8821
Image8	4	0.7703	0.7703	0.7700	0.7585	0.7675	0.7597	0.7701	0.7703
	6	0.8869	0.8861	0.8865	0.8788	0.8846	0.8852	0.8869	0.8867
	8	0.9268	0.9255	0.9212	0.9100	0.9095	0.9242	0.9226	0.9223
	10	0.9552	0.9540	0.9524	0.9402	0.9333	0.9471	0.9538	0.9540
	12	0.9668	0.9667	0.9578	0.9501	0.9540	0.9618	0.9647	0.9661
Image9	4	0.6270	0.6270	0.6270	0.6250	0.6263	0.6338	0.6270	0.6270
	6	0.7519	0.7489	0.7174	0.7499	0.7426	0.7407	0.7500	0.7500
	8	0.8181	0.8105	0.8027	0.8134	0.8157	0.8121	0.8136	0.8156
	10	0.8562	0.8554	0.8538	0.8561	0.8546	0.8529	0.8545	0.8545
	12	0.8819	0.8780	0.8748	0.8810	0.8706	0.8742	0.8806	0.8810
Image10	4	0.7306	0.7301	0.7290	0.7302	0.7301	0.7278	0.7306	0.7306
	6	0.8842	0.8840	0.8763	0.8348	0.8802	0.8804	0.8840	0.8842
	8	0.9398	0.9347	0.9330	0.9198	0.9262	0.9356	0.9367	0.9390
	10	0.9690	0.9678	0.9654	0.9514	0.9642	0.9684	0.9679	0.9669
	12	0.9809	0.9804	0.9757	0.9646	0.9665	0.9731	0.9805	0.9800

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Table 8. The SSIM values using Kapur's method in comparison with other algorithms

Images	K	OBLDA	DA	PSO	SCA	BA	HSO	ALO	SSA
Image1	4	0.6850	0.6847	0.6847	0.6840	0.6858	0.6836	0.6847	0.6847
	6	0.7821	0.7812	0.7802	0.7745	0.7705	0.7801	0.7816	0.7813
	8	0.8590	0.8573	0.8349	0.8590	0.8427	0.8474	0.8582	0.8525
	10	0.8931	0.8914	0.8702	0.8783	0.8834	0.8913	0.8923	0.8929
	12	0.9077	0.9059	0.9066	0.8932	0.9008	0.9075	0.9051	0.9070
Image2	4	0.6268	0.6268	0.6266	0.6162	0.6233	0.6250	0.6284	0.6283
	6	0.7722	0.7654	0.7656	0.7440	0.7680	0.7721	0.7657	0.7657
	8	0.8293	0.8212	0.8226	0.8241	0.8269	0.8289	0.8226	0.8204
	10	0.8654	0.8652	0.8661	0.8641	0.8645	0.8645	0.8650	0.8627
	12	0.9046	0.9013	0.9026	0.8978	0.8906	0.8998	0.9015	0.8996
Image3	4	0.5026	0.5026	0.5013	0.5008	0.5015	0.4963	0.5003	0.5020
	6	0.6699	0.6668	0.6607	0.6659	0.6643	0.6630	0.6696	0.6688
	8	0.8001	0.8000	0.7347	0.7972	0.7891	0.7917	0.7823	0.7897
	10	0.8650	0.8646	0.8560	0.8551	0.8522	0.8584	0.8635	0.8616
	12	0.8882	0.8868	0.8875	0.8725	0.8861	0.8858	0.8866	0.8880
Image4	4	0.5896	0.5894	0.5894	0.5852	0.5880	0.5806	0.5896	0.5896
	6	0.7336	0.7303	0.7330	0.7316	0.7279	0.7289	0.7284	0.7330
	8	0.8191	0.8107	0.8102	0.8142	0.7879	0.8189	0.8104	0.8118
	10	0.8838	0.8828	0.8827	0.8744	0.8798	0.8806	0.8836	0.8822
	12	0.8968	0.8905	0.8965	0.8963	0.8874	0.8906	0.8960	0.8926
Image5	4	0.6234	0.6032	0.6234	0.6042	0.6203	0.6062	0.6234	0.6031
	6	0.7480	0.7479	0.7159	0.7390	0.7271	0.7473	0.7188	0.7471
	8	0.8254	0.8135	0.8088	0.8240	0.8247	0.8247	0.8222	0.8233
	10	0.8575	0.8515	0.8485	0.8512	0.8428	0.8529	0.8443	0.8553
	12	0.8734	0.8698	0.8729	0.8708	0.8719	0.8710	0.8724	0.8728
Image6	4	0.7179	0.7181	0.7178	0.7174	0.7153	0.7173	0.7136	0.7151
	6	0.8248	0.8232	0.8226	0.8010	0.8154	0.8230	0.8238	0.8223
	8	0.8961	0.8922	0.8954	0.8692	0.8283	0.8814	0.8971	0.8943
	10	0.9233	0.9208	0.9139	0.8871	0.8946	0.9094	0.9213	0.9200
	12	0.9417	0.9405	0.9412	0.9141	0.9299	0.9393	0.9410	0.9412
Image7	4	0.5540	0.5540	0.5126	0.5528	0.5473	0.5436	0.5226	0.5489
	6	0.6658	0.6641	0.6657	0.6646	0.6603	0.6646	0.6657	0.6642
	8	0.8754	0.8743	0.8744	0.8702	0.8700	0.8709	0.8751	0.8595
	10	0.9059	0.9020	0.9012	0.9053	0.9057	0.9048	0.9054	0.8951
	12	0.9160	0.9153	0.9142	0.9159	0.9095	0.9132	0.9152	0.9157
Image8	4	0.7450	0.7445	0.7446	0.7251	0.7388	0.7441	0.7450	0.7450
	6	0.8407	0.8404	0.8406	0.8225	0.8330	0.8335	0.8401	0.8406
	8	0.9031	0.9024	0.9023	0.8854	0.8783	0.9029	0.9027	0.9004
	10	0.9286	0.9259	0.9278	0.9276	0.9217	0.9188	0.9283	0.9266
	12	0.9448	0.9442	0.9440	0.9374	0.9444	0.9302	0.9432	0.9429
Image9	4	0.5710	0.5710	0.5701	0.5697	0.5704	0.5709	0.5701	0.5692
	6	0.7185	0.7175	0.7145	0.7161	0.7093	0.7112	0.7175	0.7184
	8	0.8150	0.8098	0.8092	0.8108	0.8052	0.8057	0.7901	0.8045
	10	0.8663	0.8653	0.8465	0.8634	0.8652	0.8660	0.8620	0.8609
	12	0.9169	0.9165	0.9122	0.9083	0.9002	0.9167	0.9164	0.8996
Image10	4	0.8091	0.7891	0.7965	0.7959	0.7770	0.7902	0.7934	0.7905
	6	0.8977	0.8972	0.8950	0.8608	0.8873	0.8837	0.8979	0.8920
	8	0.9349	0.9323	0.9347	0.8904	0.9256	0.9276	0.9336	0.9329
	10	0.9557	0.9533	0.9531	0.9520	0.9500	0.9504	0.9533	0.9550
	12	0.9657	0.9655	0.9651	0.9603	0.9624	0.9638	0.9651	0.9650

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